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Lens NEWSLETTER

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LENS

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COVER: Irrigated lentil field in northern Sudan (photo credit: M. C. Saxena)

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Intervarietal Variation for Chromatin Content in Lentil

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Abstract

Detailed somatic karyotype analysis carried out on 15 varieties of lentil *(Lens culinaris* Medik.) revealed significant variation in total chromatin length (26.1 to 46.26 μ) and volume (19.28 to 46.05 μ^3). Secondary constrictions, located very near the centromere, were observed in only three varieties. Karyotypes were symmetric with a preponderance of metacentric chromosomes (4-5 pairs). Symmetry %, Formula % and Total Formula % also suggested the primitive nature of lentil karyotypes.

التباين في محتوى أصناف العدس من الكروماتين

الملخص

كشف التحليل الدقيق للنمط النووي الجسدي الذي أجري على 15 صنفاً من العدس (*Lens culinaris* Medik) عن تباين معنوي في مجمل طول الكروماتين (26.1 إلى 46.26µ) وحجمه (19.28 إلى 46.05 µ^3). ولوحظ وجود تضيقات ثانوية قريبة جداً من المركز الأقسومي في ثلاثة أصناف فقط. وكانت الأنماط النووية متناسبة مع زيادة أو تفوق عدد الصبغيات المركزية الوسيطة (4 – 5 أزواج). كما أوحت النسب المئوية للتناسب والصيغة والصيغة الكلية بالطبيعة البدائية للأنماط النووية للعدس.

Introduction

Lentil (*Lens culinaris* Medik.) is one of the major pulse crops of North India. Lentils, which have fairly big chromosomes, are suitable material for detailed cytogenetic study, but have received little attention in the past. The existing information on the karyotype of lentil is quite contradictory (Sindhu et al. 1983; Slinkard 1985) and substantial variations in total chromatin length, chromosome morphology and presence of SAT-chromosomes were reported by earlier workers in different varieties of lentil. The present study is an attempt to find out the extent of karyotypic variation in 15 cultivars of lentil.

Materials and Methods

Seeds of 15 varieties of lentil belonging to ssp. *microsperma* of *L. culinaris*, procured from the lentil germplasm collections maintained at Meerut University, Meerut, were utilized in the present study.

Young, healthy root tips of about 2-3 cm length were pretreated with p-dichlorobenzene for 3 hours at low temperatures (15-20°C), washed thoroughly and fixed in freshly prepared aceto-alcohol (1:3). The material was transferred to 70% alcohol after 24 hours of fixation. Fixed root tips were kept overnight in 2% acetocarmine and then squashed in 45% acetic acid. Photomicrographs were taken on a Nikon Optiphot microscope with HFX automatic micro-photographic attachments. Measurements of the chromosomes were made with the help of an Olympus micrometer. For chromosomal classification, Levan et al. (1964) was followed. Relative length, arm ratio, Symmetry (S) %, Formula (F) %, Total Formula (TF) % and chromatin volume were calculated using the following formulae:

Relative length = individual chromosome length/total chromatin length of the haploid complement

Arm ratio = length of long arm/length of short arm

Symmetry (S) % = (length of shortest chromosome/length of longest chromosome of the complement) × 100

Total Formula (TF) % = (total sum of short arm lengths/total chromatin length of the haploid complement) × 100

Chromatin volume = $\pi r^2 l$, where l = chromosome length and r = radius of chromatid at somatic metaphase.

Results and Discussion

The data on finer details of chromosome morphology as presented in Tables 1 and 2 revealed significant variation in chromatin content among the different cultivars of lentil. The total chromatin length varied from a minimum of 26.1 μ in var. P-102 to a maximum of 46.3 μ in var. P-38, while the chromatin volume ranged from 19.8 μ^3 (var. P-102) to as high as 46.1 μ^3 (var. P-38) (Table 2). Part of this variation in chromatin content may be due to artifacts, different levels of condensation and environmental influences on differential contraction of chromosomes (Lightly and Plansted 1960). However, a substantial portion of the variation in lengths must be real, as is evident from a comparison with the estimations of chromatin volume, and may be attributed to structural changes and loss or gain of heterochromatin segments.

Of the 15 varieties studied, only three varieties, namely P-38 (Fig. 1), K-75 (Fig. 9) and LL-104 (Fig. 12), carried one pair of chromosomes each with secondary constriction, located very near to the primary constriction, while in the rest, secondary constrictions could not be detected (Figs. 2-8, 10, 11, 13-15). Sindhu et al. (1984) attributed the absence of SAT-chromosomes in some of the varieties to difficulty in detecting them in every cell, as the secondary constriction in *Lens* species is usually present very near the centromere. On the other hand, Sinha and Acharia (1972) felt that total loss of SAT-region due to translocation and hybridization might have given rise to the varieties without SAT-chromosomes. In the present case, both possibilities are still plausible and more investigation is needed.

The chromosomes were mostly metacentric (4-5 pairs) (Tables 1 and 2), indicating the symmetric nature of karyotypes in all lentil varieties studied. The values for S% among the different lentil cultivars were high, ranging from 54.1 (P-262) to 76.6 (P-577). The estimates for TF% and F% also were high in all varieties. The S% and relative length give an idea about the variation in length of different chromosomes. Based on these values, var. P-262 may be regarded as advanced compared with other varieties in the study. However, the higher values for these two parameters in all varieties indicate the primitive nature of lentil karyotypes. The TF% gives an estimate of mean position of centromere in different chromosomes, while F% is another estimate of arm ratio. The high values for TF% (about 40, Table 2) and F% also indicate that the karyotypes in lentil are symmetrical. It may be concluded that *L. culinaris* has a primitive karyotype, with a preponderance of metacentric chromosomes.

Acknowledgements

Our sincere thanks are due to Prof P.K. Gupta, Head, Department of Agricultural Botany, Meerut University, Meerut, for encouragement and facilities. Mr Salimuddin is grateful to DAE, Bombay for the award of a Research Fellowship.

References

Levan, A., K. Fredga and A.A. Sandberg. 1964. Nomenclature for centrometric position on chromosome. *Hereditas* 52:201-220.

Lightly, R.W. and R.L. Plansted. 1960. The evaluation of the sources of variation in preparation of a karyotype of a clone. *Cytologia* 25:1-7.

Sindhu, J.S., A.E. Slinkard and G.J. Scoles. 1983. Studies on variation in *Lens*. 1. Karyotype. *LENS Newsletter* 10(1):14.

Sindhu, J.S., A.E. Slinkard and G.J. Scoles. 1984. Karyotype analysis of *Lens orientalis* (Boiss.) Handel - Maxetti. *Cytologia* 49:151-155.

Sinha, S.S.N. and S.S. Acharia. 1972. Karyotype analysis in some varieties of *Lens culinaris*. *Cytologia* 37:673-683.

Slinkard, A.E. 1985. Cytology and cytogenetics of lentils. *LENS Newsletter* 12(2):1-10.

Table 1. Data on absolute length (AL, μ), relative lengths (RL, %) and arm ratio (AR) of individual chromosomes in 15 varieties of lentil.

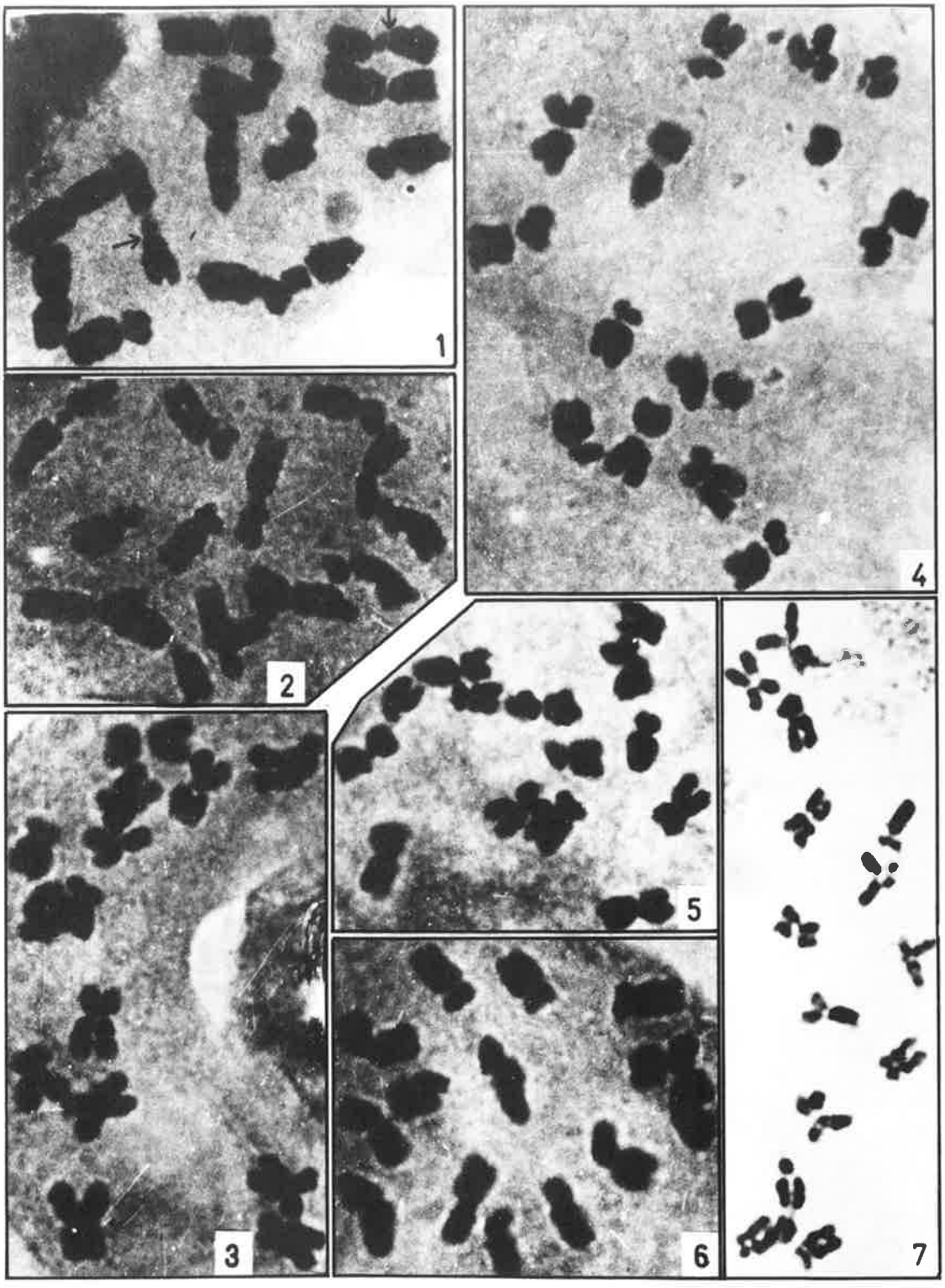
S no.	Variety		Chromosome number 1	2	3	4	5	6	7
1	P-38	AL	8.16	7.42	7.04‡	6.69	5.96	5.68	5.31
		RL	17.54	16.04	15.22	14.46	12.88	12.28	11.48
		AR	1.36m†	1.47 m	1.14 m	1.20 m	1.72 sm	2.36 sm	2.18 sm
2	K-75	AL	7.16	6.63	6.43	6.11‡	5.41	5.40	5.12
		RL	16.94	15.69	15.21	14.46	12.80	12.78	12.12
		AR	1.27 m	1.28 m	1.56 m	1.59 m	2.56 sm	1.05 sm	1.78 sm
3	LL-19	AL	6.98	6.93	6.15	5.58	5.10	4.89	4.56
		RL	17.37	17.24	13.30	13.88	12.69	12.17	11.35
		AR	1.48 m	1.11 m	2.64 sm	1.09 m	2.49 sm	1.89 sm	2.23 sm
4	LL-104	AL	5.99	5.58	5.09‡	4.75	4.46	4.22	3.97
		RL	17.59	16.38	14.94	13.95	13.09	12.39	11.66
		AR	1.51 m	1.32 m	1.46 m	1.37 m	1.97 sm	2.64 sm	1.74 sm
5	P-1278	AL	6.06	5.62	5.22	4.72	4.19	4.13	3.95
		RL	17.88	16.58	15.40	13.93	12.36	12.18	11.65
		AR	1.27 m	1.16 m	1.23 m	2.21 sm	1.67 m	1.77 sm	2.09 sm
6	L-1205	AL	5.65	5.47	4.95	4.56	4.07	4.03	3.64
		RL	17.46	16.90	15.29	14.09	12.58	12.45	11.25
		AR	1.03 m	1.51 m	1.83 sm	1.14 m	1.05 m	1.86 sm	1.96 sm
7	Sehore-34	AL	5.17	5.01	4.77	4.56	4.35	3.84	3.92
		RL	16.39	15.88	15.12	14.46	13.79	12.24	12.11
		AR	1.66 m	1.27 m	1.39 m	1.56 m	1.36 m	2.24 sm	1.79 sm
8	LL-89	AL	5.04	4.99	4.95	4.66	4.27	3.69	3.59
		RL	16.16	15.99	15.87	14.94	13.69	11.83	11.51
		AR	1.21 m	1.34 m	1.37 m	1.92 sm	1.09 sm	1.82 sm	2.09 sm
9	P-577	AL	5.0	4.75	4.61	4.32	4.27	4.12	3.83
		RL	16.18	15.37	14.92	13.98	13.82	13.33	12.39
		AR	1.58 m	1.08 m	1.11 m	1.70 sm	1.15 m	2.15 sm	1.92 sm
10	P-262	AL	6.07	5.19	4.37	3.98	3.88	3.79	3.25
		RL	19.72	17.03	14.34	13.06	12.72	12.44	10.67
		AR	1.29 m	2.18 sm	1.34 m	1.41 m	2.80 sm	2.54 sm	1.23 m
11	LL-1	AL	5.57	5.48	4.37	4.12	4.08	3.39	3.28
		RL	16.79	15.52	15.21	14.55	13.51	12.82	11.60
		AR	1.26 m	1.40 m	1.14 m	1.24 m	2.64 sm	1.92 sm	2.45 sm
12	LL-73	AL	4.85	4.48	4.39	4.20	3.90	3.71	3.35
		RL	16.69	15.52	15.21	14.55	13.51	12.82	11.60
		AR	1.64 m	1.15 m	1.24 m	2.21 sm	1.52 m	2.06 sm	2.07 sm
13	JL S-4	AL	4.68	4.39	4.00	3.88	3.73	3.45	3.21
		RL	17.12	16.06	14.63	14.19	13.64	12.62	11.74
		AR	1.48 m	1.26 m	1.94 sm	1.07 m	1.94 m	2.38 sm	1.87 sm
14	LL-408	AL	4.45	4.31	3.91	3.77	3.47	3.47	3.09
		RL	16.81	16.28	14.77	14.24	13.11	13.11	11.67
		AR	1.43 m	1.03 m	1.81 sm	1.61 m	1.94 sm	2.47 sm	1.51 m
15	P-102	AL	4.71	4.22	3.83	3.50	3.39	3.25	3.20
		RL	18.50	16.17	14.65	13.41	12.99	12.45	12.26
		AR	1.02 m	1.56 m	2.04 sm	1.40 m	1.12 m	1.58 m	2.90 sm

† m = metacentric; sm = submetacentric.
‡ Carries secondary constriction.

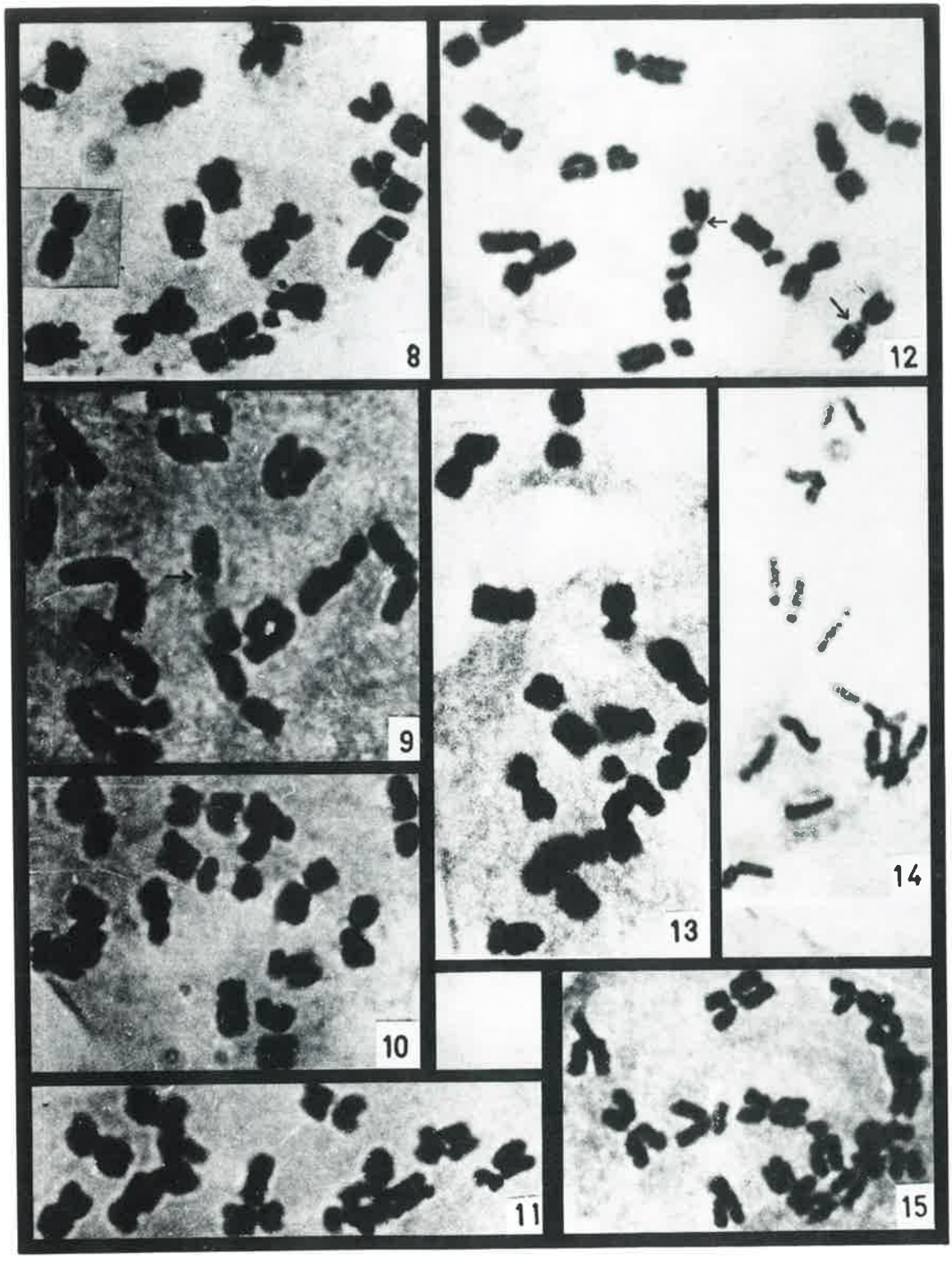
Table 2. Data on total chromatin length, chromatin volume, S%, TF% and karyotype formula of 15 varieties of lentil.

S no.	Variety	Total chromatin length (μ)	Total chromatin volume (μ^3)	S%	TF%	Karyotype formula†
1	P-38	46.3	46.1	65.1	39.7	$3A^{m} + 1_{sc}A^{m} + 3A^{sm}$
2	K-75	42.3	26.7	71.5	38.1	$3A^{m} + 1_{sc}A^{m} + 3A^{sm}$
3	LL-19	40.2	34.0	65.3	37.4	$3A^{m} + 2A^{sm} + 2B^{sm}$
4	LL-104	34.1	21.7	66.3	38.1	$2A^{m} + 1_{sc}A^{m} + 1B^{m} + 2B^{sm} + 1C^{sm}$
5	P-1278	33.9	25.3	65.2	39.6	$3A^{m} + 1B^{m} + 2B^{sm} + 1C^{sm}$
6	L-1205	32.4	25.3	64.4	41.6	$2A^{m} + 2B^{m} + 2B^{sm} + 1C^{sm}$
7	Sehore-34	31.5	23.9	73.9	39.1	$2A^{m} + 3B^{m} + 2C^{sm}$
8	LL-89	31.2	26.3	71.2	40.6	$1A^{m} + 3B^{m} + 1B^{sm} + 2C^{sm}$
9	P-577	30.9	25.3	76.6	40.8	$4B^{m} + 2B^{sm} + 1C^{sm}$
10	P-262	30.5	20.7	54.1	37.2	$1A^{m} + 1A^{sm} + 1B^{m} + 2C^{m} + 2C^{sm}$
11	LL-1	30.3	26.9	58.9	39.2	$2A^{m} + 2B^{m} + 1B^{sm} + 2C^{sm}$
12	LL-73	28.9	24.8	69.1	38.2	$3B^{m} + 1B^{sm} + 1C^{m} + 2C^{sm}$
13	JL S-4	27.3	22.4	68.6	39.1	$2B^{m} + 2C^{m} + 3C^{sm}$
14	LL-408	26.5	20.3	69.4	38.5	$2B^{m} + 2C^{m} + 3C^{sm}$
15	P-102	26.1	19.8	67.9	39.8	$2B^{m} + 3C^{m} + 2C^{sm}$

† m = metacentric; sm = submetacentric; sc = secondary constriction; A = >5.0 μ; B = 4.0 - 5.0 μ; C = <4.0 μ.



Figs. 1-7. Mitotic metaphase in lentil varieties (X 2850): (1) P-38, arrows indicate chromosomes with secondary constriction, (2) LL-19, (3) LL-73, (4) LL-89, (5) LL-408, (6) P-1278, (7) JLS-4.



Figs. 8-15. Mitotic metaphase in lentil varieties (X 2850): (8) LL-1, (9) K-75, arrows indicate chromosomes with secondary constriction, (10) P-577, (11) P-102, (12) LL-104, arrows indicate secondary constriction, (13) L-1205, (14) P-262, (15) Sehore-34.

Effect of Different Mutagens on M_1 Parameters in Lentil

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Abstract

The immediate effect of mutagenesis was studied in a large-seeded cultivar of lentil, Precoz Selection. Significant biological damage caused by different mutagenic treatments was measured by M_1 parameters. Among the mutagens used, N-nitroso-N-ethyl urea (NEU) was found most effective in causing reduction in different M_1 parameters, followed by ethylene imine (EI) and gamma rays. Similarly, the highest dose of all the mutagens caused maximum reduction in M_1 parameters in the order: NEU (0.02%) > EI (0.02%) > gamma rays (20 kR).

تأثير مطفرات مختلفة على معايير الجيل الأول في العدس

الملخص

تمت دراسة التأثير المباشر للتطفير في صنف العدس كبير الحبة المنتخب بريكوز. وقيس الضرر البيولوجي الكبير الذي سببته معاملات التطفير المختلفة بواسطة معايير الجيل الأول. ومن بين المطفرات المستخدمة، تبين أن ن- نيتروزو-ن -إتيل اليوريا (NEU) أكثرها فعاليةً في تخفيض معايير الجيل الأول المختلفة وتبعه إتلين إمين (EI) ثم أشعة غاما. وعلى نحو مشابه، سببت أعلى جرعة من جميع المطفرات تخفيضاً أعظمياً في معايير الجيل الأول حسب الترتيب التالي :

NEU (0.02%) > EI (0.02%) > أشعة غاما (20KR).

Introduction

A perusal of M_1 generation parameters is important for several reasons. Apart from being useful in comparing the effectiveness and efficiency of mutagens, it can be used to distinguish plants into different classes on the basis of genetic damage. It helps in identifying plants with maximum genetic damage that are likely to carry micromutations in M_2 and M_3 generations with higher frequency. This can help in increasing the efficiency of mutagenesis for polygenic traits because a larger proportion of the nonmutated or poorly mutated plants can be rejected even in the M_1 generation. If this assumption is confirmed experimentally, one can treat comparatively larger quantities of seed and select a sufficient population carrying a larger concentration of genetic damage in M_1 itself. Reduction in the volume of experimental material in this manner also will provide ample opportunity for concentrated efforts and attention on the material harboring maximum induced genetic variability, which should enable rapid progress.

In this study, the immediate effects of mutagenic treatments were measured on the basis of germination, leaf-aberrations (a-sectors), plant survival at maturity and seed fertility in the treated M_1 generation in comparison with untreated (control) populations.

Materials and Methods

Seed lots of dry and well-filled seeds (500, 1000 and 1500) of uniform size of a *macrosperma* lentil (cv. Precoz Selection) were treated with one of the following treatments: 5, 10 or 20 kR of gamma rays, and three doses (0.005, 0.01 and 0.02%) each of ethylene imine (EI) and N-nitroso-N-ethyl urea (NEU). The treated seeds along with a control were sown immediately in the field to raise the M_1 generation in 4-m long rows with 30 × 5 cm spacing. Recommended optimum agronomic and cultural practices were followed. The emergence of a coleoptile at the soil surface was taken as an indication of germination. The number of seeds germinated was recorded 20–25 days after sowing to determine germination percentage. The survival percentage was calculated as the proportion of plants surviving until maturity out of the total number of seedlings germinated. The plants surviving in different treatments, including control, were harvested and threshed individually, and their seeds counted. The number of seeds/plant in different treatments were estimated by dividing the total number of seeds by the total number of plants in a

particular treatment. Finally, relative plant fertility was computed by dividing the number of seeds/plant in a particular treatment by that of the control multiplied by 100. All material in each treatment was classified into two groups on the basis of fertility, henceforth called high and low damage groups. Observations on leaf aberrations, or a-sectors, were recorded from germination to the 4- to 5-leaf stage of the plant. As with plant fertility, all material in each treatment was classified into two groups on the basis of a-sector intensity, i.e., high and low seedling damage. Classification of material into high and low damage groups on the basis of plant fertility and leaf aberrations would help in better identification of mutated plants in the M_2 generation.

Results and Discussion

Germination

In general, the mutagenic treatments caused considerable reductions in germination percentage compared with the control (Table 1, Fig. 1a). Similar results have been reported in leguminous species: lentil (Sharma and Sharma 1983; Sarker and Sharma 1989), peas (Selim et al. 1974; Mohan 1983; Singh 1988) and others (Bala Ravi 1982). Dose-dependent reduction in germination recorded in the present study is also in agreement with the findings of several previous workers (Mohan 1983; Sarker and Sharma 1989; Singh 1988). Among the mutagens used, NEU caused the most drastic effects. It is well established that NEU is a very strong mutagen, which acts through alkylation and nitrosilation. Among the chemicals, nitroso compounds were shown to have a more drastic effect on germination in earlier studies (Rapoport 1966; Mohan 1983; Singh 1988; Sarker and Sharma 1989).

Plant survival

As with germination, all three mutagens drastically reduced plant survival (Table 1, Fig. 1b). Wellensiek (1965) also found positive correlations between germination, survival and fertility, all of which decreased after treatment with X-rays, gamma rays and ethyl methane sulphonate (EMS) in peas. Several other workers have supported the contention that mutagens reduce plant survival (Selim et al. 1974; Mohan 1983; Dixit and Dubey 1986; Singh 1988; Sarker and Sharma 1989). Among the mutagens tested, NEU had the maximum effect on plant survival. Similar observations were reported in peas (Mohan 1983; Singh 1988) and lentil (Dixit and Dubey 1986; Sarker and Sharma 1989). Dose-dependent reduction in plant survival was observed with all three mutagens, which is in agreement with the results of Bhadra (1982), Mohan (1983), Sharma and Sharma (1983) and Singh (1988).

Table 1. Effect of mutagens on germination, plant survival and seed fertility in M_1 generation.

Treatment	Relative %		
	Germination	Plant survival	Seed fertility
Control	100.0	100.0	100.0
Gamma rays (kR)			
5	91.1	82.2	76.5
10	85.5	74.6	72.6
20	79.1	58.2	65.2
EI (%)			
0.005	87.0	76.2	74.0
0.01	77.0	61.8	70.5
0.02	68.9	47.2	64.7
NEU (%)			
0.005	83.1	73.2	72.3
0.01	73.3	55.6	68.9
0.02	65.3	44.0	62.6

Seed fertility

High sterility was caused by the mutagenic treatments, which increased with increasing doses of all three mutagens (Table 1). Sarker and Sharma (1989) reported similar results following treatment with gamma rays, NEU, EMS and sodium azide (SA) in lentil. Dixit and Dubey (1986) also recorded similar observations after treatment with gamma rays and NMU in lentil. Many such examples are available in other pulses: peas (Mohan 1983; Singh 1988), *Phaseolus vulgaris* (Hussein and Disouki 1976), blackgram (Bhadra 1982) and *Lathyrus* (Nerkar 1970). Among the mutagens used, NEU reduced seed fertility most drastically, followed by EI and gamma rays. This was expected, as the nitroso compounds are known to cause high sterility in M_1 (Rapoport 1966; Mohan 1983; Singh 1988). However, Sarker and Sharma (1989) observed maximum reduction in fertility following gamma-irradiation than with the chemicals. One of the possible reasons for this discrepancy could be different dose ranges and the materials used in different studies.

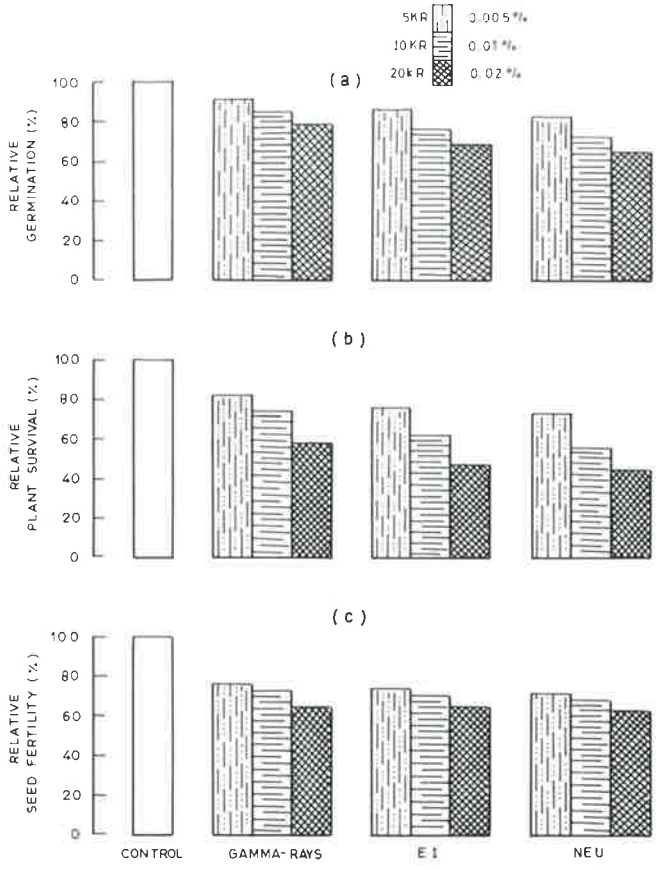

Fig. 1. Effect of mutagens on germination: (a) plant survival, (b) seed fertility, in M_1 generation.

In general, mutagenic treatments were quite effective in influencing all the three parameters selected for assessing biological damage in the M_1 generation.

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References

Bala Ravi, S. 1982. Mutational improvement of pigeonpea (*Cajanus cajan* L.) for plant architecture and grain yield. Pages 29-38 *in* Induced Mutations for Improvement of Grain Legume Production. II. IAEA-TECDOC 260.

Bhadra, S.K. 1982. Studies on the genetic improvement of black gram (*Vigna mungo* L.) through induced mutations. Ph.D. Thesis, IARI, New Delhi.

Dixit, P. and D.K. Dubey. 1986. Chloromutations and seedling morphology mutations induced by separate and simultaneous applications of gamma rays and N-nitroso-N-methyl urea in lentil. *LENS Newsletter* 13(1):5–8.

Hussein, H.A.S. and I.A.M. Disouki. 1976. Mutation breeding experiments in *Phaseolus vulgaris* L. 1. EMS and gamma rays induced seed coat color mutants. *Zeitschrift fuer Pflanzenzuechtung* 76:190–199.

Mohan, D. 1983. Combined effect of hybridization and mutagenesis on increasing genetic variability in peas. Ph.D. Thesis, IARI, New Delhi.

Nerkar, Y.S. 1970. Studies on the induction of mutations in *Lathyrus sativus* with special reference to the elimination of the neurotoxin principle. Ph.D. Thesis, IARI, New Delhi.

Rapoport, E.A. 1966. Supermutagens: Peculiarities and mechanism of action of supermutagens. Publ. House, Nauka, Moscow, USSR:9–23.

Sarker, A. and B. Sharma. 1989. Effect of mutagenesis on M_1 parameters in lentil. *LENS Newsletter* 16(2):8–10.

Selim, A.R., H.A.S. Hussein and I.I.S. Shawaf. 1974. EMS and gamma rays induced mutations in *Pisum sativum* L. II. Effects of EMS and gamma rays on M_1 germination, seedling height and fertility. *Egyptian Journal of Genetics and Cytology* 3:172–192.

Sharma, S.K. and B. Sharma. 1983. Mutagenic sensitivity and mutability in lentil. Abstr. XV International Congress of Genetics, Delhi, 5:330.

Singh, N.P. 1988. Mutation studies with early generation selection for polygenic variability in peas (*Pisum sativum* L.). Ph.D. Thesis, IARI, New Delhi.

Wellensiek, S.J. 1965. Comparison of the effect of EMS, gamma rays, neutrons, and x-rays on pea. *Radiation Botany* (Suppl.) 5:227–235.

Sapna (LH 84-8): a Lentil Cultivar for the Northwest Plain Zone of India

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Abstract

Key traits of a new large-seeded and high-yielding cultivar, LH 84-8 (Sapna) released for the North West Plain Zone (NWPZ) of India, are described. In multilocation trials in Haryana State, it gave an average seed yield of 1776.8 kg/ha compared with 1560 and 1436 kg/ha for L 9-12 and L 4076 with yield advantages of 14.0 and 24.0%, respectively. Similarly, in coordinated varietal trials in the NWPZ, its average seed yield was 1522 kg/ha compared with 1196 kg/ha for L 4076 with a yield advantage of 27.3%. In farmers' fields, it yielded on average 1260 kg/ha compared with 1067 kg/ha for L 9-12, giving a yield advantage of 18.1%.

سابنا (LH 84-8) : صنف من العدس يلائم المنطقة السهلية الشمالية الغربية من الهند

الملخص

ترد هنا الصفات الرئيسية للصنف الجديد LH 84-8 (سابنا) الكبير الحبة والعالي الغلة الذي اعتمد للمنطقة السهلية الشمالية الغربية من الهند. ولقد أعطى، في التجارب المتعددة المواقع في ولاية هريانا، متوسط غلة حبية بلغت 1776 كغ/هـ بالمقارنة مع 1560 و 1436 كغ/هـ للصنفين L 9-12 و L 4076 متفوقاً في الغلة عليهما بنسبة 14.0 و 24.0٪ على التوالي. وعلى نحوٍ مماثل، كان متوسط غلته الحبية في تجارب الأصناف المنسقة التي جرت في NWPZ 1522 كغ/هـ مقارنة مع 1196 كغ/هـ للصنف L 4076 بتفوق في الغلة نسبته 27٪. وفي حقول المزارعين أعطى متوسط غلة مقداره 1260 كغ/هـ مقارنةً مع 1067 كغ/هـ للصنف L 9-12 بتفوق في الغلة نسبته 18.1٪.

Introduction

Among the pulse crops, lentil has a history as old as the history of agriculture itself. Its cultivation started in the earliest Neolithic farming village of the Near East between 7000 and 8000 B.C. (Cubero 1981). It is now one of the important winter pulses in the Indian subcontinent, and is used as *dal* by a majority of the people. Among the pulses, lentil ranked fifth in production in India in 1987, occupying 1.07 million ha with production of 666,000 t and an average yield of 620 kg/ha (Anonymous 1989). Despite the obvious importance of lentil among pulses, little attention has been given in the past to improving its yield potential. The low yield of existing varieties and poor farm practices are the main reasons for the low production level of lentil. Thus, a cultivar of lentil, LH 84-8 (named Sapna), was developed at HAU, Hisar and released for cultivation in the North West Plain Zone (NWPZ) of the country.

LH 84-8 is a large-seeded cultivar for Indian conditions with an average seed size of 2.68 g/100 seeds. Its seed coat color is grayish with small black dots and the cotyledon color is red. It originated from a cross between large- and small-seeded Indian lentils: L 9-12 × JL S-2.

LH 84-8 flowers earlier and is comparatively taller than L 4076, which was the large-seeded check (Table 1). It has a higher number of primary branches and pods/plant than L 4076. The test weights of LH 84-8 and L 4076 are almost comparable, and they have an equal number of seeds/pod (1.6). The crude protein contents of LH 84-8 and L 4076 are 28.0 and 26.3%, respectively. LH 84-8 has a comparatively lower amount of total sugars, phenols, methionine and ether extract, but has a higher tryptophan content than L 4076.

Ten yield trials were conducted at two locations—HAU, Hisar and Rice Research Station, Kaul—for seven consecutive years from 1984/85 to 1990/91, using LH 84-8 and two checks, large-seeded L 4076 and L 9-12. LH 84-8 outyielded L 9-12 and L 4076 by 13.9 and 23.8%, respectively (Table 2).

Similarly, the seed yield of LH 84-8 was compared with that of the latest recommended, identified and qualifying cultivars of lentil in coordinated varietal trials (CVTs) in the NWPZ of India from 1986/87 to 1989/90. LH 84-8 was far superior to all of them. LH 84-8 had an average seed yield of 1522.1 kg/ha compared with 1195.7 kg/ha for L 4076, giving a yield advantage of 27.3% (Table 3).

Table 1. Description of key traits of LH 84-8 (Sapna), L 9-12 (local) and L 4076 (check for NWPZ) lentils.

Trait	LH 84-8	L 9-12	L 4076
Time to flower (days)	77	70	81
Time to maturity (days)	140	130	139
Plant height (cm)	53.6	55.0	50.4
Primary branches/plant	3.3	5.4	2.6
Pods/plant	68	64	58
Seeds/pod	1.6	1.8	1.6
100-seed wt. (g)	2.68	1.7	2.71
Crude protein (%)	28.0	25.5	26.3
Total sugars (%)	5.7	5.6	6.1
Starch (%)	40.1	43.8	38.4
Phenols (%) (tannic acid equivalents)	0.39	0.42	0.40
Methionine (g/100 g protein)	0.82	0.90	0.87
Tryptophan (g/100 g protein)	0.93	0.90	0.91
Ether extract (%)	0.87	1.12	1.10

Table 2. Seed yield (kg/ha) of LH 84-8, L 9-12 and L 4076 lentil cultivars in Haryana from 1984/85 to 1990/91.

		Cultivar		
Season	Location	LH 84-8	L 9-12	L 4076
1984/85	Hisar	2611.0	2378.0	—
1985/86	Hisar	1925.0	958.0	—
1986/87	Hisar	959.0	1341.0	—
1987/88	Hisar	1455.0	1721.0	—
1987/88	Kaul	1247.0	1130.0	—
1988/89	Kaul	1139.0	1167.0	1028.0
1989/90	Hisar	2648.0	2096.0	1792.0
1989/90	Kaul	2319.0	1824.0	1940.0
1990/91	Hisar	1650.0	1567.0	1061.0
1990/91	Kaul	1815.0	1420.0	1357.0
Mean		1776.8	1560.2	1435.6
% advantage of LH 84-8		—	13.9	23.8

The results of field demonstrations conducted by different Krishi Gyan Kendras (extension stations of the University) and individual farmers during *rabi* (winter season), 1990/91, also were very encouraging. Twenty-three trials were conducted in farmers' fields in five districts of the state, where the average seed yield of LH 84-8 was 1259.6 kg/ha compared with 1066.6 kg/ha for L9-12, giving a yield advantage of 18.1% (Table 4).

Table 3. Seed yield (kg/ha) of the latest recommended, identified and qualifying cultivars† of lentil in NWPZ of India from 1986/87 to 1989/90.

Cultivar	Locations over years	Weighted zonal mean	% advantage of LH 84-8
LH 84-8	15	1522.1	—
LH 82-6	18	1345.0	13.2
L 4125	20	1233.2	23.4
K 303	15	1157.4	31.5
L 4076 (ch.)	20	1195.7	27.3
JL-1 (ch.)	6	809.0	88.1

† Qualifying cultivars are those which have obtained the first five ranks on the basis of weighted mean yield of the last 3 years in coordinated varietal trials in the zone.

Table 4. Results of field demonstrations conducted by Krishi Gyan Kendras and individual farmers during *rabi*, 1990/91.

District of Haryana	No. trials	Average yield (kg/ha)	
		LH 84-8	L 9-12
Hisar	1	1500.0	1200.0
Jind	3	1040.0	926.7
Rohtak	6	702.5	613.3
Sonepat	9	1537.8	1352.8
Kaithal	4	1517.5	1240.0
Mean		1259.6	1066.6
% advantage		18.1	

References

Anonymous. 1989. Top twenty lentil producing countries with their annual area and production ranked on 1987 production. *LENS Newsletter* 16(1):46.

Cubero, J.I. 1981. Origin, taxonomy, and domestication of lentils. CAB/ICARDA, Syria.

Comparative Radiosensitivity and Radiation Stimulation in Diploid and Autotetraploid Lentil

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Abstract

Seeds of diploid and artificially induced tetraploid of lentil (*Lens culinaris*) (C8) were exposed to gamma rays at 10, 20, 30 and 50 kR and sown under uniform agroclimatic conditions. All parameters, including germination and survival, were investigated to compare the radiosensitivity of 2× and 4× and also the stimulation imparted by the treatment to these plants. The tetraploids were found to be radio-resistant at doses of 50 kR in germination and 30 kR in survival. Additionally, tremendous radiation stimulus was displayed by 4× for certain parameters.

مقارنة الحساسية الإشعاعية والتنشيط الإشعاعي في عدس ثنائي التضاعف وعدس رباعي التضاعف

الملخص

عُرِضت بذور عدس (*Lens culinaris*) (C 8) ثنائية التضاعف وأخرى رباعية التضاعف مستحدثة اصطناعياً، ومزروعة تحت شروط مناخية زراعية متشابهة، لأشعة غاما عند10، 20، 30، 50 KR. درست جميع المعايير بما فيها الإنبات والمحافظة على البقاء لمقارنة الحساسية الإشعاعية لـ 2x و 4x والتنشيط الإشعاعي المكتسب الناجم عن معاملة هذه النباتات. وقد وجد أن البذور رباعية التضاعف مقاومة للإشعاع عند جرعة 50 KR في الإنبات وجرعة 30 KR في المحافظة على البقاء. وبالإضافة إلى ذلك، ظهر تنشيط إشعاعي ضخم بواسطة 4x بالنسبة لبعض المعايير المحددة.

Introduction

Although the comparative radiosensitivity of diploids and polyploids has been studied by a number of workers, the controversy still continues. Sparrow et al. (1956), Sparrow (1965) and Ichikawa and Sparrow (1967) reported diploids to be comparatively more sensitive. In *Saccharomyces cerevisae* polyploids proved to be radiosensitive (Motimer 1958). On the other hand, in wheat the radiosensitivity was found to be independent of the level of ploidy (Swaminathan and Natrajan 1957; Fujii and Matsumura 1958; Bhaskaran and Swaminathan 1960; Matsumura and Nezu 1961). On exposure to gamma rays and thermal neutrons, Gopal Ayengar et al. (1970) found autoploids of *Chorchorus* to be radiosensitive. Joshua et al. (1972) reported similar results when they exposed 2× and 4× of this species to fast neutrons and thermal neutrons.

During the course of a literature survey on comparative radiosensitivity of diploids and autotetraploids, we found that the different workers have used allopolyploids or naturally occurring autoploids for studying the effect of ploidy on radiosensitivity. Investigations in our laboratory have clearly indicated that even different varieties of the same species having the same chromosome number may show marked differences in radiosensitivity (Raghuvanshi and Singh 1979). It is apparent that under such circumstances use of allopolyploid material may make it difficult to distinguish genomal effect from that of ploidy. Taking this point into consideration, it is proposed that for studying comparative radiosensitivity of 2× and 4×, only the use of autopolyploids is recommended. During the course of investigations, autoploids in *Phlox drummondii*, *Tabernaemontana divaricata*, *Trigonella foenum-graecum*, *Melilotus alba* and *Lens culinaris* have been produced in our laboratory.

The present paper deals with our investigations on comparative radiosensitivity of diploid and artificially induced tetraploid of *Lens culinaris*. According to Mackey (1959) use of polyploids in mutation breeding programs has advantages over diploid because, owing to genomal multiplication, the polyploids can withstand chromosomal losses better than diploids. It may be observed that mutation breeding is of special interest in polyploids, since they generally exert a higher frequency of viable mutations than comparable diploids (Mackey 1959; Swaminathan 1964). Mutations in polyploids are recovered in M_3 and subsequent generations. This procedure may be more successful in allopolyploids than autoploids because in the latter a comparatively larger plant population has

to be grown to select useful mutations. This approach has successfully been tried in autoploids of *Brassica campestris* (Swaminathan 1964).

It may be mentioned that studying radiosensitivity with special reference to the level of ploidy is of applied significance in both plants and animals. A large population of domestic plants are polyploid, and polyploid condition is closely linked with malignant and pathological condition in animals.

Lens culinaris under investigation is one of the main pulse crops in India. So, results obtained in this investigation will be helpful in planning experiments to develop high-yielding bold-seeded mutants in 4× *Lens*. These autotetraploids were raised in our laboratory through shoot-tip treatment of seedlings in 1982. Stabilized 4× C8 seeds were used for the present study.

Materials and Methods

Dry seeds of diploids and autotetraploid (C8) of *L. culinaris* having 9% moisture content were exposed to gamma rays at 10, 20, 30 and 50 kR (dose rate = 14 sec/kR; temperature: dry 16°C, wet 14°C) at National Botanical Research Institute, Lucknow. The seeds after irradiation were sown under uniform agroclimatic conditions along with a control. Various parameters investigated were germination, survival, growth reduction, time of flowering, pollen fertility, seed setting, duration of flowering and fruit-flower ratio.

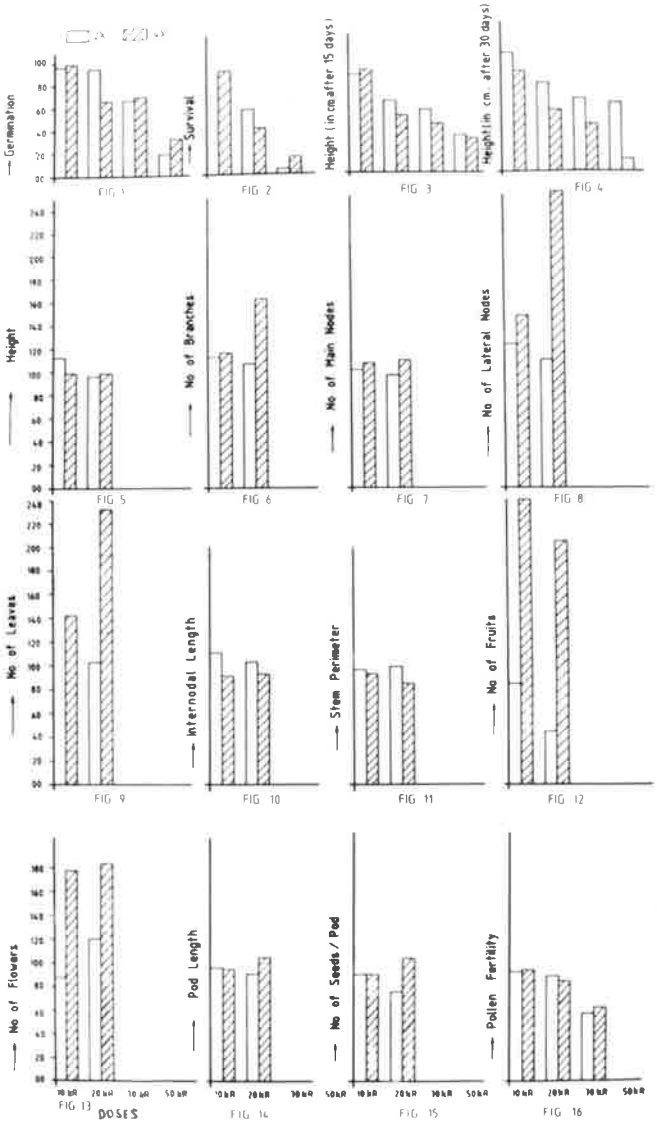
Results

Although germination took place at all doses, the percentage showed a direct correlation with dose (Fig. 1). At 50 kR there was no survival. Very few plants at 30 kR survived for some time, so the studies are based on data of control, 10 kR and 20 kR only.

Germination of 4× is slightly better than 2× at 10 kR and 30 kR (Fig. 1) but distinctly better at 50 kR. However, at 20 kR, 2× showed better germination. Survival is similar at 10 kR; at 20 kR, 2× is better; but at 30 kR 4× is distinctly resistant (Fig. 2).

In height, after 15 and 30 days, 2× is resistant (Figs. 3, 4). At maturity at 10 kR 2× is better, but at 20 kR 4× shows slightly greater resistance (Fig. 5). In internodal length at 10 and 20 kR and in stem perimeter, 2× is more resistant.

For the parameters number of branches, number of main nodes, number of lateral nodes, number of leaves, number of fruits and number of flowers, 4× is resistant (Figs. 6–9, 12, 13). In pod length and number of seeds/pod better resistance of 4× is evident at 20 kR, while at 10 kR, 2× and 4× are similar (Figs. 14, 15). However, very marked resistance of 4× is clearly displayed by the number of lateral nodes at 20 kR, number of leaves at 20 kR, number of fruits at 10 and 20 kR and number of flowers at 10 and 20 kR (Figs. 8, 9, 12, 13). In pollen fertility, 2× and 4× behave more or less similarly at 10 and 20 kR, but at 30 kR, 4× is slightly more resistant (Fig. 16).



Figs. 1-16. Effects of gamma irradiation on diploid and tetraploid *Lens* (all values are in percentage of control).

Stimulation

There was only slight stimulation in height in 2× at 10 kR. In number of branches, there was stimulation in both, but 4× at 20 kR gave marked stimulus of 160%. There was slight stimulus in the number of main nodes of 4× at 20 kR. In the number of lateral nodes there was some stimulus (120%) in 2× at 10 kR but in 4× distinct stimulus (145%) at 10 kR and extremely marked stimulus (250%) at 20 kR was noted. In 2× number of leaves showed some stimulus (118%) at 10 kR. In 4× some stimulus occurred at 10 kR (148%), but tremendous stimulus (230%) was noted at 20 kR. Internodal length displayed some stimulus at 10 kR (110%) (Fig. 10). In number of fruits, while 2× showed marked reduction in both doses, 4× showed tremendous stimulation of 240% at 10 kR and 210% at 20 kR. In number of flowers only slight stimulation in 2× at 20 kR was observed; however, in 4× there was almost uniformly marked stimulus of 178 and 182% at 10 and 20 kR, respectively. Number of seeds per pod showed only slight stimulus in 4×.

Discussion

During the course of irradiation investigation in our laboratory, it has been noted that the relationship between germination and survival in different species may show differences and these could be classified into two categories. In the first group, percentage of germination and survival is the same, i.e., all the seeds that germinate also survive. Examples are *Impatiens balsamina* (Raghuvanshi and Singh 1979) and *Phaseolus aureus* (Pathak 1976). The lethal radiation effects manifest themselves at the time of germination. In the second group exemplified by *T. foenum-graecum* and *P. drumondii*, the germination is not severely affected by radiation. However, after germination, the seedlings die, showing relationships with dose. It appears that in this category there are again two types: (1) in which there is no growth of shoot system beyond the two-cotyledonary stage but the root system does show some growth, e.g., *T. foenum-graecum*; and (2) in which the root system shows some growth but death manifests itself beginning with the root system, e.g., *P. drumondii*.

In 2× and 4× *L. culinaris* the germination was reduced with increase in dose but at higher doses of 30 kR, 4× was slightly more resistant. At 50 kR 4× was distinctly more resistant than 2×.

An inverse relationship between dose and germination has been reported by Gustaffson (1944), Sparrow and Gunkal (1950), Fujii and Matsumura (1958), Matsumura and Nezu (1961), Saric et al. (1961) and Bremer-Reinders (1962). However, Fujii and Matsumura (1958) using ^{60}Co, reported that seeds of certain genera (*Triticum vulgare*, *Zea mays*, *Fagopyrum sagittatum*) showed increased percentage of germination at all doses, although there was death of seedlings at higher doses.

The survival in this case showed an inverse correlation with dose. It is interesting that the trend regarding comparative resistance noted in the germination percentage is also maintained in the survival percentage, i.e., better germination in the present case appears to ensure better survival. Stimulatory effects of radiation have been reported on growth in *Trifolium* (Jones and Plummer 1960) and germination in 4× *P. drumondii* (Pathak 1976), 4× *T. foenum-graecum* (Raghuvanshi and Singh 1980) and *Solanum melongena*. However, such marked stimulatory effects as observed in 4× with regard to number of parameters are remarkable and comparatively rare. Indeed the stimulatory effect on number of fruits in 4× is exceptionally remarkable.

Polyploids have generally been considered to be more resistant than diploids, but there are exceptions like *Petunia* and *Tagetes* where there is no difference in radiosensitivity in diploids and polyploids. Generally it has been accepted that genetic reduplication and redundancy in polyploid plants are the main factors that make polyploids more radio-resistant than diploids. However, reduced chromosome volume of polyploids could also play a significant role in their radio resistance.

In the present case tetraploids are resistant at higher doses of 50 kR in germination and 30 kR in survival. The most interesting point of this investigation was the tremendous radiation stimulation displayed by 4× for certain parameters.

References

Bhaskaran, S. and M.S. Swaminathan. 1960. Polyploidy and radiosensitivity in wheat and barley I. Cytological and cytochemical studies Part I. *Genetics* 32:1-32.

Bremer-Reinders. 1962. Mutation research in Canary grass. *Euphytica* 11:293–310.

Fujii, T. and S. Matsumura. 1958. Radiosensitivity in cereals. Proc. II. Atomic Energy Symposium, Tokyo, 185-89.

Gopal Ayengar, A.R., N.S. Rao, B.Y. Bhatt, K.B. Mistry, D.C. Joshua and R.C. Thakre. 1970. Studies on effect of neutron radiation on seeds. Final Report of IAEA Research Contract No. 497.

Gustaffson, A. 1944. The X-ray resistance of dormant seeds in agricultural plants. *Hereditas* 30:165-178.

Ichikawa, S. and A.H. Sparrow. 1967. Radiation induced loss of reproductive integrity in the stamen hair of *Tradescantia blossfeldrin* Mildhr, a twelve-ploid species. *Radiation Botany* 7:333-345.

Jones, I. and G.L. Plummer. 1960. Aspects of growth of some species of *Trifolium* following gamma irradiations. *Agronomy Journal* 62:462-464.

Joshua, D.C., P.G. Thakare and N.S. Rao. 1972. Radiosensitivity in jute. *Indian Journal of Genetics and Plant Breeding* 32:340-348.

Mackey, J. 1959. Mutagenic response of *Triticum* at different levels of ploidy. Pages 88-111 *in* Proceedings of 1st International Wheat Genetics Symposium, Canada.

Matsumura, S. and M. Nezu. 1961. Relation between polyploidy and effects of neutron radiation on wheat. Pages 543-552 *in* Effects of Ionizing Radiation on Seed. IAEA, Vienna, Austria.

Motimer, R.K. 1958. Radiobiological and genetic studies on a polyploid series (haploid and hexaploid) of *Saccharomyces cerevisiae*. *Radiation Research* 9:312-326.

Pathak, C.S. 1976. Cytogenetical studies of some economically useful plants with special reference to induction of polyploids and mutations. Ph.D. Thesis, Lucknow University, India.

Raghuvanshi, S.S. and D.N. Singh. 1979. Comparative radiosensitivity of five varieties of *Impatiens balsamina*. *Cytologia* 44:111-121.

Raghuvanshi, S.S. and A.K. Singh. 1980. Genotype dependent radiosensitivity of autoploids in *Trigonella foenum-graecum* L. *Theoretical and Applied Genetics* 58:237-239.

Saric, M., I. Cuzic and Hadzijev. 1961. Effect of gamma irradiation of some varieties of wheat seed on the morphological characteristics of the seedlings. Pages 503-518 *in* Proceedings of the Symposium on the Effect of Ionizing Radiations on Seed. IAEA, Vienna, Austria.

Sparrow, A.H. 1965. Relationship between chromosome volume and radiation sensitivity in plant cells. Pages 199-218 *in* Cellular Radiation Biology. William and Wilking, Baltimore, MD, USA.

Sparrow, A.H. and J.E. Gunkal. 1950. The effect on plants with chronic exposure to gamma radiation from radiocobalt. *In* Proceedings of International Conference on Peaceful Uses of Atomic Energy 12:52-59.

Sparrow, A.H., R.C. Sparrow, K.H. Thompson and L.A. Schairer. 1956. The use of nuclear and chromosomal variables in determining and predicting radiosensitivities. *Radiation Botany (Suppl.)* 5:105-132.

Swaminathan, M.S. and A.T. Natrajan. 1957. Polyploidy and radiosensitivity. *Nature* 179:479-490.

Swaminathan, M.S. 1964. A comparison of mutation induction in diploids and polyploid. Technical Meeting on the Use of Induced Mutation in Plant Breeding. FAO/IAEA. *Radiation Botany (Suppl.)* 5:619-641.

Agronomy and Mechanization

Response of Lentil (L-5) to Different Sowing Dates

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Abstract

An experiment was conducted at the Regional Agricultural Research Station, Ishurdi, on a lentil line with five dates of sowing (15 October, 1 and 15 November, 1 and 15 December). Date of sowing had a profound effect on the yield and yield components, which declined linearly with the advance of sowing dates. The early sown crop attained more vegetative growth, set more pods and had more time for grain growth, resulting in larger seed size and increased yield. In contrast, the later sown crops had less time for vegetative and reproductive phases, resulting in poor growth, less fruiting, small seed size and reduced yield. Yield reduction ranged from 14% (1 November sowing) to 80% (15 December sowing) compared with the 15 October sowing. The last fortnight of October may be considered as the optimum time of sowing for lentil (L-5) under rain-fed conditions in Bangladesh.

استجابة سلالة العدس (L-5) لمواعيد زراعة مختلفة

الملخص

أجريت تجربة في محطة البحوث الزراعية الإقليمية في إشوردي على سلالة عدس طبقت عليها خمسة مواعيد للزراعة (15 تشرين الأول/أكتوبر، 1 و 15 تشرين الثاني/نوفمبر، 1 و 15 كانون الأول/ديسمبر). وكان لموعد الزراعة تأثير عميق على الغلة ومكوناتها إذ تدنت خطياً مع تقديم مواعيد الزراعة. وقد حقق المحصول المزروع في وقت مبكر نمواً خضرياً زائداً وعُقدت قرون أكثر واستغرق فترةً أطول لنمو الحبة، الأمر الذي أدى إلى زيادة في حجم البذرة وزيادة الغلة. وعلى النقيض من ذلك، فإن المحاصيل المزروعة في وقت متأخراستغرقت وقتاً أقل للطورين الخضري والثمري مما أدى إلى ضعف النمو وإعطاء ثمار أقل كما كان حجم البذرة صغيراً وتدنت الغلة. وقد تراوح انخفاض الغلة من 14٪ (في موعد 1 تشرين الثاني/نوفمبر) إلى 80٪ (في موعد 15 كانون الأول/ديسمبر) بالمقارنة مع غلة المحصول المزروع في 15 تشرين الأول/أكتوبر. وقد يعتبر الأسبوعين الأخيرين من تشرين الأول/أكتوبرموعداً مثالياً لزراعة سلالة العدس (L-5) تحت الظروف البعلية في بنغلاديش.

Introduction

Lentil (*Lens culinaris* Medik.) is the second most important pulse crop of Bangladesh in terms of areas and production. It is grown on 216,404 ha of land, producing 158,719 t of grain with an average yield of 733 kg/ha (BBS 1989). Although a potential yield of as high as 2000 kg/ha has been reported (BARI 1988), such high yields are not realized by the farmers. Even where inputs are given, maximum yields in the existing cultivars cannot be guaranteed. The agronomic requirements for the maximum seed yield have not been satisfactorily defined (Smithson et al. 1985). In the presence of slightly more than adequate soil moisture, vegetative growth becomes excessive, lodging occurs, diseases (rust, stemphylium blight) are aggravated and seed yield declines. On the contrary, limited soil moisture (dry seed bed) reduces germination, establishment, vegetative growth and yield. Delay in sowing is another factor causing low productivity of lentil.

In the rice-based cropping pattern, the farmers of Bangladesh sow this crop from the 3rd week of October until the last week of November. It is observed that yield reduction occurs in late sowing, but it is not known how much yield is reduced by different sowing dates or how flexible the sowing dates are without any appreciable yield loss. Therefore, this study was planned to determine the response of yield and yield components of lentil (L-5) to changes in sowing time.

Materials and Methods

A trial with L-5, a promising line of lentil, was conducted at the Regional Agricultural Research Station, Ishurdi,

during the period October 1988 to March 1989. The soil of the experimental plot was silt loam with pH = 7.5. The crop was grown under rain-fed conditions. Seeds were broadcast on 15 October, 1 November, 15 November, 1 December and 15 December. The experiment was laid out in a randomized complete block design with five replications. The size of each unit plot was 25 m^2. The land was fertilized with 20 kg N, 40 kg P_2O_5 and 20 kg K_2O per ha from urea, triple superphosphate and muriate of potash, respectively. All the fertilizers were applied at final land preparation.

Data on plant height and number of pods/plant were recorded on 10 randomly selected plants from each plot. The 1000-seed weight was recorded from the sample drawn from the grain yield obtained from each plot. The data were analyzed by LSD following Steel and Torrie (1960).

Results and Discussion

The yield and yield components of lentil at different dates of sowing are presented in Table 1. The date of sowing exerted a significant influence on the yield and yield parameters. All the characters linearly declined with the advance of sowing dates (Table 2). The crop duration, including vegetative and reproductive phases, was affected as the sowing dates were delayed. The crop sown on 15 October started flowering 58 days after sowing and that of 15 December at 45 days after sowing. Similarly, the total crop duration for these crops was 119 days and 86 days, respectively. The crop sown on 15 October matured on 14 February, the three sowings following (up to 1 December) matured by 6 March and the 15 December sowing matured on 11 March. These variations in maturity period are not commensurate with the variations in sowing dates. This clearly indicates that a rise in

Table 1. Yield and yield components of lentil as affected by different dates of seeding.

Date of sowing	Days to flowering	Days to maturity	Plant height (cm)	No. pods/ plant	Grain growth duration	1000-seed weight (g)	Yield (t/ha)	Yield reduction (%)†
15 October	58	119	45.57	106.11	61	19.0	1.73	0
1 November	55	110	39.49	88.17	55	17.5	1.49	14
15 November	53	105	35.81	79.90	52	16.0	1.10	36
1 December	49	95	30.31	58.14	46	14.1	0.79	54
15 December	45	86	27.17	29.17	41	13.3	0.35	80
LSD (0.01)	3.86	2.87	3.20	9.16	2.63	1.32	0.31	—
CV %	3	4	13	12	2	3	11	—

† Yield reduction over 15 October sowing.

Table 2. Mean square values of yield components as affected by dates of sowing.

Item	df	Mean square value					
		Days of maturity	Grain growth duration	Plant height	No. pods/ plant	1000-seed weight	Yield
Replication	4	2.78	1.75	3.45	731.58	0.22	0.15
Date of sowing	4	708.75**	211.00**	343.40**	15842.02**	10.45**	2.31**
Linear	1	2120.09**	633.25**	1167.28**	74982.31**	55.81**	15.18**
Residual	3	6.16	9.28	12.41	810.18	1.02	0.32
Error	16	3.21	4.13	8.68	386.14	0.36	0.19

**$P < 0.01$

temperature around 14 February curtailed the growth period of the crop. Summerfield et al. (1984) reported a similar result and concluded that heat stress during the reproductive period curtailed growth and reduced yield significantly.

A curtailment in growth period is reflected in the growth of the crop. Earlier-sown crops grew taller and had more branching and podding, whereas the later-sown ones attained less than three-fourths of the height, less branching and produced fewer pods (Table 1). These results agree with the findings of Yousef et al. (1984). A similar trend was observed in grain growth duration and grain size. The crop sown on 15 October had 61 days for grain filling, consequently its 1000-seed weight was the greatest (19.0 g), whereas the crop sown on 15 December had only 41 days for grain filling, resulting in a 1000-seed weight of only 13.3 g.

Finally, the trend of contribution of all these characters was reflected in the seed yield. The crop sown on 15 October produced the highest yield, 1.73 t/ha, which was not significantly different from the 1 November sowing (1.5 t/ha). Yield reduction occurred in later sowings (14, 36, 54 and 80%, respectively, for 1 November, 15 November, 1 December and 15 December) compared with the 15 October sowing. The reason for these yield variations is quite clear; the early sown crop had more time for vegetative growth, podding and grain growth, which ultimately contributed toward more yield. On the contrary, the later-sown crops had less time for vegetative growth and grain filling. Thus plant size was diminished and branches were fewer. The number of pods/plant and the size of the grains were reduced, which finally resulted in less grain yield. Similar results were reported by Gowda and Kaul (1982), Murinda and Saxena (1985), Bejiga (1984), Saxena et al. (1983), Sandhu (1984), Sinha and Chowdhury (1984) and Sadapal (1988), who concluded that mid-October to early November is the ideal period for lentil sowing and any deviation from this causes yield reduction.

References

BARI (Bangladesh Agricultural Research Institute). 1988. Annual Report of Pulses Improvement Programme.

BBS (Bangladesh Bureau of Statistics). 1989. The Year Book of Agricultural Statistics of Bangladesh 1987–88, pp. 43–49. Statistics Division, Ministry of Planting, Dhaka.

Bejiga, G. 1984. Lentils in Ethiopia. *LENS Newsletter* 11(2):1–6.

Gowda, C.L.L. and A.K. Kaul (eds.). 1982. Pulses in Bangladesh. BARI/FAO, Dhaka.

Murinda, M.V. and M.C. Saxena. 1985. Agronomy of faba beans, lentils and chickpeas. Pages 229-244 *in* Proceedings of an International Workshop on Faba Beans, Kabuli Chickpeas and Lentils in the 1980s, 16–20 May 1983 (M.C. Saxena and S. Varma, eds.). ICARDA, Syria.

Sadapal, M.N. 1988. Agronomy of pulses. Pages 456-512 *in* Pulse Crops (B. Baldev, S. Ramanujam and H.K. Jain, eds.). IBH.66, Janpath, New Delhi.

Sandhu, P.S. 1984. Effect of sowing dates, phosphorus levels and herbicides on the response of *Rhizobium* inoculation in lentils. *LENS Newsletter* 11(2):35.

Saxena, M.C., M.V. Murinda, M. Rurk and N. Trablusi. 1983. Productivity and water of lentil as affected by date of sowing. *LENS Newsletter* 10(1):28–29.

Sinha, R.P. and S.K. Chowdhury. 1984. Late sowing lentils in Bihar, India. *LENS Newsletter* 11(2):24.

Smithson, J.B., J.A. Thompson and R.J. Summerfield. 1985. Chickpea. Pages 315-345 *in* Grain Legume Crops (R.J. Summerfield and E.H. Roberts, eds.). Collins, London.

Steel, R.G.D. and J.A. Torrie (eds.). 1960. Principles and Procedures of Statistics, pp. 107–109. McGraw Hill Book Co. Inc., New York, Toronto, London.

Summerfield, R.J., P. Hadley, E.H. Roberts, R.J. Minchin and S. Rawsthorne. 1984. Effect of date of sowing on lentil. *Experimental Agriculture* 20:77–93.

Yousef, M.A., T.A. Hussein, A.L.I. Latif and A.E. El-Karamity. 1984. Effect of sowing dates and seeding rates on yield of lentil. *Minia Journal of Agricultural Research and Development* 6(1):121–131.

Effect of Sowing Date and Seeding Rate on Lentil in Eastern Libya

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Abstract

The investigation was carried out with three sowing dates (7 December, 2 February and 24 February), using two varieties (Safsaf-1 and Safsaf-3) and five seeding rates (160, 220, 280, 340 and 400 plants/m^2) in three seasons (1985–88) at El-Safsaf Research Station, Libya. Sowing early (7 December) produced a significantly higher grain yield/ha than did late sowing (2 and 24 February). There was a linear increase in grain yield with increasing plant density; 400 plants/m^2 produced the highest grain yield. There were no differences between the two varieties.

تأثير موعد الزراعة ومعدل البذار على العدس في شرقي ليبيا

الملخص

أجريت الدراسة في ثلاثة مواعيد للزراعة (7 كانون الأول/ديسمبر، 2 شباط/فبراير و 24 شباط/فبراير) باستخدام صنفين (صفصاف -1 وصفصاف -3) وخمسة معدلات بذار (160، 220، 280، 340، 400 نبتة/م^2) في ثلاثة مواسم زراعية (1985-88) في محطة بحوث الصفصاف بليبيا. وقد أعطت الزراعة المبكرة (7 كانون الأول/ديسمبر) غلة حبية/هـ أعلى معنوياً من الزراعة المتأخرة (2 و 24 شباط/فبراير). وكانت هناك زيادة خطية في الغلة الحبية اقترنت بتزايد الكثافة النباتية إذ أعطت 400 نبتة/م^2 أعلى غلة حبية. ولم تكن هناك فروق بين الصنفين.

Introduction

Lentil (*Lens culinaris* Medik.) in Libyan Jamhiriya is grown by a few farmers in limited areas in the eastern part of Libya (El Gabal El Akhdar). The average yields are very low because of poor management, lack of high-yielding varieties, weeds and late planting. Almost all of Libya's lentil requirement is imported. The present investigation was undertaken to determine the most suitable sowing date and seeding rate for lentil to obtain high yields and encourage farmers to produce lentil to satisfy domestic consumption.

Materials and Methods

Three experiments were carried out at El-Safsaf Station, Agriculture Research Center, El-Marj, Libya (32° 49' N, 21° 54' E; 641 m a.s.l.), during the 1985–88 seasons on heavy clay soil.

Season 1985/86

The experiment was laid out in a split-split plot design with three replications. Sowing dates (7 December, 2 February and 24 February) were applied in the main plot, varieties (Safsaf-1 and Safsaf-3) in the subplot and seeding rates (160, 220 and 280 seeds/m^2) in the sub-subplot. The experimental unit consisted of four 4-m long rows, 30 cm apart. Total rainfall was 384.1 mm during the season; major rainfall was received during December and January (Table 1).

Season 1986/87

The designs were split-split plots with three replications. Sowing dates (7 December and 24 February) were applied in the main plots, varieties (Safsaf-1 and Safsaf-3) in the subplots and seeding rates (160, 220, 280 and 400 seeds/m^2) in the sub-subplots.

The experimental unit consisted of four 4-m long rows, 30 cm apart. Total rainfall was 507.1 mm during the season with the majority falling in December, January and March.

Season 1987/88

The experiment was laid out in a single split-plot design with four replications. Sowing dates (7 December and 24 February) were kept for the main plots and seeding rates (160, 220, 280, 340 and 400 seeds/m^2) for the subplots.

Table 1. Maximum and minimum temperatures and average rainfall received during the growing seasons of 1985–88.

Month	1985/86		1986/87		1987/88	
	Rainfall (mm)	Temp. (°C) (min–max)	Rainfall (mm)	Temp. (°C) (min–max)	Rainfall (mm)	Temp. (°C) (min–max)
October	75.9	10.5–24.0	20.0	11.0–23.0	00.0	14.0–34.5
November	37.0	10.5–26.5	60.0	9.0–20.6	74.0	9.0–23.0
December	105.0	3.5–19.0	127.4	4.0–16.5	117.6	5.5–23.5
January	107.0	6.0–17.5	80.3	4.0–22.0	85.9	6.5–22.0
February	34.7	5.5–20.5	56.0	5.5–21.0	117.6	3.5–17.5
March	29.5	3.5–23.0	163.4	1.0–20.0	73.7	5.0–19.5
Total rainfall	384.1		507.1		468.8	

Source: Meteorology Station, Shahat, Libya.

Only one variety, Safsaf-3, was used in this year. The experimental unit consisted of four 4-m long rows with 30-cm spacing. The total rainfall was 468.8 mm during the season with most received during December, January and February. In three seasons the total seed yield was recovered for every plot from a harvested area of 2.4 m^2.

Before planting, 150 kg/ha of diammonium phosphate were applied. On June 10, the crop was harvested when 90% of the plants reached maturity. Sun-dried bundles were threshed and seed yield was recovered.

Results and Discussion

Data on the average yield of sowing dates and seeding rates in the trials conducted during the 1985–88 seasons are presented in Table 2. Seed yield was significantly affected by the time of sowing in the 1986–88 seasons.

The highest seed yield was obtained from the early sowing date (7 December) which outyielded the late sowing dates (2 February and 24 February). These results agree with the results of Sekhon et al. (1986), who found

Table 2. Effect of sowing date and seeding rate on the grain yield (kg/ha) of lentil cultivars during the 1985–88 seasons.

	1985/86	1986/87	1987/88	Mean
Sowing date				
7 December	1356	2524	1610	1830
2 February	1289			1289
24 February	546	1288	945	926
Mean	1064	1906	1278	
LSD at 5%	NS	646*	395*	
Seeding rate (plants/m^2)				
160	985	1564	1073	1207
220	1054	1813	1260	1376
280	1153	2005	1250	1469
340			1380	1380
400		2245	1425	1425
Mean	1064	1906	1278	
LSD at 5%	NS	263**	209*	
Varieties				
Safsaf-1	1080	1848		
Safsaf-3	1048	1945		
Mean	1064	1906		
LSD at 5%	NS	NS		

*, ** Significant at 5% and 1%, respectively, NS = not significant.

that early sowing between 20 October and 10 November was better than later sowing. Also, Mohamed (1988) reported that delaying planting caused a drastic reduction in yield and yield attributes.

The superiority of early sown crops could be due to (1) a longer vegetative growth period in which the crop can make better use of rainfall, which occurs mainly in December and January (Table 1), and (2) the crop does not have to rely on infrequent and irregular spring rain for crop growth. This was in agreement with the results of Singh and Ram (1986), who found that an inadequate period for vegetative as well as reproductive growth might be responsible for this trend. This is clear from the data on time to maturity (Table 3), which was reduced from 170 to 104 days because of the delay in planting from 7 December to 24 February. Higher temperatures during the seed development period of the late-planting crop might have resulted in forced maturity and poor seed development.

Yields in 1985/86 were lower than in either 1986/87 or 1987/88, which could be related to weather conditions. Unlike the other two seasons, the winter of 1985/86 had less rain, which resulted in shorter plants, higher seed weight and lower yield.

Table 3. Effect of sowing date on yield characters, total of three seasons, 1985-88.

	Sowing date	
	7 Dec	**24 Feb**
Days to flowering	102	58
Days to podding	120	71
Days to maturity	170	104

The overall results of this study indicate that seed yield could be maximized by increasing plant density to 400 plants/m^2, corresponding to a total yield of 2243 and 1425 kg/ha in 1986/87 and 1987/88, respectively (Table 2). So higher seeding rates improved the grain yield of lentil, and this agrees with the results of Tosun and Eser (1979). There were no differences between the two varieties.

Conclusion

The time of sowing had a marked effect on the productivity of lentil. The results indicated that lentil sown in early December gave higher grain yield. Delaying planting after this date caused a drastic reduction in yield. There was a linear increase in grain yield with an increasing number of plants/m^2. So, the highest yield was attained from sowing 400 seeds/m^2.

References

Mohamed, A.K. 1988. Effect of sowing method, rate, and date on lentil in Shendi area of the Sudan. *LENS Newsletter* 15(1):23–26.

Sekhon, H.S., K.K. Dhingra, P.S. Sandha and S.C. Bhandari. 1986. Effect of time of sowing, phosphorus and herbicides on the response to *Rhizobium* inoculation. *LENS Newsletter* 13(1):11–14.

Singh, N.P. and A. Ram. 1986. Effect of sowing date and row spacing on the performance of lentil cultivars. *LENS Newsletter* 13(1):15–17.

Tosun, O. and D. Eser. 1979. Studies on plant density in lentil. I. The effect of plant density on yield. *LENS Newsletter* 6:8–9.

Seed Quality and Nutrition

Effect of Heat and Germination on Antinutritional Factors in Lentil

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Abstract

The effects of temperature (dry heating, autoclaving and heating in boiling water), soaking and germination on antinutritional factors, i.e., trypsin inhibitor activity, phytohemagglutinin activity and flatulence-causing factors (oligosaccharides), were determined in seven genotypes of lentil (*Lens culinaris* Medik.). Trypsin inhibitor activity and phytohemagglutinin activity decreased substantially by all three treatments. While heating increased the oligosaccharide content, germination decreased it. The possible reasons for these changes are discussed. Germination up to 6 days appears to be the most reliable means of eliminating oligosaccharides for preparation of lentil-based food products. Heating in boiling water is more effective for inactivating trypsin inhibitor and phytohemagglutinins than dry heating or autoclaving.

تأثير الحرارة والإنبات على العوامل المضادة للتغذية في العدس

الملخص

تم تحديد تأثير درجات الحرارة (التسخين الجاف ، التسخين في وعاء موصد، التسخين في ماء غالٍ) والنقع والإنبات على العوامل المضادة للتغذية ، أي النشاط الكابح للتربسين ونشاط فايتوثيماجلوتينين والعوامل المسببة للغازات في البطن أو لتطبل البطن (اوليجوساكارايدس)، في سبعة طرز وراثية من العدس (Lens culinaris Medik.) وقد تناقص بشكل كبير كل من النشاط الكابح للتربسين ونشاط فايتوثيماجلوتينين في جميع المعاملات الثلاث . ففي حين أدى التسخين إلى زيادة محتوى اوليجوساكارايدس أدى الإنبات إلى إنقاصه. وتجري دراسة الأسباب الممكنة وراء حدوث هذه التغيرات. ويبدو أن الإنبات لمدة ستة أيام أفضل وسيلة موثوقة للتخلص من اوليجوساكارايدس لتحضير المنتجات الغذائية المرتكزة على العدس. كما أن التسخين في ماء غالٍ أكثر فعالية في إضعاف فعالية النشاط الكابح للتربسين والفاتيوثيماجلوتينين من التسخين الجاف والتسخين في وعاء موصد.

Introduction

Legumes contain some antinutritional factors, including trypsin inhibitors, phytochemagglutinins (henceforth referred to as hemagglutinins) and flatulence-causing factors (oligosaccharides of the raffinose family, henceforth referred to as oligosaccharides) (Liener 1980). Efforts have been made to reduce the content of antinutritional factors in legumes, or at least to make them less effective, through breeding for improved genotypes and processing, including heating and germination (Liener 1980). Although heating and germination limit the subsequent use of legume seeds or flour, these processes are, on the whole, effective in reducing the content of antinutritional factors or inactivating them. This report summarizes some findings on the effect of heating and germination on antinutritional factors in lentil. Effects of heat and germination on antinutritional factors have been reported for other legumes, including pigeonpeas (Batra et al. 1986) and chickpea (Bansal et al. 1988).

Materials and Methods

Clean seeds and finely ground flour samples of seven genotypes of lentil (*Lens culinaris* Medik.), viz., L-9-12, L-82-3, L-82-4, L-82-6, L-82-7, LH-21 and LH-311, were subjected to dry heating (121°C; 10 min, 20 min, 1 hour, 2 hours), autoclaving (121°C; 15 lbs in 10 min, 20 min), and heating in boiling water (10 min and 20 min). The seeds also were soaked in water for 24 hours, then allowed to germinate for 6 days. Methods used for estimation of trypsin inhibitor activity, hemagglutinin activity and for separation and determination of oligosaccharides have been described earlier (Batra et al. 1986; Vasishta et al. 1986; Batra and Dhindsa 1989).

Results and Discussion

Trypsin inhibitor activity

All the genotypes of lentil analyzed possessed trypsin inhibitor activity (TIA) (Table 1) and it was maximum in L-9-12 genotype, which otherwise is of good quality on the basis of proximate analysis (Batra et al. 1987). Jaffe (1950) also reported substantial TIA activity in lentil, although it was much lower than that in other legumes, including soybean, limabean and pigeonpea. Tannous and Ullah (1969), however, failed to detect TIA in lentil seeds.

Heating lentil flour for 2 hours at 121°C destroyed more than 80% of TIA (Table 1). Dry heating of winged beans at 200°C for 30 minutes has been reported to destroy TIA completely (Tan et al. 1984). Autoclaving of lentil seeds for 20 minutes led to complete inactivation of trypsin inhibitor (Table 1). Autoclaving of legume seeds even for 5 minutes has been found to cause a drastic loss of TIA (Tan et al. 1984; Kakade and Evans 1965). However, the decrease in TIA might be accompanied by a decrease in protein efficiency ratio in rats (Kakade and Evans 1965). Heating lentil seeds in boiling water for even 10 minutes destroyed trypsin inhibitor completely (Table 1). As expected, moist heating enhanced the loss of TIA over dry heating. Moisture appears to mediate some unidentified biochemical reaction or change in inhibitor protein conformation, accomplishing inactivation of the inhibitors. Purified trypsin inhibitors are, in general, resistant to heat (Tsukamoto et al. 1983). Trypsin inhibitor in horse gram has been reported to be thermostable even during cooking (Ghorpade et al. 1986).

Soaking lentil seeds for 24 hours resulted in a marked decrease in TIA and the decrease was maximum in genotype LH-311 (Table 1). Germination of soaked seeds led to further loss in TIA. In mungbean, trypsin inhibitor has been found to be modified rapidly by limited proteolysis during early stages of seedling growth and the modifying activity increased up to 6 days after imbibition (Wilson and Tan-Wilson 1983). This may explain the marked decrease in TIA on soaking and germination.

Hemagglutinin activity

All the heating procedures led to substantial decreases in hemagglutinin activity (HA) (Table 2). A perusal of the data reveals that heating in boiling water is the most effective (and economical) means of destroying HA in lentil. Soaking lentil seeds in distilled water for 24 hours eliminated at least 50% of HA except in LH-6 genotype in which HA remained almost unchanged (Table 2). The decrease in HA continued with time up to 6 days of germination.

Little is known about the basis for the decrease in HA on heating of lentil. Possibly, the hemagglutinin protein breaks down into its subunits or undergoes some other unknown conformational change in structure that might be required for its hemagglutinin activity. Differences in effects of different heating procedures on HA in the same genotype might be due to the differences in the extent to which the hemagglutinin molecule in the food particle is exposed to heating, and this might in turn be affected by the association of hemagglutinin molecule with other

Table 1. Effect of heating and germination on trypsin inhibitor activity† in lentil seeds and flour.

		Dry heating flour (hours)		Autoclaving flour (minutes)				Germination (days)	
Genotype	Control	1	2	10	20	Heating seeds in boiling water (10 minutes)	Soaking (24 hours)	3	6
L-9-12	695	93	100	75	Nil	Nil	259	256	100
LH-82-3	638	139	63	75	Nil	Nil	240	216	73
LH-82-4	642	106	48	128	Nil	Nil	221	205	63
LH-82-6	695	185	48	88	Nil	Nil	260	250	134
LH-82-7	692	155	52	46	Nil	Nil	268	250	115
LH-21	660	139	63	75	Nil	Nil	252	225	48
LH-311	684	117	40	46	Nil	Nil	289	212	48

† μmol of tyrosine released/g of material. Each value in this table is an average of two replicates.

Table 2. Effect of heating and germination on hemagglutinin activity† in lentil seeds and flour.

		Dry heating flour (hours)		Autoclaving flour (minutes)		Heating seeds in boiling water (minutes)		Soaking	Germination (days)	
Genotype	Control	1	2	10	20	10	20	(24 hours)	3	6
L-9-12	4096	16	8	32	16	32	16	1024	256	128
LH-82-3	2048	16	4	256	16	32	16	512	256	64
LH-82-4	2048	8	2	128	8	16	16	128	64	—
LH-82-6	2048	8	4	32	8	64	16	2048	64	64
LH-82-7	2048	16	4	128	16	32	8	1024	512	256
LH-21	2048	16	Nil	256	16	16	8	1024	128	64
LH-311	2048	16	Nil	256	16	8	8	1024	1024	64

† Hemagglutinin activity is expressed in terms of maximum dilution of the seed extract at which agglutination could be observed (for details, see Batra 1987). Each value in this table is the mean of two replicates.

macromolecules. HA in cereals has been associated with several protein fractions including glutelins (Newburg and Concon 1985). In rice endosperm, the acid-soluble glutelin fraction was found to be heat labile whereas the alkali-soluble fraction was heat stable. If a similar situation exists in legumes, the differences in hemagglutinin activity and its response to heat and germination may be due to differences in the amount and proportion of different protein fractions contributing to hemagglutinin activity.

Oligosaccharides

The average oligosaccharide concentration in lentil increased irrespective of the heating procedure (Table 3). Even though oligosaccharide concentrations in the seeds did not change much by heating in boiling water for 10 minutes, the increase was evident after taking into account the oligosaccharides brought into the solution through the surrounding medium. Earlier reports on the subject report either no change (Kalirawana and Bhat 1983) or a decrease (Jood et al. 1985) in oligosaccharides. Results obtained in our laboratory agree with those obtained by Rao and Belavady (1978) for several legumes, including red, black and green gram. The differences in the pattern of changes in oligosaccharides through heating might be due to differences in heating procedure and the physical condition of the sample. For example, dry flour (Chrompreeda and Fields 1984) or seeds immersed in water (Silva and Braga 1982) have been used for autoclaving (or pressure cooking). In the case of seeds immersed in water, cooked samples have been prepared by including the cooking medium (Jood et al. 1985) or excluding it (Ayengar and Kulkarni 1977).

The observed increase in oligosaccharides by heating (Table 3) might be due to release of oligosaccharides from bound macromolecules including higher molecular weight α-galactosides, which might occur in legume seeds. These macromolecules may also be protein in nature, since air-classified protein-rich fractions of several legumes are 40–90% higher in α-galactosides, especially raffinose, stachyose and verbascose, compared with starch-rich fractions (Sosulski et al. 1982). Nonenzymatic hydrolysis of verbascose to stachyose, raffinose and sucrose also might contribute to an increase in concentration of the latter sugars.

Although a slight increase in total as well as individual oligosaccharides occurred during 24 hours of soaking of seeds in water, all oligosaccharides decreased 3 days after germination (Table 3). At 6 days after germination, raffinose and stachyose had disappeared completely while sucrose showed a proportionate increase. The increase in oligosaccharides observed after soaking does not agree with earlier reports for other legumes which show a decrease in these sugars (Silva and Braga 1982; Jood et al. 1985). These differences might be due to variation in details of methodology, e.g., whether seeds were weighed before or after soaking, and species variability. Possibly, oligosaccharides might be released from bound form during imbibition of water and this process may surpass the leaching out of sugars from seeds, by diffusion, depending upon solubility (Silva and Braga 1982). The released sugars will be hydrolyzed by α-galactosidase (Jood et al. 1985) during germination and seedling growth. Activity of α-galactosidase increases during germination (Alani et al. 1990).

Table 3. Effect of heating and germination on oligosaccharide concentration† (g/100 g dry weight) in lentil seeds and flour.

	Oligosaccharide			
Treatments	**Sucrose**	**Raffinose**	**Stachyose**	**Total**
Control	1.71	1.11	0.83	3.65
Dry heating (minutes)				
10	2.46	2.34	2.21	7.01
20	1.59	1.02	1.17	3.78
Autoclaving (minutes)				
10	2.20	1.29	1.06	4.55
20	2.33	1.69	1.04	5.06
Heating in boiling water 10 minutes				
Seeds	1.27	0.95	1.38	3.60
Medium	0.35	0.11	0.22	0.68
Total	1.62	1.06	1.60	4.28
20 minutes				
Seeds	1.69	1.48	1.77	4.94
Medium	0.63	0.54	0.34	1.51
Total	2.33	2.02	2.11	6.45
Soaking (24 hours)				
Seeds	1.81	1.36	1.05	4.22
Medium	0.20	0.04	0.04	0.28
Total	2.01	1.40	1.09	4.50
Germination (days)				
3	1.14	0.40	0.32	1.86
6	1.74	0.00	0.00	1.74

† Each value in this table is an average of seven values representing seven genotypes and each value for single genotype is based on four determinations (duplicate extract for each sample and duplicate estimation for each extract).

The increase in sucrose at the expense of stachyose and raffinose at 6 days after germination (Table 3) further strengthens the view that raffinose and stachyose are hydrolyzed to produce sucrose during germination. Germination of lentil seeds for 6 days is perhaps the most reliable means of completely eliminating raffinose and stachyose, the most gas-forming sugars, and therefore may be applied in preparation of lentil-based food products.

References

Alani, S.R., D.M. Smith and P. Markakis. 1990. Changes in α-galactosidase activity and oligosaccharides during germination and incubation of cowpeas (*Vigna unguiculata*). *Food Chemistry* 38:135–158.

Ayengar, A.K. and P.R. Kulkarni. 1977. Oligosaccharide levels of processed legumes. *Journal of Food Science and Technology* 14:222–223.

Bansal, K.K., K.S. Dhindsa and V.I.P. Batra. 1988. Trypsin inhibitor and hemagglutinin activities in chickpea (*Cicer arietinum* L.): Effects of heat and germination. *Journal of Food Science and Technology* 25:46–48.

Batra, V.I.P. 1987. Effects of cooking and germination on hemagglutinin activity in lentil. *Indian Journal of Nutrition and Dietetics* 24:15–19.

Batra, V.I.P. and K.S. Dhindsa. 1989. Changes in oligosaccharides of lentil on cooking and germination. *Indian Journal of Nutrition and Dietetics* 26:75–83.

Batra, V.I.P., R. Vasishta and K.S. Dhindsa. 1986. Effect of heat and germination on trypsin inhibitor activity of some strains of lentil and pigeonpea. *Journal of Food Science and Technology* 23:260–263.

Batra, V.I.P., R. Vasishta and K.S. Dhindsa. 1987. Proximate composition and limiting amino-acids of some strains of lentil and pigeonpea. *Haryana Agricultural University Journal of Research* 17:120–124.

Chrompreeda, P.T. and M.L. Fields. 1984. Effects of heat and natural fermentation on amino acids, flatus producing compounds, lipids oxidation and trypsin inhibitor in blends of soybean and corn meal. *Journal of Food Science* 49:563–565.

Ghorpade, V.M., S.S. Kadam and D.K. Salunkhe. 1986. Thermal stability and changes in trypsin inhibitor during cooking of horse gram. *Journal of Food Science and Technology* 23:164–165.

Jaffe, W.G. 1950. Protein digestibility and trypsin inhibitor activity of legume seeds. *Proceedings of the Society of Experimental and Biological Medicine* 75:219–220.

Jood, S., U. Mehta, R. Singh and C.M. Bhat. 1985. Effects of processing on flatus producing factors in legumes. *Journal of Agricultural and Food Chemistry* 33:268–271.

Kakade, M.L. and R.J. Evans. 1965. Nutritive value of navy beans (*Phaseolus vulgaris*). *British Journal of Nutrition* 19:269–276.

Kalirawana, D. and C.M. Bhat. 1983. Effects of pressure cooking on the in vitro digestibility and flatulence factors in high yielding varieties of Bengal gram, green gram and lentils. *Haryana Agricultural University Journal of Research* 13:604–609.

Liener, I.E. 1980. Toxic Constituents of Plant Food-stuffs. Academic Press, Inc., New York.

Newburg, D.S. and J.M. Concon. 1985. Lectins in rice and corn endosperms. *Journal of Agricultural and Food Chemistry* 33:685–687.

Rao, P.U. and B. Belavady. 1978. Oligosaccharides in

pulses: Varietal differences and effects of cooking and germination. *Journal of Agricultural and Food Chemistry* 26:316–319.

Silva, H.C. and G.L. Braga. 1982. Effect of soaking and cooking on oligosaccharide content of dry beans (*Phaseolus vulgaris* L.). *Journal of Food Science* 47:924–925.

Sosulski, F.W., L. Elcovicz and R.D. Reichert. 1982. Oligosaccharides in eleven legumes and their air classified protein and starch fraction. *Journal of Food Science* 47:498–502.

Tan, N., K. Wong and B.O. Delumen. 1984. Relationship of tannin level and trypsin inhibitor activity with the in vitro protein digestibility of raw and heat treated winged beans (*Psophocarous tetragonolobus*). *Journal of Agriculture and Food Chemistry* 32:819–822.

Tannous, R.I. and M. Ullah. 1969. Effects of autoclaving on nutritional factors in legume seeds. *Tropical Agriculture* 46:123–129.

Tsukamoto, I., M. Miyoski and Y. Hamaguchi. 1983. Purification and characterization of three trypsin inhibitors from beans, *Phaseolus vulgaris* "Kinetiki." *Cereal Chemistry* 60:281–286.

Vasishta, R., K.S. Dhindsa and V.I.P. Batra. 1986. Pigeon pea strains: Deficient in phytochemagglutinin activity. *Current Science* 55:1236–1237.

Wilson, K.A. and A.L. Tan-Wilson. 1983. Proteinases involved in degradation of trypsin inhibitor in germination of mungbean. *Acta Biochemica Poland* 30:139.

Physiology and Microbiology

Effect of Co-inoculation (*Azospirillum* and *Rhizobium* Strains) on Nodulation, Yield, Nutrient Uptake and Quality of Lentil in Calcareous Soil

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Abstract

A field experiment was conducted on lentil in calcareous saline-alkali soil to evaluate the effectiveness of single and mixed culture inoculation of *Azospirillum* (strains ICM-104 and SL-33) and *Rhizobium* (strains TAL-634 and LC-5). *Rhizobium* alone or in combination with either of the two *Azospirillum* strains significantly increased the total number of nodules and dry weight of nodules/plant. Significant increases in straw yield and considerable increase in grain yield also were obtained from inoculation with *Rhizobium* LC-5 + *Azospirillum* SL-33 at 45 days after sowing. Yield and uptake parameters were positively and significantly correlated with total number and oven-dry weight of nodules/plant.

تأثير التلقيح المختلط (بسلالات *Azospirillum* والريزوبيا) على تكون العقد الجذرية والغلة وامتصاص العناصر المغذية وجودة العدس في التربة الكلسية

الملخص

نفذت تجربة حقلية على العدس في تربة كلسية ملحية - قلوية لتقييم فعالية اللقاح الفردي والمختلط بـ *Azospirillum* (السلالتان ICM-104 و SL-33) والريزوبيا (السلالتان TAL-634 و LC-5). فقد أدت الريزوبيا وحدها أو بالإشتراك مع إحدى سلالتي *Azospirillum* إلى زيادة معنوية في مجمل عدد العقد الجذرية والوزن الجاف للعقد الجذرية/النبات. كما تم الحصول على زيادات معنوية في غلة التبن وزيادة ملحوظة في غلة الحب نتيجة التلقيح بسلالة الريزوبيا LC-5 + وسلالة SL-33 من *Azospirillum* في اليوم الخامس والأربعين بعد الزراعة. وقد ارتبط معيارا الغلة والإمتصاص إيجابياً ومعنوياً بالعدد الإجمالي والوزن الجاف (باستعمال حرارة الفرن) للعقد الجذرية/النبات.

Introduction

A beneficial effect of specific *Rhizobium* and *Azospirillum* strains on yield and quality of cowpea was found in field experiments (Gunawadena and Vlassak 1986). No information is available regarding use of mixed inoculation of *Azospirillum* and *Rhizobium* strains on yield and quality of lentil in calcareous soil. However, a synergistic effect of specific *Rhizobium* and *Azotobacter* spp. on yield and quality of seed was shown in field experiments conducted on chickpea (Rawat and Sanoria 1977) and pea (Ram and Sanoria 1979). A similar effect has been reported with lentil in calcareous soil (Kumar et al. 1988).

Materials and Methods

Pure cultures of *Rhizobium* strains TAL-634 and LC-5 and *Azospirillum brasilense* strains SL-33 and ICM-104 were used in this study. Cultures were grown in liquid medium for 6 days at 30±1°C and slurry inoculant was used for inoculation. The symbiotic N_2-fixing and associative N_2-fixing abilities of *Rhizobium* and *Azospirillum* strains were assessed in a field experiment with lentil in a three-replicate randomized block design. Surface-sterilized seeds of lentil genotype PL-77-2 were inoculated singly as well as mixed with *Rhizobium* strains and *Azospirillum* strains in equal amounts using approximately 10^7 viable cells (*Rhizobium* + *Azospirillum*) per seed. Chemical properties of soil were pH=8.3, free $CaCO_3$=30.4% and total N=0.053%. Soil was basally dressed with urea (N) at a rate of 20 kg/ha and single superphosphate (P_2O_5) at a rate of 50 kg/ha. Ten plants from each plot at 45 days after sowing were uprooted carefully for nodulation study. Grain and straw samples collected after harvest were analyzed for N (Arther and Herbert 1977). Uptake of N was calculated separately for grain and straw. For nitrogenase activity, 0.5 g fresh nodules were taken in a serum vial. Ten percent of the air

was replaced by acetylene and incubated for 1 hour. Ethylene formed was determined by gas chromatography.

Results and Discussion

A significant increase in total number of nodules/plant over the control was found in seed inoculated with single and mixed *Azospirillum* and *Rhizobium* strains (Table 1). The data indicate that number of nodules, dry weight of nodules and nitrogenase activity increased with *Rhizobium* and *Azospirillum* inoculation. The maximum number of nodules, dry weight of nodules and nitrogenase activity were recorded with mixed inoculation of *Rhizobium* LC-5 and *A. brasilense* SL-33 compared with *Rhizobium* strain alone. It was noted that a single inoculation of *Azospirillum* strain gave a nonsignificant increase over the control in dry weight of nodules and nitrogenase activity. This suggested that *Azospirillum* SL-33 caused better nodulation with *Rhizobium* strain LC-5.

A significant increase in straw yield over the control and highest grain yield (Table 2) was due to inoculation with *Rhizobium* LC-5 + *A. brasilense* SL-33. Using this combination, straw and grain yield increased firstly over control by 18.5 and 63%, and secondly over *Rhizobium* LC-5 alone by 0.2 and 25%, respectively. *Rhizobium* TAL-634 + *A. brasilense* ICM-104 inoculation significantly

lowered the straw yield and caused minimum grain yield. Mixed inoculation with *Rhizobium* LC-5 + *A. brasilense* SL-33 gave better yield results compared with a mixed culture of *Rhizobium* TAL-634 + *A. brasilense* ICM-104.

Rhizobium strain inoculation, alone or mixed with *Azospirillum* strain, significantly increased uptake of nitrogen by straw and grain. The maximum uptake of nitrogen by straw, grain and whole crop was found with a mixed inoculation of *Rhizobium* LC-5 + *Azospirillum* SL-33. However, that grain protein was nonsignificant with mixed and single inoculation.

Nodulation, yield and uptake of nitrogen were positively related with each other (Table 2). This indicated the contribution of better nodulation toward the postharvest characters. Therefore, *Rhizobium* LC-5 either alone or in mixture with *Azospirillum* performed better in a calcareous soil system because of its inherent tolerance of adverse soil properties.

Table 2. Correlation coefficients (r) between variables.

Variable	r
Total number of nodules/plant vs. ODW† of nodules/plant	0.86*
Total number of nodules/plant vs. grain yield	0.82*
Total number of nodules/plant vs. straw yield	0.92**
Total number of nodules/plant vs. nitrogenase activity	0.96**
ODW of nodules/plant vs. grain yield	0.96**
ODW of nodules/plant vs. straw yield	0.80*
ODW of nodules/plant vs. nitrogenase activity	0.90**
ODW of nodules/plant vs. nitrogen uptake by grain	0.96**

† ODW = Oven-dry weight.
*,** Significant at 5% and 1% probability levels, respectively.

References

Arther, B.O. and D.S. Herbert. 1977. Colorimetric determination of exchangeable ammonium, urea, nitrate and nitrite in a single soil extract. *Agronomy Journal* 69:49–53.

Gunawadena, S.F.B. and K. Vlassak. 1986. Response of cowpea (*Vigna unguiculata* (L) Walp) to combined inoculation of *Azospirillum* and *Rhizobium*. *Biitrage zur Tropischen Landwirt Schaff and Veterinar Medizin* 24(1):25–28.

Kumar, A., M.K. Malik and N. Ahmad. 1988. Effect of mixed culture inoculation of *Rhizobium* and *Azospirillum* on yield, nutrient uptake and quality of lentil in calcareous saline soil. *LENS Newsletter* 15:24–27.

Ram, G. and C.L. Sanoria. 1979. Effect of seed inoculation on peas (*Pisum sativum*) with *Rhizobium* and *Azospirillum* in alkali soil. *Journal of the Indian Society of Soil Science* 27:489–491.

Rawat, A.K. and C.L. Sanoria. 1977. Influence of seed bacterization on nodulation yield and amino acid composition of seed protein of *Cicer arietinum* var. Type-1. *Current Science* 46:373–375.

Table 1. Effect of bacterial inoculation on nodulation, oven-dry weight (ODW), nitrogenase activity (NA) of nodules, and yield, nitrogen uptake and grain protein content of lentil.

Treatments	Total number of nodules/plant	ODW of nodules/ plant (mg)	NA† of nodules	Yield (kg/ha)		Nitrogen uptake (kg/ha)		Grain protein (%)
				Grain	Straw	Grain	Straw	
Control (no inoculation)	3.3	6.7	4.5	870	3820	34.8	80.2	25.0
Rhizobium TAL-634	6.2	10.2	16.4	1050	4320	42.4	95.1	25.8
Rhizobium LC-5	11.3	11.0	24.1	1130	4520	45.7	104.0	25.6
A. brasilense ICM-104	4.0	5.4	6.0	970	4100	38.9	86.1	25.1
A. brasilense SL-33	4.3	5.2	5.2	930	4020	37.5	92.5	25.8
Rhizobium TAL-634 + *A. brasilense* ICM-104	8.4	14.3	17.2	1360	4320	56.0	99.4	25.8
Rhizobium TAL-634 + *A. brasilense* SL-33	6.8	13.3	18.0	1280	4220	52.7	97.1	25.8
Rhizobium LC-5 + *A. brasilense* ICM-104	11.0	16.4	25.2	1400	4500	58.2	108.0	26.0
Rhizobium LC-5 + *A. brasilense* SL-33	12.0	18.2	26.0	1420	4530	58.9	108.7	25.9
LSD at 5%	0.30	0.35	3.2	189	312	3.24	5.20	NS

† Nitrogenase activity (nmol C_2H_4 g^{-1} fresh nodules $hour^{-1}$).

Research on the Growth and Flowering Conditions of Lentil

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Abstract

Differences between the vegetative and reproductive growth stages of lentil were delineated by daily observation of the development stage and flowering process. Days to 50% flowering and days to 100% flowering were recorded. Data also were collected on the relationships between flowering and temperature, humidity, flowering habit, flowering on stems and branches by location on the plant, and pod setting percentage. The optimum temperature for flower production was 14-22°C and optimum relative humidity was 50–80%; 93% of flowers were on branches. Lentil has an indeterminate flowering habit.

دراسة ظروف النمو والإزهار في العدس

الملخص

تم تحديد الفروقات بين طوري النمو الخضري والثمري للعدس عن طريق الملاحظة اليومية لكل من طور النمو وعملية الإزهار. وسجل عدد الأيام حتى 50٪ و 100٪ من الإزهار. كما تم جمع البيانات عن العلاقات بين الإزهار ودرجات الحرارة، والرطوبة، وطبيعة الإزهار، وتحديد مواقع الإزهار على السوق والفروع من النبات والنسبة المئوية لعقد القرون. وكانت درجة الحرارة المثلى للإزهار 14-22 ^{0} م والرطوبة النسبية المثلى 50-80٪. كما كانت نسبة 93٪ من الزهور على الفروع. ويتمتع العدس بطبيعة إزهار غير محدودة.

Introduction

This study was conducted to quantify the length of different growth stages in lentil and relate this to prevailing climatic conditions and the latitude of origin of lentil lines. Additionally, the location within plants of flowers and pods was recorded.

Materials and Methods

The experiment was conducted in Yangling, Shaanxi Province (34°21' N), using 36 Shaanxi lentil lines. Length of development phases was recorded. Dali and Binxian lentils also were selected to observe their flowering conditions. Four plants per lentil variety were observed daily every other hour from 7 a.m. until 6 p.m. The number of flowers, the flowering locations/plant and the location of all pods were recorded. The opened flowers were removed after recording to create a favorable climate for the next data collection.

Results and Discussion

Vegetative and reproductive growth

The experimental results showed that the growth rates of lentil varieties differed in vegetative and reproductive stages. In Yangling, the vegetative growing stage of various lentil varieties was 194–212 days and the reproductive growing stage was 28–40 days. On the basis of place of origin of lentil varieties, vegetative and reproductive growth can be classified into three types of regions (Table 1). The following points can be seen from Table 1:

- the period of vegetative growth is reduced with the latitude of collection of the lentil lines
- variation in the reproductive growing days of different regions is contrary to the vegetative growing days; accordingly, the length of reproductive growth increased with a decrease in the latitude
- the total number of days for growth and development is largely governed by the length of the vegetative growth period.

These results indicate that the total days for lentil growth and development are chiefly dependent upon the length of the vegetative growing stage. As lentil is a long-day crop, from the high latitudes in North Shaanxi southward to Guanzhong (the middle part of Shaanxi), lentil flowering is delayed because of the decrease in the daylength; from the low latitudes in South Shaanxi northward to Guanzhong, lentil blooming starts earlier because of the increased daylength, which causes a reduction in the vegetative growing stage.

Table 1. The growing and developing days of lentil varieties of three different regions and available accumulated temperature in a single location.

	Origins of varieties					
	North Shaanxi (35°–39° 20′N)		Guanzhong (34°–35° 20′N)		South Shaanxi (31°–34° 45′N)	
	Length of:		Length of:		Length of:	
	Veget. growth	Repro. growth	Veget. growth	Repro. growth	Veget. growth	Repro. growth
Days	206.4	32.4	201.7	34.3	200.6	34.9
Mean whole growing and developing days	238.8		236.0		235.5	
Accumulated temperatures of ≥10°C	7331.4	679.3	6351.4	703.5	6102.5	720.2
Total accumulated temperatures	8028.7		7054.9		6822.7	

Accumulated temperatures of ≥10°C for the entire growth duration of the crop varied from 6822.7 to 8010.7°C and for the vegetative growing stage from 6102.5 to 7331.5°C, with the decreasing-temperatures sums reflected by the order of the regions of collection: North Shaanxi, Guanzhong and South Shaanxi. Accumulated temperatures of ≥10°C in the reproductive growth stage were from 679.3 to 720.2°C, with regions by decreasing temperature reversed, i.e., South Shaanxi, Guanzhong and North Shaanxi. Accumulated temperatures of ≥10°C tend to be in agreement with the corresponding days of every growth stage. Thus the days for growth and development of lentil varieties have a close relationship with the accumulated temperature ≥ 10°C; that is, less available accumulated temperatures results in a reduced period of vegetative growth.

Blooming days, quantities and full blooming stage

Under average temperatures of 9.7–25.6°C and a relative humidity range of 46–88%, lentil blooming lasts from 20 April to 26 May. The length of the blooming stage differed among varieties. The average blooming days of Dali and Binxian were the same (Table 2).

Lentil varieties and individual plants vary in the number of flowers. A single plant can bear 114–278 flowers. Dali lentil had 153.3 flowers on average and Binxian lentil had 196 flowers on average. The overall mean was 174.8 flowers/plant.

The full blooming stage of lentil falls between 3 and 20 May, during which time 84% reach full flower. In the 13 days prior to this time, 14.1% reach 100% flowering, and in the 6 days after the 18-day period, only 1.9% (the remainder) reach full flowering (Table 3).

Table 2. The blooming days and number of flowers per lentil plant.

Variety	Flowering start and finish, and no. days	Average no. flowers/plant
Dali	26 Apr–20 May = 25	139
	24 Apr–26 May = 33	168
Binxian	20 Apr–20 May = 31	278
	26 Apr–21 May = 26	114

Most (94.4%) flowers open in the morning. Between 9 a.m. and 12 noon, 48.2% opened. After 12 noon, flowering was reduced; after 6 p.m., a small number of flowers bloom. On a single plant, an average of 10.8 flowers open each day.

Relationship between flowering, and temperature and humidity

It can be seen from Table 3 that the optimum temperature range for lentil flowers to bloom is 14–22°C, accounting for 80.1% of the total; they seldom if ever bloom below 10°C or above 26°C. The temperature required by lentil flowers to bloom was related to the place of origin. Dali lentil, which comes from a warm area, only bloomed in a temperature range of 10–26°C; in Binxian lentil, which comes from an area with a lower temperature, 1.1% of flowers bloomed below 10°C.

Table 3. Number of flowers at different dates, temperatures and humidity levels, and number of flowers on main stems and branches.

Conditions	Dali lentil		Binxian lentil		Total no. flowers	% of total flowers
	No. of flowers	%	No. of flowers	%		
Flower production						
20–26 April	5.0	3.3	18.5	9.4	23.5	6.7
27 Apr–2 May	11.5	7.5	14.5	7.4	26.0	7.4
3–8 May	54.0	35.2	40.5	20.7	94.5	27.0
9–14 May	45.5	29.6	63.5	32.4	109.0	31.2
15–20 May	33.5	21.8	56.5	28.8	90.0	25.8
21–26 May	4.0	2.6	2.5	1.3	6.5	1.9
Temperature (°C)						
<10			4.0	2.0	4.0	1.1
10.1–12.0	10.0	6.5	10.0	5.1	20.0	5.7
12.1–14.0	10.0	20.5	7.5	3.8	17.5	5.0
14.1–16.0	31.5	6.2	28.5	14.5	60.0	17.2
16.1–18.0	9.5	31.9	28.0	14.3	37.5	10.7
18.1–22.0	49.0	18.9	58.0	29.7	107.0	30.6
20.1–22.0	29.0	7.8	47.5	24.2	76.5	21.6
22.1–24.0	12.0	1.7	12.5	6.4	24.5	7.1
24.1–26.0	2.5				2.5	0.7
Humidity (%)						
20–29			3.0	1.5	3.0	0.9
40–49	18.5	12.1	14.0	7.2	32.5	9.3
50–59	59.5	38.7	72.5	37.0	132.0	37.8
60–69	36.0	23.5	51.0	26.0	87.0	24.9
70–79	25.5	16.6	43.5	22.2	69.0	19.7
80–89	14.0	9.1	12.0	6.1	26.0	7.4
Number of flowers						
Main stems	18	10.7	25	9.0	43	9.7
Branches						
2	42	25.0	84	30.3	126	28.3
3	36	21.4	27	9.7	63	14.1
4	16	9.5	41	14.8	57	12.8
5	5	3.0	24	8.6	29	6.5
6	19	11.3	30	10.8	49	11.0
7	14	8.3	28	10.1	42	9.4
8	11	6.6	4	1.4	15	3.4
9	3	1.8	5	1.8	8	1.8
10	2	1.2	4	1.4	6	1.3
11	2	1.2	4	1.4	6	1.3
			2	0.7	2	0.4

A relative humidity of 50–80% was most conducive to lentil flowering, accounting for 82.4% of total flowers. Lentil seldom bloomed when humidity was under 40% or over 80%, but Binxian lentil had a few flowers when humidity was below 29%.

The experimental results indicate that the optimum temperature and atmospheric humidity for lentil blooming are 14–22°C and 50–80%, respectively (Table 3).

Blooming orders

From 20 April to 26 May, the location of each flower on each variety was recorded daily. Within 37 days, 446 blooming flowers were observed. The blooming tendencies of the two lentil varieties were in agreement with whether they were branching plants or the whole plants. They bloomed from basal nodes to more apical nodes. This indicates that the flowering habit of lentil is indeterminate.

Percentage of blooming and pod setting related to different stems and branches

Lentil can have more than 10 branches on which most flowers grow (accounting for 90.3%), while only a small number of flowers grow on the main stems (accounting for 9.7%) (Table 3). Therefore, the ratio of flowers on the branches and the main stems is 9:1. The majority of flowers are found on the first primary branch; the number gradually reduces apically.

Table 4. Pod-setting percentage and stages.

Lentil variety	No. of flowers	No. of pods setting	Pod setting (%)	Date of start of zero pod set
Dali	168	156	92.9	May 14
Binxian	278	257	93.2	May 15
Average			93.1	

There were some differences in the pod-setting percentage among different lentil varieties, with an average pod setting of 93.1%. The flowers that did not set pods opened late (14–15 May) (Table 4). The relative humidity after 15 May was 50–60% on average, while the daily mean temperature was over 20°C, reaching as high as 22°C after 18 May (Table 3). This clearly indicates that a temperature >22°C is unfavorable for lentil to fertilize and bear fruits and further proves that the optimum temperature for lentil to bloom is within the range of 14–22°C. Also, it can be seen that temperature is the major climatic factor affecting ability to bear pods. In addition, the nutrient supplies have a certain effect on the pod-setting percentage. The flowers blooming after 14–15 May located on the apical part of primary and secondary branches were lower in pod-setting ability than those on more basally located branches.

Plasticity of Small and Large-seeded Lentil Cultivars†

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Abstract

The use of two different population densities for growing small- and large-seeded lentil can indicate differences in plasticity of these two types. To test this phenomenon, a field experiment was conducted in 1979/80 at the Agricultural Research and Education Centre of the American University of Beirut with five small- and five large-seeded lentil cultivars in three levels of population densities: 1,600,000, 533,000 and 266,000 plants/ha. A split-plot design with densities as main plot and cultivars as subplot was used. Data were collected on a per-plant basis. Effect of population density was significant for all the characters studied except 100-seed weight. Effect of cultivar was significant for all characters except biological yield. Interaction between density × cultivars was significant for yield/plant, plant height, number of seeds/pod, leaflets/leaf and one- and two-podded peduncles/plant. Orthogonal comparison showed the difference between two lentil types was significant for number of seeds/pod, 100-seed weight, plant height, stem diameter, days to maturity, number of primary and secondary branches, one-podded peduncles, nodes/plant, height of the first pod-bearing nodes and number of leaflets/leaf. Interaction of the two types with density was not significant for all characters studied, which shows the similar ability of these two types to utilize available resources.

† Contribution from the Faculty of Agricultural and Food Sciences, American University of Beirut, Beirut, Lebanon. Adapted from the M.Sc. work of the senior author.

كفاءة أصناف العدس الصغيرة الحبة والكبيرة الحبة

الملخص

إن استخدام كثافتين نباتيتين مختلفتين في زراعة أصناف عدس صغيرة الحبة وكبيرة الحبة يمكن أن يبرز الفروق في كفاءة هذين الطرازين. ومن أجل اختبار هذه الظاهرة نفذت تجربة حقلية في موسم 80/1979 في مركز البحوث الزراعية والتربوية التابع للجامعة الأمريكية في بيروت على خمسة أصناف عدس صغيرة الحبة وخمسة أصناف كبيرة الحبة زرعت في ثلاثة مستويات من الكثافة النباتية : 1,600,000 ، 533,000 ، 266,000 نبات/هـ. استخدم تصميم القطع المنشقة واعتبرت الكثافات كقطع رئيسية والأصناف كقطع ثانوية. وجمعت البيانات على أساس كل نبتة. كان تأثير الكثافة النباتية معنوياً بالنسبة لكل الصفات المدروسة باستثناء وزن المئة حبة. وكان تأثير الصنف معنوياً بالنسبة لجميع الصفات باستثناء الغلة البيولوجية. كما كان التأثير المتبادل بين الكثافة X الأصناف معنوياً بالنسبة للغلة/النبات، طول النبات، عدد البذور/القرن، الوريقات/الورقة، العنق ذات القرن الواحد أو القرنين/النبات. وقد أظهرت المقارنة المتعامدة أن الفرق بين هذين الطرازين من العدس معنوي بالنسبة لعدد البذور/القرن، وزن المئة بذرة، طول النبات، قطر الساق، عدد الأيام حتى النضج، عدد الفروع الأساسية والفرعية، وأعناق القرن الواحد، العُقد/النبات، طول العُقد الأولى الحاملة للقرون، وعدد الوريقات/الورقة. ولم يكن التفاعل بين الطرازين والكثافة معنوياً بالنسبة لجميع الصفات المدروسة مما يظهر القدرة المتشابهة لكلا الطرازين على الإستفادة من الموارد المتاحة.

Introduction

Plasticity refers to the ability of a crop to use efficiently the available resources. It points to the efficient use of resources in the partition of dry matter into harvestable products and in the partition of resources available to individual plants in the crop, allowing manipulation by crop management. Available resources like irrigation, fertilizer and space allocated per plant are quite easy to manipulate; even the availability of solar radiation is somewhat manageable in one way or another. In developing countries, crop management is more difficult to manipulate as tools and means are limited. Farmers usually grow crops under rain-fed conditions and fertilizer application is a rare practice. Only the staple crops, such as rice or wheat, get more careful attention. A legume crop, like lentil, which is an additional crop between two rice seasons or a fallow land crop, gets few inputs. Thus, for lentil grown under rain-fed, unfertilized conditions, the space allocated per plant remains the only easy way to manipulate plasticity. In those areas of the world where both small- and large-seeded lentils are grown, farmers use a high population density for small-seeded type and medium density for large-seeded type. The notion is that the large-seeded type has relatively higher plasticity in making better use of space allocated per plant than small-seeded types. This study tested the responses of small- and large-seeded lentil to different plant population levels.

Materials and Methods

A field experiment was conducted in 1979/80 at the Agricultural Research and Education Centre (AREC) of the American University of Beirut (AUB) with five small-seeded and five large-seeded lentil cultivars of diverse origin. Seeds were collected from the lentil world germplasm collection of the International Center for Agricultural Research in the Dry Areas (ICARDA), Aleppo, Syria. The countries of origin and seed characteristics of the cultivars are listed in Table 1.

Table 1. Accession number, country of origin and seed types of 10 lentil cultivars.

Accession number	Common name	Country of origin	Seed type
ILL 4401	Syrian local small	Syria	Small
ILL 1877	Wint pull 11	Turkey	Small
ILL 1880	Wint red 51	Turkey	Small
ILL 4399	Lebanese local	Lebanon	Small
ILL 179	74 TA 181	Turkey	Small
ILL 915	74 TA 66182	Spain	Large
ILL 467	—	Chile	Large
ILL 101	74 TA 138	Morocco	Large
ILL 468	—	Chile	Large
ILL 4400	Syrian local large	Syria	Large

Three levels of population densities, 1,600,000 (high density D_1), 533,000 (medium density D_2) and 266,000 (low density D_3) plants/ha, were used. To achieve these

different levels of population densities, row spacings of 2.5, 7.5 and 15 cm were used. A split-plot design with four replications was used with densities as main plots and cultivars as subplots. Each subplot was planted in four 5-m rows, 25 cm apart. The soil condition and the available nutrient status of the experimental plot (C-63) were studied by Ryan et al. (1980). Cropping history of that plot for the last 2 years was wheat in 1976/77 and sweet corn in 1977/78. The seed bed was prepared after plowing down the residues of the previous crop using a moldboard plow. Furadan was incorporated in the soil to control *Sitona* sp. at the rate of 60 kg/ha. Planting was done by hand on 15 November 1979. Seeds emerged on 17 December because of late rainfall. All plots were planted at a high seeding rate and plants were thinned later to establish the desired population densities.

Data were collected on eight plants from the central two rows in each subplot. The following characters were evaluated on a per-plant basis: grain yield (g), number of pods and seeds/pod, 100-seed weight (g), plant height (cm), stem diameter (mm), height of the first pod-bearing node from soil level (cm), number of leaflets/leaf based on eight leaves randomly picked per plot, days to physiological maturity recorded at 90% of pods yellowing or drying, number of primary and secondary branches, nodes, and one-, two-, three- and four-podded peduncles, biological yield after air drying (g) and harvest index.

Data were analyzed for all characters using a split-plot analysis. Orthogonal comparisons were done to partition sum of squares of densities, cultivars and their interaction following Steel and Torrie (1960).

Results and Discussion

Effect of population density was significant for all the characters studied except 100-seed weight, seed number/pod and plant height. There were significant differences between cultivars for all characters except biological yield (Table 2). Interaction between cultivars and population density was significant for grain yield, number of seeds/pod, plant height, number of leaflets/leaf and number of one- and two-podded peduncles/plant. Partitioning of treatments and interaction was done to show the effect of population density (i.e., available resources allocated as space per plant) on two lentil types (Table 3). Orthogonal comparison between small- and large-seeded lentil varieties (Q_1) indicates the differences between these two

Table 2. Mean squares for analysis of variance of split-plot design for characters in 10 lentil cultivars.

Character	Density	Main plot error	Cultivars	Cultivars × density	Subplot error
df	3	6	9	18	81
Grain yield/plant (g)	27.36**	1.75	4.23**	1.00**	0.51
Biological yield/plant (g)	273.99*	1.39	4.59	3.21	2.85
Harvest index	7.134**	0.008**	0.061**	0.010	0.005
No. pods/plant	46424.0**	211.0	1920.0**	529.0	318.0
No. seeds/pod	1.262	0.021	0.380**	0.095**	0.027
100-seed weight (g)	0.246	0.717	8.659**	0.333	0.228
No. primary branches/plant	195.23**	6.53	33.05**	3.10	2.23
No. secondary branches/plant	1465.88**	3.36	48.27**	7.37	10.45
No. nodes/plant	113658.0**	942.0	5102.0**	670.0	1493.0
Plant height (cm)	39.13	18.71	71.85**	8.99*	4.62
Height of first pod-bearing node from soil (cm)	132.36**	1.70	17.83*	1.63	1.18
No. leaflets/leaf	1.613**	0.122	7.884**	0.550*	0.303
No. one-podded peduncles/plant	3017.0**	34.0	288.0**	95.0**	31.0
No. two-podded peduncles/plant	4152.0**	29.0	358.0**	98.0**	37.0
No. three-podded peduncles/plant	112.0**	2.32	127.0**	14.0	8.63
Stem diameter (mm)	0.0693**	0.0001	0.0124**	0.0005	0.0004
Days to maturity	448.0**	21.83	350.67**	16.78	13.53

**, * Significant at 1% and 5% probability levels, respectively.

Table 3. Mean squares for orthogonal comparisons of characters in 10 lentil cultivars.

Characters	Q_1 (small- vs large-seeded type)	Q_2 (medium vs high and low density)	$Q_1 \times Q_2$
Grain yield/plant (g)	0.01	38.46**	0.06
Biological yield/plant (g)	1.64	13.5**	0.41
Harvest index	0.0002	0.09*	0.00006
No. pods/plant	568.0	3265.0**	526.0
No. seeds/pod	1.048**	0.743*	0.038
100-seed weight (g)	61.30**	0.021	0.009
No. primary branches/plant	174.6**	18.0	0.43
No. secondary branches/plant	170.2**	21.6	2.87
No. nodes/plant	24696.0**	1556.0	1262.0
Plant height (cm)	17.6*	5.64	1.85
Height of first pod-bearing node from soil (cm)	22.5**	7.01	0.58
No. leaflets/leaf	15.5**	1.8**	0.001
No. one-podded peduncles/plant	389.0**	28.0	0.0006
No. two-podded peduncles/plant	0.94	222.0*	134.0
No. three-podded peduncles/plant	0.0009	49.0**	0.149
Stem diameter (mm)	0.038**	0.007**	0.003
Days to maturity	371.0**	17.6	2.6

**, * Significant at 1% and 5% probability levels, respectively.

types and, between medium (D_2) vs. high (D_1) and low (D_3) density (Q_2), explains the behavior of cultivars over density levels. The third column of Table 3 ($Q_1 \times Q_2$) shows the interaction of two types with density, which reflects whether these two seeded types will have higher yield with more space allocated per plant, i.e., more available resources. The difference between the two lentil types was significant for number of seeds/pod, 100-seed weight, plant height, stem diameter, days to maturity, number of primary and secondary branches, one-podded peduncles and nodes/plant, heights from soil level of the first pod-bearing node and number of leaflets/leaf (Table 3). The effect of medium density over high and low density was significant for grain yield/plant, number of seeds/pod, stem diameter, biological yield, harvest index, number of leaflets/leaf, number of pods, secondary branches and two- and three-podded peduncles per plant. Interaction of two types with density levels was not significant for any of the characters studied, which reflects that these two lentil types do not differ in ability to use available resources given, i.e., space allocated per plant. The farmers' traditional concept about using different densities for different lentil types is in dispute. However, for conclusive comments, further experiments with different types of density levels should be conducted involving a number of small- and large-seeded cultivars.

References

Ryan, J., G. Musharrafieh and A. Barsumian. 1980. Soil fertility characterization at the Agricultural Research and Education Center of the American University of Beirut, Beirut, Lebanon. Publication No. 64. AUB, Beirut.

Steel, R.G.D. and J.H. Torrie. 1960. Principles and Procedures of Statistics: with Special Reference to the Biological Sciences. McGraw-Hill Book Company, Inc., New York.

Chemical and Mineral Composition of Lentil in the Flowering Stage as Affected by Herbicide Application in the Field

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Abstract

The paper presents the results of studies on the effect of soil and foliar herbicides on the chemical and mineral composition of lentil in the flowering stage and on its yield. The content of C, N, S, P, K, Ca, Mg, Na, Cl, Fe, Mn, Zn and Cu was determined in the plants and then the ratios of carbon to the other elements calculated. It was proved that the use of herbicides had not deteriorated the quality of lentil in the flowering stage. An increase in the carbon level in lentil in the flowering stage increased its seed yield; however, an increased sulphur level decreased it. The herbicides affected the yield of lentil mainly through accessibility of the mineral elements in the agrosystem.

تأثير استعمال المبيدات العشبية في الحقل على تركيب العدس الكيميائي والمعدني في طور الإزهار

الملخص

تعرض هذه الورقة نتائج دراسة عن تأثير المبيدات العشبية المضافة إلى التربة وتلك التي ترش على الأوراق، على التركيب الكيميائي والمعدني للعدس في طور الإزهار وعلى غلته. وتم تحديد محتوى نباتات العدس من العناصر التالية C، N، S، P، K، Ca، Mg، Na، Cl، Fe، Mn، Zn، Cu وبعدئذ حُسبت نسب الفحم إلى العناصر الأخرى. ولقد ثبُتَ أن استعمال المبيدات العشبية لم يؤدِ إلى تدهور جودة العدس في طور الإزهار. ولقد أدت زيادة مستوى الفحم في العدس في طور الإزهار إلى زيادة غلته البذرية، إلا أن الزيادة في مستوى الكبريت أدت إلى إنقاص تلك الغلة. وهكذا تؤثر المبيدات العشبية على غلة العدس من خلال نفاذ العناصر المعدنية إلى المجموع العشبي بشكل رئيسي.

Introduction

The use of herbicides modifies the agrosystem and affects cultivated plants both indirectly through changes in the number of plants and weeds, and directly through the chemical action of the organic compounds that herbicides contain. A considerable effect of herbicides is exerted also on soil microorganisms, hence on organic matter changes, i.e., the processes of mineralization and immobilization in the soil. All these influences may affect both the yield and quality of lentil (Trivedi and Tiwari 1986; Hernando et al. 1987; Bhatty 1988).

The objective of this study was to determine the effect of various herbicides on the chemical and mineral composition of lentil's aboveground parts in the flowering stage.

Materials and Methods

Studies on the lentil (*Lens culinaris* Medikus) cv. Trebisovska were carried out in the years 1987–89 on loess soil, near Lublin (51°19′ N, 22°16′ E, 206 m a.s.l.). The soil reaction in 1 mol KCL/dm^3 was 5.6; P and K content in soil, determined with the method of Egner-Riehm (Egner et al. 1960) was 130 and 152 mg/kg of soil, respectively; available Mg determined in 0.0125 mol $CaCl_2$ was 93 mg/kg of soil and the total N content was 1.120 g/kg. Organic carbon content, as determined with the method of Tiurin (Sokolov 1975), was 8.578 g/kg of soil.

The experiment was set up in a system of equivalent subblocks. It included 14 treatments in 4 replications: (1) hand weeding control, (2) Triflurotox (trifluralin 26%) 2 L/ha, (3) Afalon (linuron 50%) 2 kg/ha, (4) Comodor (tebutam 72%) 4 L/ha, (5) Azogard (prometryn 50%) 3 kg/ha, (6) Tribunil (methabenzthiazuron 70%) 3.5 kg/ha, (7) Stomp 330E (pendimethalin 33%) 4 L/ha, (8) Dosamix (metoksuron 72% + simazine 8%) 2.5 kg/ha, (9) Azogard + Kerb (prometryn 50% + propyzamide 50%) 3 + 1 kg/ha, (10) Command (clomazone 48%) 0.6 L/ha, (11) Aretit (dinoseb acetate 40%) 2 kg/ha, (12) Aretit 3 kg/ha, (13) Aretit 4 kg/ha and (14) Basagran (bentazon 50%) 2 L/ha. Treatments 2–10 were the

herbicides used in the soil, and Treatments 11–14 were the herbicides used on leaves. Triflurotox was used 3 days before seed sowing and incorporated into the soil; the remaining herbicides were used 3–10 days after sowing. Foliage herbicides were used when tendrils appeared on the plants, which was between 4 and 9 June.

In the crop rotation system lentil was cultivated after oats in the 5th year since the application of manure. Mineral fertilizers were applied (P, 35 kg/ha; K, 83 kg/ha); N fertilization was not used. Lentil seeds were sown in rows 25 cm apart, at 3–4 cm depth, in 4-m^2 plots. There were 200 seeds/m^2, which corresponded to 60 kg seed/ha. The dates of seeding in the study years were between 4 and 14 April. Flowering began between 15 and 19 June.

To determine the chemical and mineral composition of the lentil, plants in the flowering stage were used when the first small pods appeared. Annually from each treatment the whole 4 m^2 aboveground parts of the plant were taken. The number of weeds and their dry matter were determined before harvesting. The date of harvest was between 7 and 11 August.

Chemical composition was determined according to the following procedure: the dry matter was determined at 105°C, crude protein using the coefficient 6.25 × N% as total N, crude fibre with the acid-alkaline method, crude fat with the extraction method, crude ash was determined at 550°C and nitrogen-free extract based on the determined compounds.

The mineral composition was determined in the flowering stage way; C and N content with a Perkin-Elmer 240 CHN analyzer; P, K, Ca, Mg, Fe, Mn, Zn and Cu content after the mineralization of the plant material in quartz crucibles at 550°C; P calorimetrically with the vanadomolibdenic method; K with flame photometry method; Ca, Mg, Fe, Mn, Zn and Cu with the atomic absorption spectrophotometry method; total S with the nephelometric method; Na and Cl after plant material extraction with the acetic acid solution; Na with the flame photometry method, and Cl using silver nitrate calorimetrically.

The chemical analyses were made twice in each sample of plant material and the results were given in terms of dry matter. The ratios of carbon to the determined elements were calculated on a molar basis.

Results and Discussion

The characteristics of weed infestation and yield of lentil as affected by the herbicides are presented in Table 1 according to the studies of Wesolowski (Annales UMCS, parts I and II, in press). The highest increase in the yield of lentil seeds was caused by Dosamix 2.5 kg/ha, Azogard + Kerb 3+1 kg/ha, Tribunil 3.5 kg/ha, Stomp 330E 4 L/ha and Aretit 2 kg/ha. Command and Basagran were ineffective for weed control in lentil. The herbicides used in the studies, with the exception of Basagran, limited the number and weight of weeds in lentil.

Table 1. The characteristic of weeding and yield of lentil as affected by the application of herbicides.

Treatment	No. weeds/m^2	Dry matter of weeds (g/m^2)	No. plants/m^2	Seed yield (g/m^2)
1	52	183.8	110	98.5
2	127	488.3	94	53.6
3	49	308.7	91	35.5
4	85	278.0	113	66.0
5	81	307.7	117	59.2
6	71	358.6	111	68.7
7	82	306.7	105	68.5
8	70	309.3	107	73.8
9	74	293.7	105	71.2
10	66	286.1	77	55.9
11	84	288.3	115	83.8
12	72	295.8	112	79.9
13	75	285.5	109	77.8
14	105	415.3	69	18.6
LSD (0.05)	60	189.7	25	26.2

Table 2. The content of chemical compounds in lentil (g/kg dry matter) at the flowering stage as affected by the application of herbicides.

Treatment	Crude protein	Crude fiber	Crude fat	N-free extract	Crude ash
1	205.7	272.1	32.4	393.4	96.4
2	182.1	253.7	28.9	444.6	90.7
3	184.0	277.3	39.4	402.5	96.8
4	183.9	282.1	33.5	413.2	87.3
5	189.2	279.1	31.1	410.9	87.9
6	200.0	279.2	34.4	391.8	94.6
7	182.9	277.9	30.3	411.8	97.1
8	186.1	286.1	38.9	401.4	87.5
9	176.3	274.8	34.7	431.2	83.0
10	191.0	284.4	32.9	397.6	94.1
11	192.5	298.2	34.4	385.4	89.5
12	203.9	255.6	40.7	398.5	101.3
13	178.4	258.5	33.3	438.8	91.0
14	217.1	266.0	40.7	352.0	124.2

These herbicides also affected the chemical composition of lentil in the flowering stage (Table 2). The changes in the content of chemical compounds were dependent on the herbicides. The fodder value of green tops of lentil in the flowering stage, expressed in the content of chemical compounds, was high irrespective of the herbicides used. The greatest changes occurred in the content of crude proteins, crude fat and crude ash; however, the content of crude fibre and nitrogen-free extract changed in a lesser degree. Therefore, use of the herbicides clearly affected the chemical composition of lentil in the flowering stage.

The mineral composition of lentil in the flowering stage is presented in Table 3. The content of C, N, S, P, K, Na, Cl and Fe was significantly changed as affected by the herbicides; however, no significant differences between the element and the average level were found in Ca, Mg, Mn, Zn and Cu. Thus, it can be stated that significant differences were found in such elements as C, N, S, P and K. A significant differentiation in the carbon suggests that the herbicides applied affected the process of photosynthesis, which might have been caused primarily by the accessibility and uptake of the remaining mineral elements. The correlation between the mineral elements and the yield of lentil seeds shows that it was significant only between the content of C and S in lentil in the flowering stage and the yield of seeds; for C: $r = 0.657^{*}$, $b_{yx} = 3.251$ and for S: $r = -0.632^{*}$, $b_{yx} = -26.887$. Thus, limitation in carbon assimilation caused by the herbicides and increased sulphur accessibility are the two main factors that affected the yield of lentil.

The herbicides used were not homogeneous either chemically or in dosage, so it was accepted that the ratios determining quantitative correlations between carbon and the remaining mineral elements in lentil in the flowering stage characterize element ratios in the agrosystem because carbon was in the same amount in all treatments. The ratios of carbon to the other elements are presented in Table 4. The herbicides used had a significant effect on the uptake of mineral elements from the soil, which affected the yield of seeds irrespective of the conditions existing in the canopy of plants.

References

Bhatty, R.S. 1988. Composition and quality of lentil (*Lens culinaris* Medik): A review. *Canadian Institute of Food Science and Technology Journal* 21(2):144–160

Egner, H., H. Riehm and W. Domingo. 1960. Untersuchungen uber die chemische Bodenanalyse als grundlage fur die Beurteilung des Nahrstoffzustandes der Boden. *Annals of the Royal Agricultural College, Sweden* 26:199.

Hernando, J., R. Portillo, E. Garcia-Orbegozo and T. Fuertes. 1987. Weed survey and control studies on lentil in central Spain. *LENS Newsletter* 14(1/2):12–15.

Sokolov, A.V., ed. 1975. The Methods in Soil Science Analysis [in Russian]. Nauka, Moscow.

Trivedi, K.K. and J.P. Tiwari. 1986. Herbicidal weed control in lentil. *LENS Newsletter* 13(2):29–32.

Wesolowski, M. (in press). Effects of herbicides on yielding and weeding of lentil. Part I. Yielding of lentil. *Annales Universitatis Mariae Curie-Sklodowska, Sectio E.* [in Polish].

Wesolowski, M. (in press). Effects of herbicides on yielding and weeding of lentil. Part II. Weeding of lentil. *Annales Universitatis Mariae Curie-Sklodowska, Sectio E.* [in Polish].

Table 3. The mineral content of lentil (g/kg dry matter) at the flowering stage as affected by the application of herbicides.

Treatment	C	N	S	P	K	Ca	Mg	Na	Cl	Fe	Mn	Zn	Cu
1	439.1	35.1	1.84	5.04	21.3	7.79	1.95	0.46	5.92	0.17	0.028	0.072	0.008
2	441.9	29.8	1.83	4.55	20.5	6.03	1.78	0.53	6.38	0.17	0.041	0.088	0.009
3	436.7	32.6	1.97	4.53	21.2	6.51	1.74	0.41	9.07	0.23	0.021	0.071	0.008
4	440.5	28.5	1.44	4.39	20.3	5.82	1.63	0.40	6.80	0.13	0.026	0.073	0.015
5	442.3	29.9	2.16	4.64	20.7	5.89	1.72	0.48	6.41	0.12	0.029	0.073	0.011
6	436.4	33.4	2.12	5.03	21.3	7.08	1.97	0.43	6.71	0.17	0.029	0.079	0.011
7	441.0	28.0	1.57	4.36	21.3	6.38	1.69	0.50	8.82	0.15	0.022	0.065	0.007
8	440.2	33.7	1.55	4.71	20.7	6.20	1.69	0.46	5.49	0.14	0.037	0.068	0.010
9	443.5	30.2	1.81	4.28	18.7	6.48	1.73	0.41	3.93	0.18	0.035	0.070	0.012
10	438.6	34.7	1.93	4.34	20.8	7.41	1.64	0.52	7.08	0.20	0.022	0.056	0.014
11	443.8	31.9	1.84	8.73	21.3	9.83	2.34	0.42	6.57	0.25	0.040	0.098	0.015
12	438.3	32.8	2.21	4.50	21.3	7.20	1.86	0.57	8.16	0.28	0.030	0.063	0.013
13	443.0	30.9	1.54	4.26	19.2	6.59	1.65	0.55	4.29	0.21	0.029	0.067	0.013
14	428.0	35.4	3.36	6.11	23.1	7.35	1.91	0.58	5.51	0.42	0.027	0.071	0.014
LSD (0.05)	7.10	4.41	0.690	0.806	1.13	ns	ns	0.131	0.843	0.164	ns	ns	ns

Table 4. The ratio of carbon to determined elements in lentil at the flowering stage as affected by the application of herbicides.

Treatment	C:N	C:S	C:P	C:K	C:Ca	C:Mg	C:Na	C:Cl	C:Fe	C:Mn	C:Zn	C:Cu
1	14	641	224	67	203	455	1842	218	12470	70404	32982	297721
2	17	643	250	70	244	503	1600	204	12064	48783	27287	268993
3	15	595	248	67	223	507	2045	142	9461	93081	33465	290145
4	18	815	258	70	252	548	2131	191	15882	77701	32845	151297
5	17	547	247	69	251	519	1759	204	16997	68573	32722	204137
6	15	539	223	66	205	450	1952	192	11833	72065	29753	207484
7	18	756	261	67	230	528	1675	147	14188	90764	36558	298020
8	15	759	240	69	237	527	1841	236	15074	53862	34816	242283
9	17	654	266	77	228	518	2095	333	11370	57006	34512	186353
10	14	609	260	68	197	542	1618	183	10130	87956	42224	163709
11	16	641	130	67	172	435	2010	199	9246	59810	26448	150819
12	15	529	251	66	203	477	1483	159	7272	66407	37309	177748
13	16	623	268	75	224	542	1550	305	9817	69277	36002	170360
14	14	340	180	60	194	453	1426	229	4791	71585	32453	152821
LSD (0.05)	2	155	41	4	ns	ns	581	29	6986	ns	12421	ns

Pests and Diseases

Biological Control of Root Rot Disease of Lentil

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Abstract

***Gliocladium virens*, *Trichoderma harzianum* and *Paecilomyces lilacinus* significantly reduced root rot infection of lentil caused by *Macrophomina phaseolina*, *Rhizoctonia solani* and *Fusarium* spp. Use of microbial antagonists as soil drench or inoculum multiplied on wheat bran and rice grain was more effective than their use as seed dressing.**

المكافحة الحيوية لمرض تعفن الجذور على العدس

الملخص

قللت *Gliocladium virens* و *Trichoderma harzianum* من الإصابة إلى حد كبير بتعفن الجذور على العدس المتسبب عن *Paecilomyces lilacinus* و *Macrophomina phaseolina* و *Rhizoctonia solani* و *Fusarium* spp. وتبين أن استخدام الأعداء الميكروبية في تخضيل التربة أو في إكثار اللقاح على نخالة القمح أو حبوب الأرز أكثر فعالية من استخدامها في معاملة البذور.

Introduction

Lentil (*Lens culinaris*), an important pulse crop, was found to suffer from root rot and wilt diseases caused by *Macrophomina phaseolina* (Tassi) Goid, *Rhizoctonia solani* Kuhn and *Fusarium* spp. in Pakistan (Ghaffar 1990). Use of fungicides for the control of fungal pathogens is a common practice. Considering the cost of chemical pesticides and their associated environmental hazards, the use of microbial antagonists in the control of soil-borne plant pathogens has received increasing attention throughout the world (Mulder 1979). Experiments were therefore carried out on the biological control of root rot of lentil.

Materials and Methods

Cultures of *Trichoderma harzianum* Rifai (KUMH 115), *Gliocladium virens* Miller, Giddings & Foster (KUMH 464) and *Paecilomyces lilacinus* (Thom) Samson (KUMH 244) obtained from the Karachi University culture collection were used. The inoculum was multiplied on potato dextrose agar (PDA) for 5 days and the conidial suspension was used as seed dressing or as soil drench. For seed dressing, 1% gum arabic was used as sticker and each seed contained 3.6×10^5 conidia of *T. harzianum*, 5.6×10^5 conidia of *G. virens* and 4.9×10^5 conidia of *P. lilacinus*. For soil drench, a 300-ml conidial suspension of each microbial antagonist was applied in 2-m furrows. Each milliliter of suspension contained 1.2×10^7 conidia of *T. harzianum*, 1.2×10^7 conidia of *G. virens* and 2.5×10^7 conidia of *P. lilacinus*.

In another set the biocontrol agents were multiplied on wheat bran and rice grain and 7-day-old cultures were applied in soil at 0.1 and 0.3% w/w in 2-m furrows. The wheat bran culture contained 5.6×10^9 conidia/g of *T. harzianum*, 0.4×10^9 conidia/g of *G. virens* and 6.1×10^9 conidia/g of *P. lilacinus*. The rice grain culture contained 5.1×10^8 conidia of *T. harzianum*, 5.4×10^8 conidia of *G. virens* and 20.9×10^8 conidia of *P. lilacinus* per rice grain. The experiment was carried out on 2×1 m microplots in a randomized complete block design at the experimental field of the Department of Botany, University of Karachi, in January 1990. The soil had a natural infestation of 1–5 sclerotia of *M. phaseolina*/g of soil as found by using wet sieving and dilution technique (Sheikh and Ghaffar 1975), 4% colonization of *R. solani* on sorghum seeds used as baits (Wilhelm 1955), and 3000 cfu/g of soil of *Fusarium* spp. as assessed by soil dilution plate method (Waksman and Fred 1922). Each treatment was replicated three times.

Plants were uprooted after 30 days of growth. Ten 1-cm-long root pieces from each plant were cut, surface sterilized with 1% $Ca(OCl)_2$ for 3 minutes and transferred

to PDA plates containing Penicillin (10^5 units/L) and Streptomycin (0.2 g/L). Plates were incubated for 5 days at 28°C and the incidence of root-infecting fungi, viz. *M. phaseolina, R. solani* and *Fusarium* spp., was recorded.

Data of infection percentage were subjected to factorial analysis of variance (FANOVA) after arcsine transformation (Orlóci and Kenkel 1985).

Results and Discussion

Results of FANOVA are presented in Table 1. Infection percentage differed significantly among pathogens ($P<0.001$) but antagonists did not exhibit significant differences with respect to infection percentage. However, the different methods of application had significant ($P<0.001$) differential influence on infection percentage. Only the interaction of pathogen × method of application was significant ($P<0.001$); other interactions were not significant.

Infection of *M. phaseolina* was completely controlled when *T. harzianum* and *P. lilacinus* were used either as seed dressing, as soil drench or where wheat bran culture at 0.1% or rice grain culture at 0.1% and 0.3% w/w were used. *Gliocladium virens* showed complete control of *M. phaseolina* infection when used as soil drench and where wheat bran and rice grain inoculum were used (Fig. 1).

Infection by *R. solani* was completely inhibited by wheat bran and rice grain culture of *T. harzianum* and *G. virens* and where *G. virens* was used as soil drench. Infection of *R. solani* also was controlled where *P. lilacinus* was used as seed dressing or as soil drench or when rice grain culture of *P. lilacinus* was used at 0.3% w/w.

Fusarium infection was controlled by seed dressing with *G. virens* and *P. lilacinus*, in soil drench by *T. harzianum*, *G. virens* and *P. lilacinus*, and when wheat bran and rice grain culture of *T. harzianum* and *P. lilacinus* were used (Fig. 1).

In the present study all the microbial antagonists showed promising results in the control of *M. phaseolina*, *R. solani* and *Fusarium* infection on lentil roots. It may be mentioned that seed dressing or soil treatment with *T. harzianum*, *G. virens* and *P. lilacinus* effectively reduced infections of *M. phaseolina*, *R. solani* and *Fusarium* spp. on okra, sunflower, soybean and mungbean (Ehteshamul-Haque et al. 1990). Similarly, *P. lilacinus*, a parasite of *Meloidogyne* eggs, significantly reduced the infection of *M. phaseolina* on mungbean, okra and sunflower (Shahzad and Ghaffar 1989; Hussain et al. 1990).

The present study suggests that multiplication of biocontrol agents on organic substrate or its delivery in soil as drench is more effective for the control of root-infecting fungi than when used as seed dressing. There is a need to develop a simple, inexpensive method for the multiplication of microbial antagonists on different substrates and their delivery to the soil environment for control of root rot diseases.

Acknowledgements

We are thankful to Dr S. Shahid Shaukat for the statistical analysis of data. Funds provided by the NSRDB, Islamabad for research studies are gratefully acknowledged.

Table 1. Results of factorial analysis of variance (FANOVA) of infection by root-infecting fungi.

Source of variation	Sum of squares	df	Mean square	F	Prob.
Pathogen (A)	69802.010	2	3401.005	265.221	<0.001
Antagonists (B)	261.761	2	130.881	0.995	NS
Method of application (C)					
AB	242.040	4	60.510	0.460	NS
AC	36495.766	16	2280.985	17.334	<0.001
BC	2963.347	16	185.209	1.407	NS
ABC	4385.856	32	137.061	1.042	NS
Block	3419.261	2	1709.631		
Error	21054.739	160	131.592		
Total	189246.910	242			

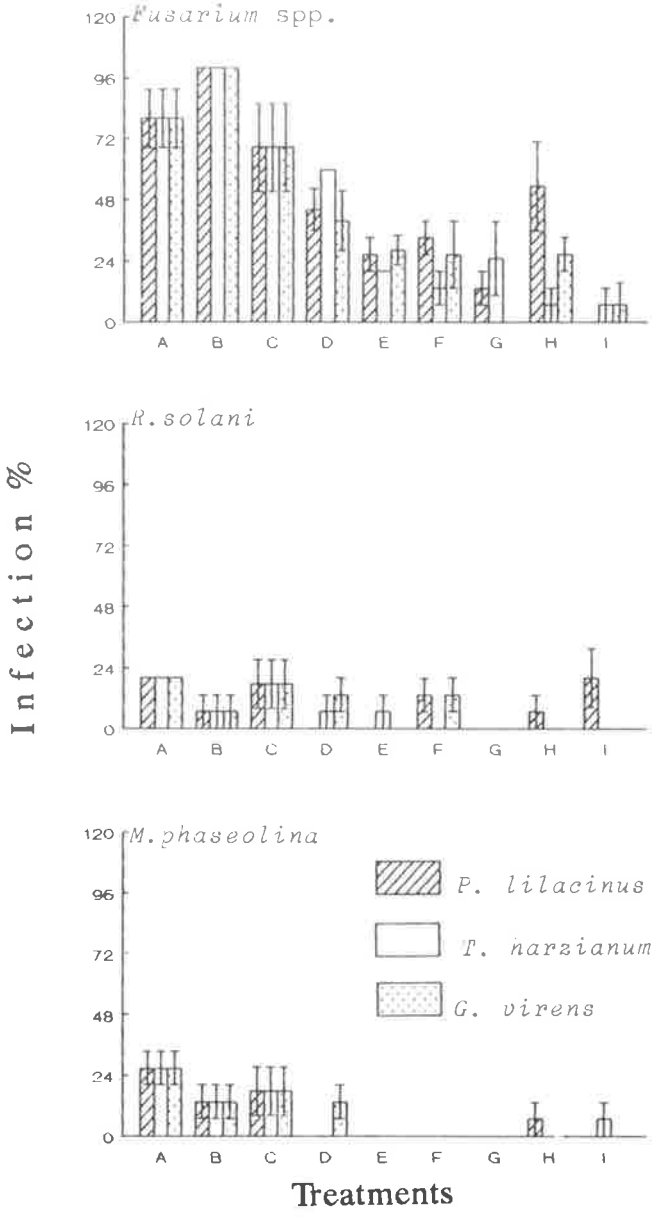

Fig. 1. Effect of *Trichoderma harzianum* (TH), *Gliocladium virens* (GV) and *Paecilomyces lilacinus* (PL) on infection of *Macrophomina phaseolina*, *Rhizoctonia solani* and *Fusarium* spp. on lentil roots. A, control (no substrate); B, control (wheat bran); C, control (rice grain); D, seed dressing; E, soil drench; F, 0.1% rice grain inoculum; G, 0.1% wheat bran inoculum; H, 0.3% rice grain inoculum; I, 0.3% wheat bran inoculum.

References

Ehteshamul-Haque, S., A. Ghaffar and M.J. Zaki. 1990. Biological control of root rot diseases of okra, sunflower, soybean, and mungbean. *Pakistan Journal of Botany* 22:121–124.

Ghaffar, A. 1990. Use of microorganisms in the biological control of root rot diseases of crop plants. Page 58 *in* First Annual Research Report, Department of Botany, University of Karachi, Karachi 75270, Pakistan.

Hussain, S., A. Ghaffar and M. Aslam. 1990. Biological control of *Macrophomina phaseolina* charcoal rot of sunflower and mungbean. *Journal of Phytopathology* 130:157–160.

Mulder, D. 1979. Soil Disinfestation. Elsevier Scientific Publication 10. Elsevier, Amsterdam.

Orlóci, L. and N.C. Kenkel. 1985. Introduction to data analysis: with examples from population and community ecology. ICPH, Fairland, Maryland, USA.

Shahzad, S. and A. Ghaffar. 1989. Use of *Paecilomyces lilacinus* in the control of root rot and root knot disease complex of okra and mungbean. *Pakistan Journal of Nematology* 7:47–53.

Sheikh, A.H. and A. Ghaffar. 1975. Population study of sclerotia of *Macrophomina phaseolina* in cotton fields. *Pakistan Journal of Botany* 7:13–17.

Waksman, S.A. and E.B. Fred. 1922. A tentative outline of the plate method for determining the number of microorganisms in the soil. *Soil Science* 14:27–28.

Wilhelm, S. 1955. Longevity of the *Verticillium* wilt fungus in the laboratory and field. *Phytopathology* 45:180–181.

Root Morphology and Anatomy in Relation to Wilt Incidence in Lentil

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Abstract

Vascular wilt in lentil is caused by *Fusarium oxysporum* f.sp. *lentis*. Incidence of the disease is influenced by both environment and host. A study of root morphology and anatomy revealed that lentil varieties with short roots and few secondary roots showed a low incidence of vascular wilt resistance. Furthermore, compact cork cambium, fully developed phellogen, thin-walled and narrow metaxylem were the characteristics of lentil varieties exhibiting resistance to wilt. No significant anatomical variation was found between varieties of lentil resistant and moderately resistant to vascular wilt.

الشكل الظاهري للجذور وتشريحها فيما يتعلق بإصابتها بالذبول الوعائي في العدس

الملخص

يسبب *Fusarium oxysporum* f.sp. *lentis* مرض الذبول الوعائي في العدس. وتتأثر الإصابة بالبيئة والعائل معاً. وقد بينت دراسة عن الشكل الظاهري للجذور وتشريحها أن أصناف العدس القصيرة الجذور والقليلة الجذور الثانوية أظهرت مقاومة متدنية للإصابة بالذبول الوعائي. كما كانت الطبقة الفلينية المتراصة (الكامبيوم) والطبقة المولدة للفلين والنسج الكاملة النمو والخشب الإبتدائي الضيق ذي الجدران الرقيقة خصائص أصناف العدس التي تبدي مقاومة لذلك المرض. ولم يكن هناك تباين معنوي بين تشريح أصناف العدس المقاومة والمتوسطة المقاومة لمرض الذبول الوعائي.

Introduction

Much work has been carried out on the host resistance of lentil against rust (Reddy 1980; Reddy and Khare 1984). However, information is lacking for soil-borne diseases in lentil. The present work was undertaken to determine whether root morphology and anatomy influence incidence of wilt in lentil.

Materials and Methods

To study the influence of host structure on vascular wilt incidence in lentil, six varieties, namely Pant L-234 and Pant L-639 (resistant), JPL-355 and JPL-1014 (moderately resistant) and JL-1 and JPL-18 (susceptible), were selected. Observations were recorded when the crop was 45 days old. Morphological characteristics were examined after carefully uprooting the plant and thoroughly washing it. Transverse sections of 25 μm thickness were cut with a microtome to study the root anatomy. To record wilt incidence (in %), sterilized seeds were sown in infested soil containing the desired inoculum of the pathogen (Khare 1980).

Results and Discussion

Root length was significantly less in resistant and moderately resistant varieties than in susceptible varieties (Table 1). It was minimal (5.0 cm) in Pant L-234, which exhibited 4.2% wilt incidence. The maximum incidence of wilt was 53.5% in JPL-18, which had 10.27-cm-long roots. Similarly, secondary roots were significantly less in resistant and moderately resistant varieties than in susceptible ones. The least number of secondary roots (4.67) was noted in Pant L-234, where incidence of wilt was minimum. The incidence of wilt increased with the increase of root length and secondary roots. Correlation coefficients of root length ($r = 0.95$; $y = -51.8 + 10.2x$) and secondary roots ($r = 0.99$; $y = 24.0 + 5.8x$) were significant. Susceptibility may be due to exposure of more surface because of long roots. The pathogen *Fusarium oxysporum* f.sp. *lentis* gains entry through natural openings, such as emergence of secondary roots, or through wounds, which expose xylem (Khare 1980). The greater number of secondary roots in susceptible varieties provided more potential entry points for the pathogen and increased the contact surface.

Besides morphology, anatomical characters of root-like cuticle thickness (Martin 1964), type of epidermis and periderm (Campbell et al. 1980) are involved in resistance. The cells composing periderm arise from cork

Table 1. Influence of root morphology and anatomy on vascular wilt incidence in lentil.

Varieties	Wilt incidence (%)	Reaction†	Morphology		Anatomy of metaxylem	
			Root length (cm)	Number of secondary roots	Diameter (μm)	Wall thickness (μm)
Pant L-234	4.2	R	5.00	4.67	25.70	2.997
Pant L-639	5.0	R	5.43	5.00	29.98	2.997
JPL-355	8.9	MR	6.13	5.67	29.98	4.280
JPL-1044	8.1	MR	7.07	6.00	29.13	3.850
JL-1	40.1	S	8.33	13.67	35.12	4.710
JPL-18	53.5	S	10.27	10.33	35.98	4.710
SEM ±			0.454	1.088	1.099	0.391
LSD (0.05)			1.399	3.356	3.410	1.206

† R = resistant; MR = moderately resistant; S = susceptible.

cambium (phellogen). The periderm provides strong resistance to the invading pathogen (Jensen et al. 1963). Internal structures of lentil root revealed that cork cambium cells were more compact and multilayered in resistant varieties. The phellogen also was fully developed, causing a barrier to the invading pathogen (Fig. 1). The fungus ultimately colonizes the metaxylem and stops the supply of water and mineral ions, resulting in loss in turgidity and finally wilting. Critical studies of metaxylem (Fig. 2) showed that diameter of metaxylem in resistant varieties was significantly less (25.7–29.98 μm) than in susceptible varieties (35.12–35.98 μm). No marked differences were found in the diameter of metaxylems of moderately resistant and resistant varieties. The thickness of metaxylem in roots of resistant varieties was at least 2.997 μm, whereas in susceptible varieties it was 4.71 μm (Table 1). It is evident that thickness and diameter of metaxylem were positively correlated with the fusarial wilt incidence and values of correlation coefficients were 0.81 ($y = 66.0 + 21.9x$) and 0.92 ($y = -136.9 + 5.1x$), respectively. The narrow metaxylem and thin outer wall influence translocation and provide more flexibility in resistant varieties; this is responsible for rapid translocation of water and mineral substances. Thus, the fungus has less time to colonize in the metaxylem of the root in resistant varieties. A large lumen of metaxylem provides more space for the pathogen and a slow rate of translocation favors its development and colonization in susceptible varieties.

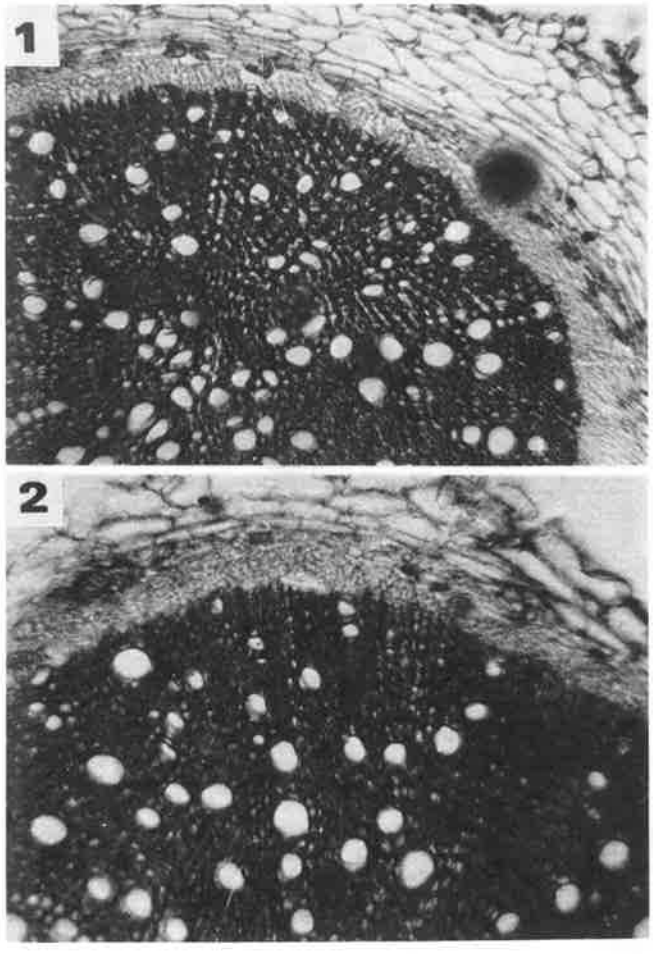

Fig. 1. Transverse sections of lentil roots: (1) compactness of cork cambium cells in Pant L-234 resistant to wilt; and (2) large and loose cork cambium cells in JPL-18 susceptible to wilt. (145 X)

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The senior author is thankful to the Indian Council of Agriculture Research for providing a Senior Research Fellowship.

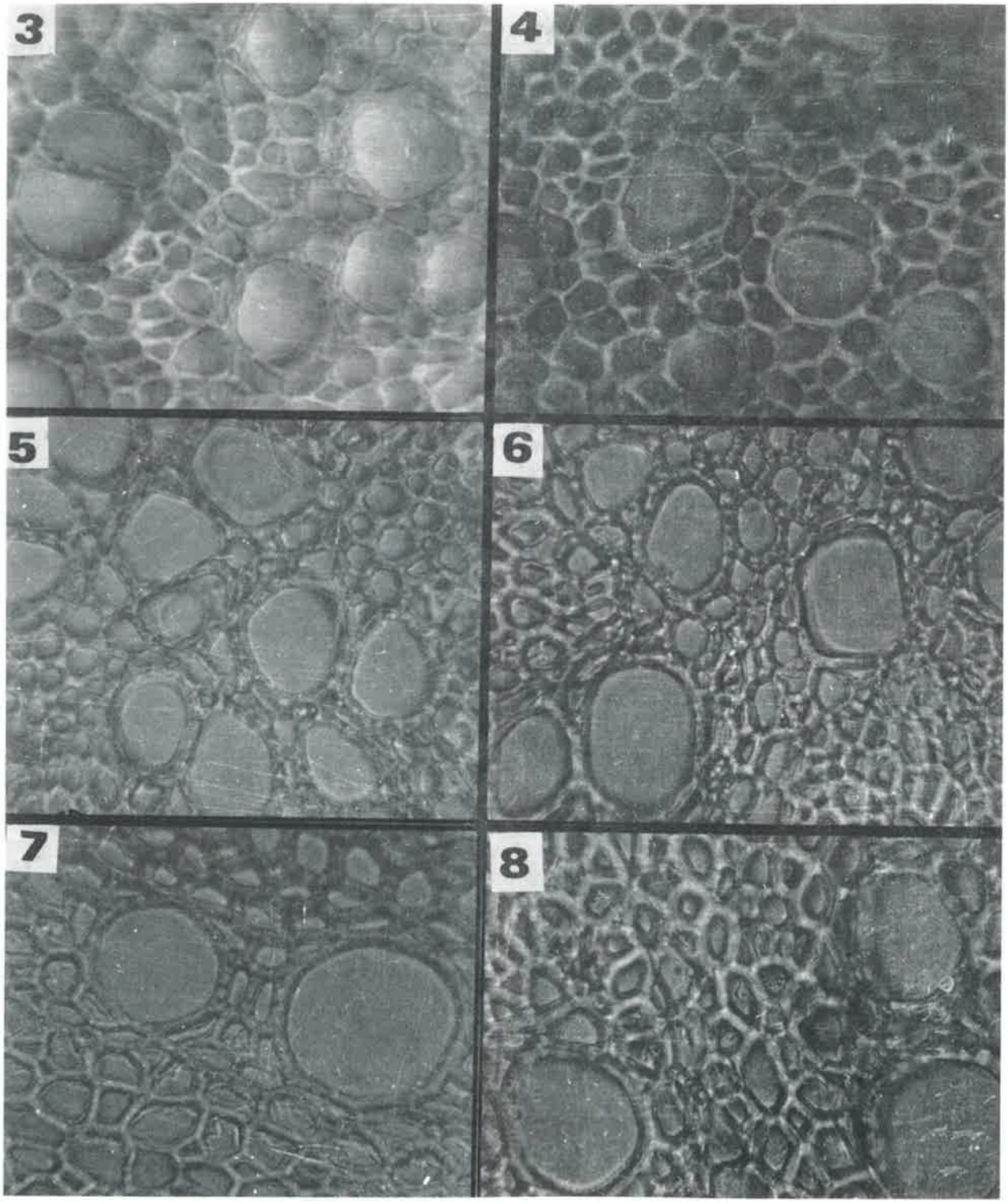

Fig. 2. Structure of metaxylem in roots of different lentil varieties: (3) and (4) narrow metaxylem vessels and thin wall in roots of Pant L-234 and Pant L-639 (resistant to wilt); (5) and (6) intermediate type of metaxylem vessels and thickness of wall in roots of JPL-355 and JPL-1014 (moderately resistant to wilt); (7) and (8) large metaxylem vessels and thick walls in susceptible varieties of lentil JL-1 and JPL-18. (600 X)

References

Campbell, C.L., J.S. Huang and G.A. Payne. 1980. Defense at the perimeter: The outer walls and the gates. Pages 103-120 *in* Plant Disease—An Advanced Treatise (J.G. Horsfall and E.B. Cowling, eds.), Vol. 5. Academic Press, New York.

Jensen, W., K E. Fremer, P. Sierila and V. Watiovaara. 1963. The chemistry of bark. Pages 587–666 *in* The Chemistry of Wood (B.L. Browning, ed.). Wiley (Inter Science), New York.

Khare, M.N. 1980. Wilt of Lentil. Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (M.P.).

Martin, J.T. 1964. Role of cuticle in the defense against plant disease. *Annual Revue of Phytopathology* 2:81–100.

Reddy, P.N. 1980. Mechanism of resistance in lentil (*Lens culinaris* M.) to rust (*Uromyces fabae* (Pers.) de Bary). M.Sc. Thesis, Jawaharlal Nehru Agricultural University Jabalpur, India.

Reddy, R.R. and M.N. Khare. 1984. Further studies on factors influencing the mechanism of resistance in lentil (*Lens culinaris* M.) to rust (*Uromyces fabae* (Pers.) de Bary). *LENS Newsletter* 11:29–32.

In vitro Evaluation of Fungicides against *Botrytis cinerea* of Lentil

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Abstract

Using the poisoned-food technique, 14 fungicides (Antracol, Bayton, Benlate, Calixin-M, Cobox, Daconil, Dithane M-45, Liromenzeb, Polyram Combi, Ridomil, Tecto-60, Topsin-M, Tri-Miltox Forte and Vitavax) were tested against *Botrytis cinerea* Pers. ex Fr, the causal fungus of lentil blight. Benlate, Calixin-M and Tecto-60 were the most effective in suppressing the growth of the fungus.

تقييم مخبري للمبيدات الفطرية ضد العفن الرمادي على العدس (*Botrytis cinerea*)

الملخص

باستخدام تقنية الغذاء المسمم، تم اختبار 14 مبيداً فطرياً (أنتراكول، بيّتون، بينليت، كاليكسين-م ، كوبكس، داكونيل، ديثين م-45 ، ليروميتزيب، بوليرام كومبي، ريدوميل، تيكتو-60، توبسين-م، تري ميلتوكس فورت وفيتافاكس) إزاء *Botrytis cinerea* Pers. ex Fr الفطر المسبب للعفن الرمادي على العدس. وكانت المبيدات بينليت وكاليكسين-م وتيكتو-60 أكثر المبيدات فعالية في كبح نمو الفطر.

Introduction

Lentil (*Lens culinaris* Medik.) suffers from a number of diseases which are caused by fungi, bacteria, viruses, nematodes and phanerogamic plant parasites (Khare et al. 1979). In recent years, it has been attacked by Botrytis blight, which caused severe losses to the crop (Anonymous 1989). Blight caused by *B. cinerea* has been reported in Syria (Bellar and Kebabeh 1983) and India (Kannaiyan and Nene 1973). Varieties of lentil resistant to blight were reported in the USSR (Moghileff and Ryakhovski 1937). The best protection of lentil seeds against *B. cinerea* has been achieved with Captan and Thiram (Kovacikova 1970). Baudys (1929) suggested chemical control of the disease by spraying 1.5% lime sulphur and 1.0% sulikol.

Genetic resistance is the most effective method to control the disease. However, if resistant varieties are not available, the use of fungicides may be an alternative control measure. Therefore, the in vitro effect of some fungicides was tested on mycelial growth of *B. cinerea*.

Materials and Methods

The fungus was isolated from infected stems of lentil on potato dextrose agar (PDA) medium purified and increased on chickpea seed meal agar (CSMA) medium. The toxicity of 14 fungicides, viz., Antracol (zinc propylene bisdithiocarbamate), Bayton (beta-chlorophenoxy triazol ethanol), Benlate (methyl-N butylcarbamyl benzimidazole carbamate), Calixin-M (dimethyl tridecyl morpholine), Cobox (copper oxychloride), Daconil (tetrachloroisophythalonitle), Dithane M-45 (zinc and manganese ethylene bisdithiocarbamate), Liromenzeb (manganese and zinc ethylene bisdithiocarbamate), Polyram Combi (zinc polyethylene thiuram disulphate), Ridomil (methyl-N

dimethyl phenyl-alaninate), Tecto-60 (thiazolyl-benzimidazole), Topsin-M (bismethoxycarbonyl thioureido-benzene), Tri-Miltox Forte (zinc and manganese ethylene bisdithiocarbamate) and Vitavax (dihydro methyl-oxathiin carboxanilide), was tested by the poisoned-food technique (Nene and Thapliyal 1979).

Each fungicide was mixed separately in autoclaved melted CSMA medium to obtain the required concentration (100 ppm). Poisoned melted medium (20 ml) was then poured into each sterilized plate and allowed to solidify. CSMA medium without fungicide served as control. After solidification, 3-mm agar plugs of actively growing cultures of the fungus were placed in the center of the plates. Ten plates were used per treatment and incubated at 20 ± 2°C. Growth inhibition rate of the fungus was recorded after 8 days of incubation. Percent inhibition was calculated according to Vincent (1947).

Results and Discussion

Most of the test fungicides significantly reduced the mycelial growth of the fungus. Complete reduction in mycelial growth was observed when Benlate, Calixin-M and Tecto-60 were used. Fungicides Topsin-M, Vitavax and Ridomil significantly inhibited the mycelial growth of *B. cinerea* by 99, 84 and 82%, respectively, compared with the control (Table 1).

Table 1. In vitro evaluation of fungicides against blight of lentil caused by *Botrytis cinerea*.

S no.	Treatments	Radial growth (mm†)	Decrease over control (%)
1	Control	9.00a	—
2	Antracol	4.44e	51
3	Bayton	6.67cd	26
4	Benlate	0.00h	100
5	Calixin-M	0.00h	100
6	Cobox	9.00a	0
7	Daconil	6.30d	30
8	Dithane M-45	7.24c	20
9	Liromenzeb	3.35f	63
10	Polyram Combi	4.31e	52
11	Ridomil	1.64g	82
12	Tecto-60	0.00h	100
13	Topsin-M	0.08h	99
14	Tri-Miltox Forte	8.65ab	4
15	Vitavax	1.44g	84

† Values followed by same letters do not differ significantly using the DMR test at 5% level of probability.

Use of fungicides for the control of fungal diseases is a common practice. There are several reports that fungicides were used as foliar spray, soil drench and seed treatment. The chocolate leaf spots of faba bean caused by *Botrytis fabae* can be controlled effectively by the spray of bavistan and Benlate (Osman 1979; Elliott and Whittington 1980). Efficacy of Benlate has been confirmed against blight of lentil (Iqbal et al. 1989) and *Ascochyta lentis* (Bashir et al. 1987). Tecto-60 has been proved effective against *A. fabae* (Kharbanda and Bernier 1979). Complete reduction of seedborne *A. rabiei* of chickpea was achieved when the seeds were treated with Calixin-M (Reddy 1980).

In light of the present study, Benlate, Calixin-M and Tecto-60, followed by Topsin-M, Vitavax and Ridomil, can be recommended for further investigation.

References

Anonymous. 1989. Annual report of food legume crops 1988-89. Pulses Programme, National Agricultural Research Centre, Islamabad, Pakistan.

Bashir, M., S.S. Allam and B.A. Malik. 1987. In vitro evaluation of fungicides against *Ascochyta lentis*. *LENS Newsletter* 13(1):26-27.

Baudys, E. 1929. Phytopathological notes iii. *Ochrana Rostlin* 7(6):118-128.

Bellar, M. and S. Kebabeh. 1983. A list of diseases, injuries and parasitic weeds of lentil in Syria (survey 1979-1980). *LENS Newsletter* 10(1):30-31.

Elliott, J.E.M. and W.J. Whittington. 1980. The control of chocolate spot (*Botrytis fabae*) infection of field beans (*Vicia faba* L.) by the fungicides Benlate, bavistin, cercobin and BAS352F. *Journal of Agricultural Science* 94(2):461-464.

Iqbal, S.M., A. Bakhsh, S. Ahmad and M. Bashir. 1989. Field evaluation of fungicides against ascochyta blight of lentil. *Sarhad Journal of Agriculture* 5(3):307-309.

Kannaiyan, J. and Y.L. Nene. 1973. Sclerotial blight of lentil. *Current Science* 42:32.

Kharbanda, P.D. and C.C. Bernier. 1979. Effectiveness of seed and foliar fungicides to control Ascochyta blight of faba bean. *Canadian Journal of Plant Science* 59:661-666.

Khare, M.N., S.C. Agarwal and A.C. Jain. 1979. Diseases of lentil and their control. Technical Bulletin JNKVV, Jabalpur, M.P., India.

Kovacikova, E. 1970. Seed treatment of lentil and pea against some fungal diseases. *Ochrana Rostlin* 6(2):117-126.

Moghileff, L.M. and N.A. Ryakhovski. 1937. Varieties of lentil resistant to wilt. *Plant Protection, Leningrad* 14:110-111.

Nene, Y.L. and P.N. Thapliyal. 1979. Fungicides in Plant Disease Control. Oxford and IBH Publishing Company, New Delhi, India.

Osman, A.R. 1979. In vitro evaluation of systemic fungicides (Benlate and MBC) against the pathogenic fungus *Botrytis cinerea* infecting seeds of *Vicia faba* L. in Egypt. 1. A direct bioassy technique. Pages 1032-1045 *in* Proceedings of 3rd Egyptian Congress, Cairo, Egypt. The Egyptian Phytopathological Society, Cairo.

Reddy, M.V. 1980. Calixin-M an effective fungicide for eradication of *Ascochyta rabiei* in chickpea seeds. *International Chickpea Newsletter* 3:12.

Vincent, J.M. 1947. Distortion of fungal hyphae in the presence of certain inhibitors. *Nature* 159:850.

Effect of Lentil Strain of Pea Seedborne Mosaic Virus on Lentil

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Abstract

Pea Seedborne Mosaic Virus was isolated from naturally infected lentil variety Precoz showing serious mosaic symptoms. Leaves demonstrated chlorotic pale spots and shortening of internodes, and plants were stunted. Infected plants bore fewer flowers and pods. In growth and yield components, decrease in plant height, number of pods, number of seeds and yield/plant was 51.2, 58.4, 65.6 and 72.0%, respectively. An electron micrograph from leaf dip preparation showed flexuous, rod-shaped virus particles.

تأثير سلالة من فيروس موزاييك البازلاء، المنقول على البذور، على العدس

الملخص

عُزل فيروس موزاييك البازلاء المنقول على البذور عن صنف العدس بريكوز المصاب بصورة طبيعية والذي تظهر عليه أعراض خطيرة من التبرقش، إذ توضعت بقع صفراء شاحبة على الأوراق وقصرت السلاميات وتقزمت النباتات، كما حملت النباتات المصابة عدداً أقل من الأزهار والقرون. وفي النمو ومكونات الغلة، بلغت نسبة التناقص في طول النبات، وعدد القرون، وعدد البذور والغلة/النبات 51.2 و 58.4 و 65.6 و 72.0 ٪ على التوالي. وقد أظهرت الصورة بالمجهر الإلكتروني لمستحضر منقوع الورقة جزئيات ملتوية على هيئة عصيات من الفيروس.

Introduction

Lentil (*Lens culinaris* Medik.) is one of the important legume crops of Pakistan. In an area of 76,000 ha, 33,000 t are produced with a yield of 434 kg/ha (FAO 1990), which is low compared with yields of 1900, 1425 and 1385 kg/ha in Egypt, USA and France, respectively. Pea seedborne mosaic virus (PSbMV) of lentil strain is important among the diseases responsible for low yields.

Under field conditions the virus can overwinter in hairy vetch (*Vicia villosa* Roth.) and volunteer peas (*Pisum sativum* L.). The virus is transmissible to susceptible pea cultivars planted nearby (Stevenson and Hagedorn 1973) and yield and seed quality are adversely affected (Stevenson and Hagedorn 1970). This strain, transmissible manually or by aphids to all known pea and lentil cultivars (Hampton and Baggett 1970; Gonzalez and Hagedorn 1971), was discovered to be a seedborne contaminant of the US lentil germplasm collection (Hampton 1982). The frequency of seed transmission in lentil is estimated to range from 32 to 44% (Hampton and Muehlbauer 1977). Symptoms of PSbMV in lentil are similar to those in pea, causing plant stunting, leaf rolling, leaf size reduction, stem twisting, flower distortion and reduced seed set (Hampton and Muehlbauer 1977). The cause of the high incidence of seed transmission and the susceptibility of commercial lentil cultivars in the Pacific Northwest, USA is vulnerability to PSbMV. The purpose of this study was to identify the virus problem in lentil through symptom expression, indicator hosts and electron microscopy. Moreover, disease incidence and yield losses were assessed to determine the economic importance of the

disease. Control depends on the use of virus-free seed stocks, but the ultimate means of control would be cultivars resistant to PSbMV.

Materials and Methods

To confirm the viral nature of PSbMV, symptom expression, mechanical inoculation and particle morphology with leaf dip methods were applied. Yield loss and effects of the virus on growth components were studied at NARC, Islamabad. Seeds were collected from both PSbMV-infected and healthy plants of lentil cultivar Precoz in 1988, and planted in the *rabi* (winter) season of 1989. Each lot was planted in a 5 × 10 m plot, with a row-to-row and plant-to-plant spacing of 20 and 10 cm, respectively. Twenty healthy plants with no signs of infection and the same number of diseased plants showing distinct PSbMV symptoms at flowering stage were selected at random, marked and harvested individually at maturity. Various parameters contributing to yield, such as plant height, number of branches, pods, seeds and yield/plant were recorded. The data were statistically analyzed with student "t" test and the results in percentage of losses were compared.

Results and Discussion

The effects of the virus on growth components of lentil crop revealed that the percentages of decrease over control were 51.2, 58.4, 65.6 and 72.0 for plant height, number of pods, number of seeds and yield/plant, respectively (Table 1). The decrease in number of branches was nonsignificant. Although seed and aphid transmissions were not confirmed in our experiment, the primary infection of disease might be through infected seeds (Hampton 1982) and the secondary through aphids (Gonzalez and Hagedorn 1971). Because PSbMV is basically a disease of peas that has been transmitted to lentil, it is suggested that these two crops should not be planted near each other. The other possible control measure is the selection of resistant varieties. Attempts also should be made to eliminate neighboring leguminousweeds, which act as a source of virus and vectors. If we sow seeds collected from virus-free plants, we can control the disease by as much as 50%, because the virus is readily seed transmitted (Mink et al. 1969; Hampton and Muehlbauer 1977).

Table 1. Yield loss per plant in lentil cv. Precoz due to the effect of pea seedborne mosaic virus (PSbMV).

Characters	Average		Decrease over control (%)	t value
	Healthy	Diseased		
Plant ht. (cm)	42.8	20.9	51.2	11.4*
No. branches	13.5	10.9	19.3	1.2
No. pods	102.2	42.55	58.4	3.7*
No. seeds	157.2	54.1	65.6	4.8*
Yield (g)	8.5	2.4	72.0	5.0*

* $P < 0.05$.

The observed symptoms of the disease were similar to those reported by Hampton and Muehlbauer (1977): stunting of the plants, mild systemic mosaic, deformed pods, shortening of the internodes and downward curling of the leaflets. According to the reaction on the different hosts, the virus was mechanically transmissible to *Chenopodium amaranticolor*, which showed local lesions, and peas showed systemic mosaic symptoms. An electron micrograph from a leaf dip preparation showed flexuous, rod-shaped virus particles (Fig. 1).

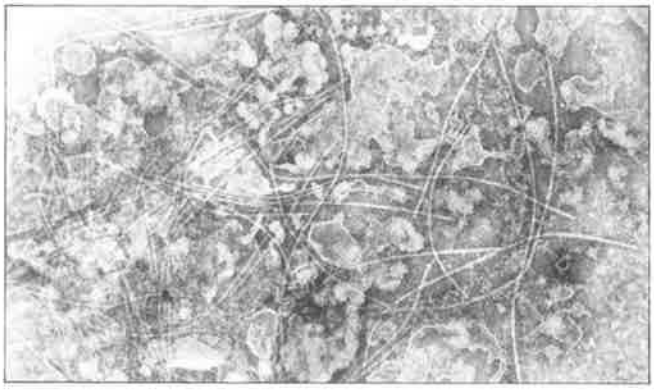

Fig. 1. Flexuous, rod-shaped particles of pea seedborne mosaic virus (magnification = 20,000; enlargement = 4.5 X)

References

FAO. 1990. Yearbook, 1989, Vol. 43. Food and Agriculture Organization of the United Nations, Rome.

Gonzalez, C.L. and B.J. Hagedorn. 1971. The transmission of pea seedborne virus by three aphid species. *Phytopathology* 6:825–828.

Hampton, R.O. 1982. Incidence of the lentil strain of pea seedborne mosaic virus as contaminant of *Lens culinaris* L. germplasm. *Phytopathology* 72:695–698.

Hampton, R.O. and J.R. Baggett. 1970. Host effects and diagnostic symptoms of pea fizzletop disease. *Plant Disease Reporter* 54:355–358.

Hampton, R.O. and F.J. Muehlbauer. 1977. Seed

transmission of the pea seedborne virus in lentils. *Plant Disease Reporter* 61:235–238.
Mink, G.I., J. Kraft, J. Knesek and A. Jafri. 1969. A seedborne virus of peas. *Phytopathology* 59:1342–1343.
Stevenson, W.R. and D.J. Hagedorn. 1970. Effect of seed size and conditions on transmission of pea seedborne mosaic virus. *Phytopathology* 60:1148–1149.
Stevenson, W.R. and D.J. Hagedorn. 1973. Overwintering of pea seedborne mosaic virus in hairy vetch *Vicia villosa*. *Plant Disease Reporter* 57:349–352.

Effect of Fungicidal Seed Treatment on Lentil Germination and Recovery of Seedborne *Ascochyta fabae* f.sp. *lentis*

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Abstract

Effect of seed dressing with eight systemic (0.1%) and nonsystemic (0.2%) fungicides on the germination of lentil seed infected by *Ascochyta fabae* f.sp. *lentis* was studied by using the blotter test technique. Benlate, Daconil, Calixin-M and Antracol significantly increased the germination of seeds over control whereas Calixin-M, Benlate, Tecto-60 and Topsin-M proved effective in the eradication of seedborne inoculum of *A. fabae* f.sp. *lentis*.

تأثير معاملة البذور بالمبيدات الفطرية على إنبات العدس وتجدد (انتعاش) التبقع الأسكوكيتي المنقول على البذور *Ascochyta fabae* f. sp. *lentis*

الملخص

تمت دراسة تأثير معاملة البذور بثمانية مبيدات فطرية جهازية (0.1٪) وغير جهازية (0.2٪) على إنبات بذور العدس المصابة بمرض التبقع الأسكوكيتي باستخدام تقنية الإختبار على ورق نشاف. أدت المبيدات بينليت وداكونيل وكاليكسين -م وانتراكول إلى زيادة معنوية في إنبات البذور مقارنة بالشاهد، في حين أثبتت المبيدات كاليكسين-م وبينليت وتيكتو-60 وتوبسين-م فعاليتها في القضاء على اللقاح المنقول على البذور من الفطر *A. fabae* f.sp. *lentis*

Introduction

Lentil blight caused by *Ascochyta fabae* Speg. f.sp. *lentis* (Gossen) is one of the most devastating lentil diseases. The disease has been reported to cause as much as 40% yield losses (Gossen and Morrall 1983). Seedborne inoculum is reported to be an important survival mechanism in lentil blight (Gossen and Morrall 1981; Kaiser 1987) and the seedborne nature of the fungus has been confirmed by Seid and Beniwal (1988). Seed dressing with various fungicides such as benomyl, carbendazim carbathiin, ipodion and thiabendazole for the control of seedborne lentil blight under field conditions has been evaluated (Morrall and Gossen 1979, 1981; Morrall 1980, 1988; Morrall and Beauchamp 1984; Beauchamp and Morrall 1985). Seed treatment with thiabendazole and benomyl were the best for control of lentil blight (France et al. 1987; Russell et al. 1987). Other fungicides such as thiabendazole, thiram and metalaxyl also were reported to be effective (Bretag 1989).

Considering the effectiveness of various fungicides that reduce or eliminate the initial inoculum and prevent the spread of seedborne diseases, this study was conducted to determine the in vitro effect of various new commercial fungicides on lentil seed germination and recovery of seedborne *A. fabae* f.sp. *lentis*.

Materials and Methods

Eight fungicides—Antracol (zinc propylene disthiocarbamate), Benlate (methyl N-butylcarbamyl

Table 1. Effect of fungicidal seed treatment of lentil on seed germination and recovery of seedborne *A. fabae* f.sp. *lentis*.

Treatment	Concentration	Seed germination		Recovery of seedborne *A. fabae* f.sp. *lentis*	
		Germination (%)	Increase over control (%)	Recovery (%)†	Decrease over control (%)
Control	—	39.2 c†	—	69.6 a	—
Antracol	0.2	69.6 a	77.6	43.2 cd	37.9
Benlate	0.1	76.0 a	93.9	21.6 fg	68.9
Calixin M	0.1	72.0 a	83.7	16.0 g	77.0
Cobox	0.2	43.2 c	10.2	64.0 ab	8.0
Daconil	0.2	73.6 a	87.8	36.8 d	47.1
Dithane M-45	0.2	51.2 bc	30.6	52.0 bc	25.3
Tecto-60	0.1	64.0 ab	63.3	24.8 efg	64.4
Topsin M	0.1	66.4 a	69.4	32.0 def	54.0

† Values followed by the same letter are not significantly different at 5% level of probability.

benzimidazole carbamate), Calixin-M (N tridecyl dimethyl morpholine), Cobox (copper oxychloride), Daconil (tetrachloroisophalonite), Dithane M-45 (zinc + manganese ethylene bis dithiocarbamate), Tecto-60 (thiazolyl benzimidazole) and Topsin-M (bismethoxy carbanyl thioureidobenze)—were tested to determine their impact on seed germination and disease eradication.

Diseased seeds of a locally adapted variety, Masoore-85, with lesions of *A. fabae* f.sp. *lentis* were surface-disinfected with 0.5% sodium hypochlorite solution for 3 minutes and dried on paper towels. Solutions of systemic (0.1%) and nonsystemic (0.2%) fungicide were prepared. Seed lots comprising 125 seeds were immersed in fungicide solutions for 4 hours, placed on filter papers in petri dishes (90 mm diam.) and incubated at 24 ± 2°C with 100% relative humidity. These treatments were irrigated once a day with 2.0 ml of distilled water. Germination counts were taken after the 7th day and percentage of seeds showing colonies of *A. fabae* f.sp. *lentis* was calculated.

Results and Discussion

The fungicides used for seed treatment varied in their effect with respect to seed germination and recovery of seedborne fungus (Table 1). Maximum germination was observed in seeds treated with Benlate, Daconil, Calixin-M, Antracol and Topsin-M. Cobox and Dithane M-45 had no significant effect on seed germination compared with the control. An increase in seed germination has been reported for benlate (Kaiser et al. 1973; Shukla et al. 1981), Calixin-M (Bhatti et al. 1984) and Daconil (Ilyas and Bashir 1987). The present studies not only confirmed the improvement in seed germination by treatment with Benlate, Calixin-M and Daconil, but also revealed the effectiveness of Antracol and Topsin-M.

Regarding eradication of Ascochyta from infected seeds, all the fungicides reduced recovery of seedborne fungi (Table 1). The most effective seed treatments in reducing seedborne fungus were Calixin-M, Benlate and Tecto-60, followed by Topsin-M. Seed treatment with Calixin-M has been reported to eradicate seedborne *Ascochyta rabiei* (Reddy 1980; Bhatti et al. 1983). In Iran, the incidence of ascochyta blight in chickpea was reduced by more than 80% and emergence was increased by about 45% when inoculated seeds were treated with Benomyl (Kaiser et al. 1973).

It is concluded from this investigation that Benlate, Daconil, Calixin-M and Antracol increased germination whereas Calixin-M, Benlate, Tecto-60 and Topsin-M eradicated seedborne inoculum of *A. fabai* f.sp. *lentis* when used as seed-dressing fungicides.

References

Beauchamp, C.J. and R.A.A. Morrall. 1985. Effects of combining fungicides as seed treatments of ascochyta blight. Pesticide Research Report:270. Agriculture Canada, Ottawa.

Bhatti, M.A., B.A. Malik and S.A. Hussain. 1983. Efficacy of Calixin-M and other fungicides against Ascochyta blight in chickpea. *International Chickpea Newsletter* 8:23–24.

Bhatti, M.A., S.A. Hussain, B.A. Malik, M. Tahir and M.A. Zahid. 1984. Effect of fungicidal treatment of

diseased seed against *Ascochyta rabiei* on germination in chickpea. *Pakistan Journal of Agricultural Research* 5(1):23–25.

Bretag, T.W. 1989. Evaluation of fungicides for the control of ascochyta blight in lentils. Tests of agrochemicals and cultivars. *Annals of Applied Biology* 114 (*Suppl.*):44–45.

France, A.I., J.U. Tay and M.A. Cortez. 1987. Disinfeccion de semilla de lentejas. *Investigacion y progreso agropecuario quilamapu* 31:21–26.

Gossen, B.D. and R.A.A. Morrall. 1981. The role of seed stubble and seedborne inoculum in epidemic development of ascochyta blight of lentils. *Canadian Journal of Plant Pathology* 3:114 (Abstract).

Gossen, B.D. and R.A.A. Morrall. 1983. Effect of ascochyta blight on seed yield and quality of lentils. *Canadian Journal of Plant Pathology* 5:168–173.

Ilyas, M.B. and M. Bashir. 1987. Effect of chickpea seed treatment with fungicides on the recovery of seedborne fungi. *Pakistan Journal of Agricultural Research* 8(1):114–116.

Kaiser, W.J. 1987. Disease problems on dry peas, lentils, chickpeas, and faba beans. *In* Grain Legumes as Alternative Crops. A symposium sponsored by the Centre for Alternative Crops and Products, Univ. of Minnesota, St. Paul, MN, USA.

Kaiser, W.J., M. Okhovat and G.M. Messahebi. 1973. Effect of seed treatment fungicides on control of *Ascochyta rabiei* on chickpea seed infected with the pathogen. *Plant Disease Reporter* 57:742–746.

Morrall, R.A.A. 1980. Evaluation of seed treatments to improve emergence of lentil. Pesticide Research Report:224. Agriculture Canada, Ottawa.

Morrall, R.A.A. 1988. Using thiabendazole to control seedborne ascochyta in lentil. *Canadian Journal of Plant Pathology* 10(4):370 (Abstr).

Morrall, R.A.A. and C.J. Beauchamp. 1984. Evaluation of seed treatments for ascochyta infected lentil seed. Pesticide Research Report:285. Agriculture Canada, Ottawa.

Morrall, R.A.A. and B.D. Gossen. 1979. Evaluation of seed treatments for the control of seedborne ascochyta blight of lentils. Pesticide Research Report:406-407. Agriculture Canada, Ottawa.

Morrall, R.A.A. and B.D. Gossen. 1981. Evaluation of carbathiin formulations as seed treatment for ascochyta infected lentil seed. Pesticide Research Report:227. Agriculture Canada, Ottawa.

Reddy, M.V. 1980. An effective fungicide for eradication of *Ascochyta rabiei* in chickpea seeds. *International Chickpea Newsletter* 3:12.

Russell, A.C., M.G. Cromey and W.A. Jermyn. 1987. Effect of seed treatment on seedborne ascochyta of lentil. *Proceedings of the Agronomy Society of New Zealand* 17:15–18.

Seid, A. and S.P.S. Beniwal. 1988. Seedborne nature of *Ascochyta lentis* in lentils. *LENS Newsletter* 15:30–31.

Shukla, P., P.R. Singh and A.N. Mishra. 1981. Search for best seed dressing to control chickpea wilt. *Pesticides* 15(7):15–16.

Lentil Information

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Summary

Grain legume crops are important sources of high-quality protein in human diets and important components of sustainable agriculture in rain-fed areas. Drought usually is the main constraint to crop production in such environments. A substantial body of information on responses of grain legume crops to drought has accumulated in recent years. We suggest this can be better mobilized and exploited through coordinated efforts to achieve significantly better adaptation of grain legumes to drought-prone environments. It is therefore proposed to organize a global grain legumes/drought research network. Expected outputs of such a network would include formulation of viable and cost-effective research projects and assistance to national agricultural research systems in focussing problem-solving research on drought-related constraints. We believe that this would contribute to enhancement of sustainable grain legume production, including legume benefits to the overall cropping system in drought-prone environments.

Background

- Drought is a major constraint to rain-fed production of grain legumes.
- Grain legume crops are important, particularly in developing countries as sources of proteins in human diets, and components of the sustainability equation in rain-fed, drought-prone agriculture.
- Increasing knowledge on the adaptation of grain legume crops to drought-prone environments has accumulated in recent years. This has been generated in separate studies with respect to crops, environments and researchers.
- Rapid progress in genetic adaptation of grain legumes to drought-prone environments could occur if research efforts are coordinated, and we propose a network to facilitate this.

Current Status

Little quantifiable progress has been made to date in minimizing the yield-reducing effects in grain legumes because of:

1) an unrealistic expectation of identifying crop varieties with high levels of resistance to drought,
2) an imperfect understanding of the complex nature of drought over time and its interactions with crop growth and yield,
3) an emphasis mainly on identifying simple physiological/biochemical criteria of drought resistance, which often do not relate to field performance,
4) lack of efforts to integrate studies across grain legume crops and environments to draw inferences and plan future strategies, and
5) reluctance to breed crops for drought resistance because of the unpredictability of drought environments.

Objectives

1. To establish a reference point for integrated global efforts on enhancing and stabilizing grain legume production in drought-affected environments by:
   a) providing information about active researchers and institutes working on drought and the areas of expertise,
   b) maintaining a list and passport information of traits of drought-resistant grain legume crops and varieties,
   c) documenting and updating published literature on all aspects of drought relevant to grain legume crops and disseminating specific literature searches, and
   d) facilitating regular communication between network members by means such as an informal newsletter.

2. To characterize and map the types of drought affecting legume production globally, using Geographic Information Systems (GIS) and models.
3. To quantify yield losses due to drought by using existing knowledge and data, and through experimentation where such knowledge does not exist.
4. To relate area, production, productivity and yield losses to Item 2 and to:
   a) identify priority agroecological areas and legume crops for drought research,
   b) develop agronomic management/genetic enhancement strategies to alleviate drought effects in the target regions, and
   c) set parameters for increasing effectiveness and enhancing impact in the target region.
5. To extend available technologies of genetic enhancement for drought resistance in the target regions.
6. To stimulate basic research, including on cell biology, with well-defined impact on applied or problem-solving research.
7. To organize brainstorming sessions on drought research in workshops, group discussions and conferences in crucial areas and disseminate the current understanding through publications.
8. To identify and facilitate linkages between organizations with expertise in specific areas of drought research.
9. To solicit funding to support the above activities.

Scope and Prospects

Prospects of mitigating drought effects on grain legume production appear more promising in the 1990s.

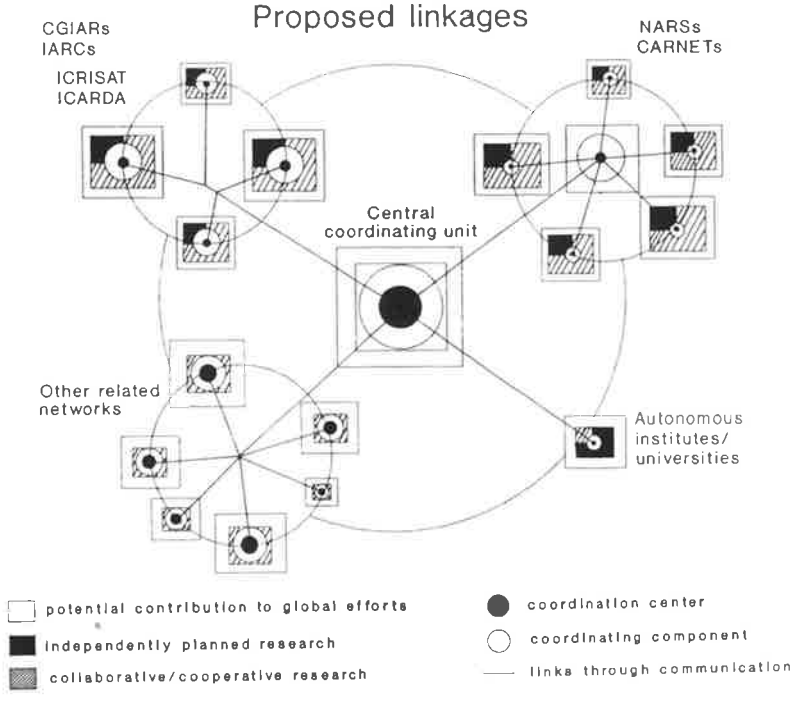
1. Good progress has been made toward a better understanding of the realities and complexity of types of drought and their effects on crop growth and yield.

2. Coordinated international efforts seem feasible because drought is an important theme of research at many international centers and institutes.

3. Precise and detailed characterization of atmospheric and soil moisture environments during crop growth is now feasible through computer modeling.

4. Various components of drought can now be mapped on field to global scale using programs such as GIS so that iso-drought environments can be delineated to enhance transfer of technology.

5. There are some examples of success in the development of grain legume crop varieties resistant to terminal drought.



Expected Outputs and Impacts

1. Development of viable projects in drought research which set realistic goals for achieving success.
2. Creation of better awareness of the existing knowledge and experience amongst drought researchers.
3. Evaluation of research projects for most efficient use of resource inputs and possible benefits.
4. Generation of self-reliance and expertise in the conduct of drought research amongst the scientists of participating NARS.
5. Enhancement and stabilization of sustainable grain legume production under rain-fed conditions.

Proposed Linkages

The proposed linkages of the network are shown in Figure 1. We also intend to publish an informal newsletter as a means of communication between the network members. We are soliciting suggestions from other related networks, national and international organizations/ institutes, universities and individuals on various aspects of the network activities and wish to determine their interest in joining such efforts.

Please indicate to Dr M.C. Saxena, Leader, Legumes Program, ICARDA if you are interested in participating in such a network and if you have any comments and suggestions on this proposal. Our decision to proceed with establishing the network and the manner in which we proceed will depend on feedback from prospective members.

Conferences

1992

The *Second International Food Legume Research Conference* was held in Cairo, Egypt, from 12—16 April 1992. It was attended by 250 participants from 38 countries. Following inauguration of the conference by Prof Dr Adel El-Beltagy, Director General of Agricultural Research Center and the National Agriculture Research Project of Egypt, progress in research on improvement of chickpea, faba bean, grasspea, pea and lentil was reviewed in plenary sessions, panel discussions and a workshop. Eight groups, formed of participants from different geographical regions, discussed regional goals, identified constraints and developed recommendations for future research. The proceedings of IFLRCII are in production, under the editorship of Drs W. J. Muehlbauer and W. J. Kaiser of Washington State University.

The next IFLRC is scheduled for 1997. Conference Chairman for that meeting will be Dr Fred Muehlbaeur.

***10th Latin American Weed Science Society Congress,* Chile, November 1992.** Contact: M. Kogan, Universidad Catolica del Chile, Vicuna Mackenna, 4860, Santiago, Chile.

1993

***Workshop on Engineering Plants against Pest and Pathogens,* Madrid, Spain, 11—13 January 1993.** Contact: Instituto Juan March, Castello 77, 28006 Madrid, Spain.

***10th Australian Plant Breeding Conference,* Gold Coast, Queensland, 19—23 April 1993.** Contact: Australian Convention and Travel Services Pty Ltd., GPO Box 2200, Canberra, ACT 2601, Australia.

***7th International Symposium on Iron Nutrition and Interactions in Plants,* Zaragoza, Spain, 27 June—2 July 1993.** Contact: Sr D. Jesus Gascon, Secretary, 7th Internat. Symp. on Iron Nutrition and Interactions in Plants, Aula Dei Experimental Station, CSIC Apdo 202, 50080 Zaragoza, Spain.

1993

***1st Crop Science Conference for Eastern and Southern Africa,* Kampala, Uganda, 14-18 June.** Contact: Dr Adipala Ekwamu, Makere University, P.O. Box 7062,

Kampala, Uganda [Phone 256-041-531152, Fax 256-041-531641].

14th North American Symbiotic Nitrogen Fixation Conference, **St. Paul, Minnesota, USA, 25-30 July.** Contact: Nancy Harvey, Program Coordinator, Educational Development System, 405 Coffey Hall, 1420 Eckles Ave., Univ. of Minnesota, St. Paul, MN 55108-6068, USA [Phone-USA only-612-625-8215, 800-367-5363; Fax 612-625-2207, E-mail INTERNET:nh@esp.mes.umn.edu].

6th International Congress of Plant Pathology, **Montreal, Canada, 28 July—6 August 1993.** Contact: Managing Editor, Bureau of Crop Protection, CAB International, Wallingford, Oxon, OX10 8DE, UK.

10th Australian Nitrogen Fixation Conference, **Brisbane, Australia, September.** Contact: H.V.A. Bushby, 306 Carmody Road, St. Lucia, Queensland 4067, Australia [Phone (07) 377-0209, Fax (07) 371-3946].

15th Congress of the International Commission on Irrigation and Drainage, **The Hague, Netherlands, 6—11 September 1993.** Contact: Prof W.A. Segeren, Chairman, Organizing Committee, Secretariat ICID, PO Box 82000, 2508 EA, The Hague, The Netherlands.

XII International Plant Nutrition Colloquium/Symposium — Zinc in Soils and Plants, **Perth, Western Australia, 21—28 September 1993.** Contact: Plant Nutrition Secretariat, The Conference Office, University of Western Australia, Nedlands, WA 6009, Australia.

2nd International Workshop on Antinutritional Factors (ANFs) in Legume Seeds, **Wageningen, The Netherlands, 1-3 December.** Contact: Dr J. Huisman, TNO-Institute of Animal Nutrition and Physiology (ILOB), P.O. Box 15, 6700 AA Wageningen, The Netherlands [Phone 31-8370-99460; Fax 31-8370-99463].

International Symposium on Pulses Research, **Kanpur, India, 4—8 December 1993.** Contact: Dr A.N. Asthana, Organizing Secretary, International Symposium ISPRD, Directorate of Pulses Research, Kanpur 208 024, India.

1994

7th International Congress of Bacteriology, Applied Microbiology and Mycology, **Prague, Czechoslovakia, 3—8 July 1994.** Contact: Dr B. Sikyta, Institute of Microbiology, Czechoslovak Academy of Sciences, Videnska 1083, CS-142 20, Prague 4, Czechoslovakia.

1995

American Phytopathological Society Annual Meeting, **Pittsburg, USA, 12—16 August 1995.** Contact: APS Headquarters, 3340 Pilot Knob Road, St. Paul, MN 55121, USA.

Visuals

ICARDA has produced three slide/tape modules dealing with legume hybridization techniques. The three programs, *Hybridization Techniques in Lentil*, *Hybridization Techniques in Chickpea* and *Hybridization Techniques in Faba Bean*, discuss the morphology of the flowers, crossing block layout, and emasculation and pollination techniques. The programs are designed as introductory material for junior scientists.

To purchase the modules, send a check for US$ 50 payable to ICARDA for each program to the Training Coordination Unit. Each slide set includes 80 slides, a cassette tape and an accompanying resource book.

International Symposium on Pulses Research
4—8 December 1993, Kanpur, India

The program of the Symposium will cover cool-season (chickpea, lentil, dry peas, grasspea, kidney bean and faba bean) as well as warm-season (pigeonpea, mungbean, urdbean, cowpea, horsegram, mothbean and ricebean) grain legumes.

The topics will cover a wide range of subjects:

- enhancement of genetic resources
- breeding for resistance (biotic and abiotic stress) and productivity
- genetics
- cytogenetics
- physiology
- biotechnology
- disease and pest management
- production technology (legume-based cropping systems, fertility management including biological nitrogen fixation, weed management and sustainable agriculture)
- grain quality
- post-harvest technology
- developmental strategies

Organized by
Indian Society of Pulses Research and Development (ISPRD)
Directorate of Pulses Research
Kanpur 208 024, India

Cosponsored by
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Contact
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First circular is being distributed

Agricultural libraries receiving ICARDA publications

ICARDA publications are deposited in agricultural libraries throughout the world to make them available to other users under normal interlibrary loan and photocopy procedures. These depository libraries are located in the countries listed. Readers requiring information on the library nearest to them should address inquiries to: Library, ICARDA, P.O. Box 5466, Aleppo, Syria.

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Malaysia
Mali
Mauritania
Mexico
Myanmar
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Nigeria
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ICARDA publications and services

ICARDA Publications

Request your list of all currently available publications from the Communication, Documentation and Information Services (CODIS).

LENS

LENS, the newsletter of the Lentil Experimental News Service, is produced twice a year at ICARDA in cooperation with the University of Saskatchewan, Canada. Short research articles provide rapid information exchange, and comprehensive reviews are invited regularly on specific areas of lentil research. The newsletter is available free to lentil researchers. For further information or to subscribe, write to: LENS/CODIS.

FABIS

FABIS is the newsletter of the Faba Bean Information Service. Produced biannually, it publishes short scientific papers on the latest research results and news items related to faba bean research. For further information or to receive a copy, write to: FABIS/CODIS.

RACHIS

This publication is aimed at cereal researchers in the Near East and North Africa region and Mediterranean-type environments. It publishes short scientific papers on the latest research results and news items. RACHIS seeks to contribute to improved barley, wheat and triticale production in the region; to report results, achievements and new ideas; and to discuss research problems. For further information or to subscribe, write to: RACHIS/CODIS.

Opportunities for Training and Post-graduate Research at ICARDA

ICARDA has active training courses on the development and improvement of food legumes, cereals, and forages with ICARDA's research scientists, trained instructors, and proven programs. For a complete brochure of the training opportunities at ICARDA, write to: Training Coordination Unit.

Opportunities for Field Research at ICARDA

This brochure is intended primarily to assist Master of Science candidates, who are enrolled at national universities within ICARDA region and selected for the Graduate Research Training Program. It explains to them the opportunity they have to conduct their thesis research work at ICARDA research sites under the supervision of international scientists. For your copy, write to: Training Coordination Unit.

Graduate Research Training Awards, Opportunities for Field Research at ICARDA

The Graduate Research Training Program (GRTP) is intended primarily to assist Master of Science candidates who are enrolled at national universities within the ICARDA region. Men and women who are selected for the program will have an opportunity to conduct their thesis research work at ICARDA research sites under the cosupervision of university and center scientists. For further information on terms of award, nomination procedure, selection criteria, appointment conditions, the university's responsibilities, and the student's responsibilities, write to: GRT Program, Training Coordination Unit.

Library Services

The ICARDA library maintains bibliographic databases for the use of researchers at the center and elsewhere. FABIS, LENS and BARLEY databases contain 5000, 1500 and 60 000 references, respectively, extracted from AGRIS since 1975. Literature searches will be conducted for research workers by the library staff, upon request, and results downloaded to diskette or hard copy. Photocopies of articles identified in a literature search can be provided to users, if available. Researchers can request a literature search by letter or telex to: Library.

A Directory of Faba Bean and Lentil Research Workers is being compiled for publication, and will be available in late 1992.

To Obtain Information

Address requests for publications or services to the specific department cited above, at: ICARDA, P.O. Box 5466, Aleppo, Syria.

Lentil references

Lentil references for 1990 are published in this issue. In 1993, the first annual supplement of LENS, containing lentil references for 1991, will be published. This publication replaces *Lentil in AGRIS*, previously published by ICARDA. All entries will be extracted from AGRIS and AGRICOLA databases (CD-ROM) in the ICARDA holdings. The supplement will be distributed to recipients of the LENS newsletter.

AGRICULTURE IN GENERAL

Agricultural Research

90-012276 [Collaborative research and training program. Annual report for 1985-86 season]. Ar. barna:maj"/u al-ta3a:wn/i al-3ilmi: al-mus"tarak. al-taqri:r/u al-sanawi:/u limawsim/i 1985/86.Ministry of Agriculture and Agrarian Reform, Damascus (Syria). International Center for Agricultural Research in the Dry Areas, Aleppo (Syria).Aleppo (Syria). International Center for Agricultural Research in the Dry Areas. 1987. 298 p. Tables; fig. Summary (En). AVAILABILITY: ICARDA, POB 5466, Aleppo - Syria RN: ICARDA-116-Ar,En.

This report presents the results and major achievements of the joint cooperative research and training program between the Syrian Ministry of Agriculture and Agrarian Reform and ICARDA during the 1985/86 season. Among the important achievements the approval to release the new bread wheat variety "Sham 4" (FLK's'-Hork) for planting under irrigation and in Zone A; identification of promising varieties (Sebou, Korifla, Bliekh and Om-Rabi durum wheat and Seri 82, Douma 6419 bread wheat and Tadmor, and Furat 1113 and Rihan 03 barley); approval to release two winter chickpea lines "Ghab 1" (ILC 482) and "Ghab 2" (ILC 3279) which are high yielding, of better resistance to Ascochyta blight, more tolerant to cold than the local varieties, and more suitable for mechanical harvesting; identification of three new lentil lines as high-yielding and more suitable for mechanical harvesting than the local varieties. These lines are the large seeded, yellow cotyledon ILL 8, the small seeded red cotyledon ILL 16, and ILL 223; identification of few lines of vetch (Vicia sativa) as future varieties in Syria. Results of the rotation studies indicated that the best wheat production was obtained after medic or forage mixture. Results of the forage/cereals/livestock integrated projects indicated that the fallow system followed by many farmers in Syria could be replaced by medics and therefore increasing forage production and improving soil fertility. Results of the fertilizer effects on barley production in the dry areas showed a significant yield increase. Organization of several field days at the Ministry's research stations, joint meetings, field trips and travelling workshops to the joint research trials.

Syria; triticum durum; triticum aestivum; barley; vicia faba; lens culinaris; pastures; sheep; medicago; soils; training; research; cooperative activities; budgets

90-091512 High-elevation research in Pakistan: the MART/AZR project annual report for 1987. En. International Center for Agricultural Research in the Dry Areas, Aleppo (Syria).Aleppo (Syria). International Center for Agricultural Research in the Dry Areas. 1988. 103 p.35 tables; 10 fig. AVAILABILITY: ICARDA, POB 5466, Aleppo - Syria RN: ICARDA-127-En.

Research conducted by the MART/AZR Project in Pakistan is reported on farming systems, agronomy, germplasm evaluation, range/livestock management, and agricultural extension. The 1987-88 season planning meeting and training are outlined. Lists of references, publications, and staff are appended.

Pakistan; lens culinaris; vicia faba; cicer arietinum; barley; vicia sativa; research; agronomy; farming systems; germplasm; grassland management; trials; experiments; livestock management; extension activities; planning; work study.

EDUCATION, EXTENSION AND INFORMATION

Education

90-012350 [Training and exchange of information]. Ar. al-tadri:b/u wa taba:dul/u al-ma3lu:ma:t.Ministry of Agriculture and Agrarian Reform, Damascus (Syria). International Center for Agricultural Research in the Dry Areas, Aleppo (Syria).ICARDA, Aleppo (Syria). Collaborative research and training program. Annual report for 1985-86 season. barna:maj"/u al-ta3a:wn/i al-3ilmi: al-mus"tarak. al-taqri:r/u al-sanawi:/u limawsim/i 1985/86. Aleppo (Syria). International Center for Agricultural Research in the Dry Areas. 1987. p. 255-266.9 tables. AVAILABILITY: ICARDA, POB 5466, Aleppo - Syria RN: ICARDA-116-Ar,En.See Also: 90-012276.

Syria; lens culinaris; vicia faba; cicer arietinum; triticum durum; triticum aestivum; feed crops; training courses; mechanization; plant breeding; harvesting; chemical analysis; soil testing; research; cooperative activities.

90-012351 [Technical and financial support]. Ar. al-da3m/u al-fanni: wa al-ma:ddi:.Ministry of Agriculture and Agrarian Reform, Damascus (Syria). International Center for Agricultural Research in the Dry Areas, Aleppo (Syria).ICARDA, Aleppo (Syria). Collaborative research and training program. Annual report for 1985-86 season. barna:maj"/u al-ta3a:wn/i al-3ilmi: al-mus"tarak. al-taqri:r/u al-sanawi:/u limawsim/i 1985/86. Aleppo (Syria). International Center for Agricultural Research in the Dry Areas. 1987. p. 267-271. AVAILABILITY: ICARDA, POB 5466, Aleppo - Syria RN: ICARDA-116-Ar,En.See Also: 90-012276.

Syria; lens culinaris; cicer arietinum; vicia faba; triticum durum; triticum aestivum; medicago; lathyrus sativus; vicia sativa; budgets; technical aid; research; training courses; cooperative activities.

AGRICULTURAL ECONOMICS, DEVELOPMENT AND RURAL SOCIOLOGY

Agricultural Economics and Policies

90-022116 The present and optimum agricultural policy in Assiut county- A comparative study [Egypt]. En. Mohamed, A.I.(Assiut Univ. (Egypt). Faculty of Agriculture). Assiut-Journal -of-Agricultural-Science (Egypt). (1988). v. 19(4) p. 139-158. Issued 1989.6 tables; 8 ref. Summaries (Ar, En).
Egypt; wheats; vicia faba; lens culinaris; agricultural policies; income

90-081342 [Stochastic efficiency and the selection of crop varieties]. Es (Spanish).Eficiencia estocastica y seleccion de variedades.Ortiz R, Claudio; Francisco G, Emilio.
Ciencia-e-Investigacion-Agraria (Chile). (Sep-Dec 1987). v. 14(3) p. 175-187.10 ref.; Summaries (En, Es).
wheats; barley; avena; rice; kidney beans; cicer arietinum; lens culinaris; decision making; selection; risk

90-118452 Seasonal changes in prices of some agricultural crops in Assiut governorate [Egypt]. En. Abdelmagied, Th.M.; El Sheemy, A.H.(Assiut Univ. (Egypt). Faculty of Agriculture).
Assiut-Journal-of-Agricultural-Science (Egypt). (1989). v. 20(2) p. 129-139. Issued 1990.6 tables; 4 ref. Summaries (Ar, En).
The study shown that wheat prices decrease during the months of October and November, broad beans prices decrease during July and August; and corn prices decrease during September, November and January, and sorghum prices decrease during October, November and December. The study also showed that lentil prices usually decline during June, July and August; and onion prices decrease during January, February and March.
Egypt; crops; prices; costs; economic analysis; vicia faba; zea mays; lens culinaris.

AGRICULTURAL ECONOMICS, DEVELOPMENT AND RURAL SOCIOLOGY

Labour and Employment

90-012574 The impact of technology application on employment in the rainfed farming areas of Irbid governorate in Jordan. En. Al Karablch, E. Jordan Univ., Amman (Jordan). Dept. of Agricultural Economics and Extension. Amman (Jordan). Oct 1989. 195 leaves. Thesis (M.Sc. in agricultural economics). 11 fig.; 100 tables; 76 ref.; Summaries (Ar, En). AVAILABILITY: JORDOC, Jordan University, Library, Amman - Jordan.
The study examines the impact of technology on employment in the rainfed areas of Irbid. Farmers were interviewed concerning their contribution of household labor force in farming operations compared to hired and migrant labor force. The socio-economic factors which affect labor input and explain the adoption of technology have been examined and analyzed. Also, the calendar for agricultural labor and operations has been developed. Moreover, the cost of production and requirements per one dunum of field crops for different labor groups have been estimated. The data used to explain impact of technology on employment were obtained by personal interviews conducted in the 1988/1989 season. Multiple regression model was developed and used in the analysis to determine factors affecting labor groups input and adoption of technology. The results of the study indicated that cropped area, household size, number of students, site of the village and age andhealth of farmers, experience in farming are significant factors affecting labor input and technology adoption. It can be concluded that the agricultural production in the rainfed areas in Irbid Governorate is dependent on hired labor. Household labor input is less than 40 % of total hours input in agricultural production where female contribution is less than 20 %. The migrant hired labour force is mainly engaged in operations that need unskilled labor and physical work.
Jordan; rain fed farming; farmers; farm area; costs; income; statistical analysis; employment; hired labour; triticum aestivum; family labour; female labour; migrant labour; social indicators.

Production Economics

90-070267 An analytical study of the structural changes in cost of production of the main field crops in El-Fayoum governorate during the period 1972-1984 [Egypt]. En. Gomaa, R.M.(Cairo Univ., Fayoum (Egypt). Faculty of Agriculture). Zagazig-Journal-of-Agricultural-Research (Egypt). (Jun 1986). v. 13(1) p. 545-581. Issued 1990.16 tables; 4 ref. Summaries (Ar, En).
The study aimed at analysing the structural changes in cost of production of cotton, wheat, onions, beans, lentils, maize, millet and sesame in El-Fayoum Governorate during the period 1972-1984. The study relied mainly upon secondary data published by the Agricultural Economics Research Institute, Ministry of Agriculture, and the Department of Agriculture, El-Fayoum Governorate. The study showed that there have been structural changes in the costs of producing these crops. The study revealed that the costs of producing these crops have increased rapidly. The main responsible for that have been wages and rent. They were responsible for about 75, 36, 47, 62, 59, 74, 60 and 45% of the increase in cost of producing the above mentioned crops respectively. The wages have increased rapidly due to migration from rural areas.
Egypt; wheats; economic analysis; production costs; crops

Organization and Management of Agricultural Farms

90-081681 An analysis of the yield-price risk associated with specialty crops. En. Weisensel, W.P.; Schoney, R.A.(University of Saskatchewan).Western-journal-of-agricultural-economics(USA).(Dec 1989). v. 14(2) p. 293-299.references.
Saskatchewan; wheats; lens culinaris; profitability; risk; rotational cropping; crop yield; consumer prices; statistics

Trade, Marketing and Distribution

90-001204 [Spain. Market of dried vegetables]. Fr. Espagne. Le marche des legumes secs. Marche-International-des-Fruits-et-Legumes-Frais (France). (20 Jul 1989). (no. 15) p. 12-16.9 graphs.
lens culinaris; spain; kidney beans; cicer arietinum; dried vegetables; marketing; imports; exports

90-049976 United States standards for whole dry peas, split peas, and lentils. En. United States. Federal Grain Inspection Service. Washington, D.C. (USA). The Service. [1989]. vp. bibliographical ref. "Effective date whole dry peas 1-18-89, split peas 1-18-89, lentils 8-01-88.". AVAILABILITY: US (DNAL aSB343.U5).
pisum sativum; usa; grading; standards; lens culinaris; dried vegetables.

International Trade

90-022728 Lentils: market concerns for North American growers. En. Young, D.; Malorgio, G.(Washington State University, Pullman). 1988. 18 p. references. Includes statistical data. AVAILABILITY: NAL, USDA, Beltsville, Md. 20705 - USA.
lens culinaris; usa; market research; prices; production costs; exports; trends.

PLANT SCIENCE AND PRODUCTION

Crop Husbandry

90-001839 [Lentil [The green lentil of Le Puy (Haute-Loire, France)] history of registered designation]. Fr. La lentille verte du Puy. Histoire d'un cru.Mestre, J.R. (Musee Charles Crozatier, Le Puy-en-Velay (France)).
Le Puy-en-Velay (France). Micro-Edition. 1988. 217 p. 5 illus., Bibliography.
lens culinaris; crop management; markets; rural sociology; auvergne; botany; environmental conditions; pest insects; insect control; insecticides; mycoses; fungicides; production location; quality; regulations; history

90-013670 [Food legumes improvement]. Ar. tah"si:n/u mah"a:si:l/i al-buqu:liyya:t/i al-g"d"a:` iyyat.Ministry of Agriculture and Agrarian Reform, Damascus (Syria). International Center for Agricultural Research in the Dry Areas, Aleppo (Syria).ICARDA, Aleppo (Syria). Collaborative research and training program. Annual report for 1985-86 season. barna:maj"/u al-ta3a:wn/i al-3ilmi: al-mus"tarak. al-taqri:r/u al-sanawi:/u limawsim/i 1985/86. Aleppo (Syria). International Center for Agricultural Research in the Dry Areas. 1987. p. 52-125.Tables. AVAILABILITY: ICARDA, POB 5466, Aleppo - Syria RN: ICARDA-116-Ar,En. See Also: 90-012276.
vicia faba; lens culinaris; cicer arietinum; syria; plant production; plant diseases; rusts; viroses; plant nematodes; orobanche; cuscuta; cooperative activities; research

90-013680 [Lentils [Lens culinaris]]. Ar. al-3adas. Ministry of Agriculture and Agrarian Reform, Damascus (Syria). International Center for Agricultural Research in the Dry Areas, Aleppo (Syria).ICARDA, Aleppo (Syria). Collaborative research and training program. Annual report for 1985-86 season. barna:maj"/u al-ta3a:wn/i al-3ilmi: al-mus"tarak. al-taqri:r/u al-sanawi:/u limawsim/i 1985/86. Aleppo (Syria). International Center for Agricultural Research in the Dry Areas. 1987. p. 68-81.17 tables. AVAILABILITY: ICARDA, POB 5466, Aleppo - Syria RN: ICARDA-116-Ar,En.See Also: 90-012276.
lens culinaris; syria; plant production; cooperative activities.

90-030339 [Lentil, cultivation]. Fr. La lentille, culture. Institut Technique des Cereales et des Fourrages, Paris (France). Union Nationale Interprofessionnelle des Proteagineux, Paris (France). Association des Producteurs de Plantes a Proteines, Paris (France). Federation Nationale des Agriculteurs Multiplicateurs de Semences, Paris (France).Paris (France). ITCF. Dec 1988. 15 p.20 ref.
lens culinaris; crop management; cultivation; plant protection; harvesting

90-040045 Agronomy and crop physiology [Chickpea; faba bean; dry bean; lentil; wheat; Hudeiba, Sudan]. En. Taha, M.B. Annual-Report-of-the-Hudeiba- Research-Station (Sudan). 1985-1986. (Oct 1989). p. 40-52.5 tables. AVAILABILITY: ARC, POB 126, Wad Medani - Sudan.
legumes; cereals; agronomy; plant population; fertilizers; spacing; irrigation; application methods; yield increase.

90-040060 Evaluation of four mechanized harvest techniques for lentil and chickpea [tractor rear-mounted mower; self-propelled mower; combine harvester; hand pulling]. En. Hussein, M.A.Y. Jordan Univ., Amman (Jordan). Dept. of Plant Production.Amman (Jordan). May 1989. 95 leaves. Thesis (M.Sc. in Plant Production). 2 fig.; 19 tables; 26 ref. Summaries (Ar, En). AVAILABILITY: JORDOC, Jordan University, Library, Amman - Jordan.
A study was conducted to evaluate four lentil and chickpea harvesting techniques: tractor rear-mounted mower; self-propelled mower; combine harvest and hand pulling. Two cultivation methods were used: leaving the soil with no additional operations (non rolling) and rolling the soil, using a mechanical roller to push down the stones and to break up the clods. Local lentil, winter planted UJC84 and a spring planted local chickpea were the crops and cultivars used in the study. Grain and straw losses under the harvesting techniques were measured. Randomized complete block design was employed with three replications. Yield was estimated and percentages of losses for the different treatments were calculated. Soil moisture measurements were taken during the growing season. The results indicated that straw and grain yields natural plant height, actual plant height and lowest pod height were not different under nonrolled and rolled soil. However, soil moisture was not affected by rolling. Percentage loss was lower in most cases under rolled soil. However, there were significant differences in losses among the harvesting methods. Hand pulling resulted in significantly lowest followed by rear-mounted tractor mower, then self-propelled mower, and finally grain combine harvester. Economic evaluation indicated that the least expensive was the use of self-propelled mower, followed by tractor rear-mounted mower, then the combine harvester, and finally the hand pulling. The highest net profit was obtained by the use of rear-mounted mower, followed by self-propelled mower, then the hand pulling and the lowest net profitable method was by the combine harvester, taken into consideration the lost income due to non-recoverable grain and straw losses.
lens culinaris; cicer arietinum; cultivation; rollers; harvesters; yield components; jordan; harvesting; income; economic analysis.

90-040061 Food legume improvement project in collaboration with IDRC: Annual report 1988/1989; Workplan for 1989/1990 [seed multiplication and maintenance breeding; full socio-economic study based on structured questionnaire]. Ar, En. Haddad, N.; Snobar, B.; Masadeh, A.Jordan Univ., Amman (Jordan). Faculty of Agriculture. Ministry of Agriculture, Amman (Jordan). National Center for Agricultural Research and Technology Transfer. Dec 1989. 144 p.11 fig.; 37 tables. Summary (Ar). AVAILABILITY: JORDOC, Jordan University, Library, Amman - Jordan.
lens culinaris; cicer arietinum; varieties; rain; plant breeding; weed control; technology transfer; farmers; economic sociology; trials; jordan; seeding rates; planting date; fertilizer application; harvesting; crop yield.

90-040062 Food legume improvement project in collaboration with IDRC: Annual report 1985/1986. En. Haddad, N.Jordan Univ., Amman (Jordan). Faculty of Agriculture. Aug 1986. 83 p.6 fig.; 45 tables. AVAILABILITY: JORDOC, Jordan University, Library, Amman - Jordan.
lens culinaris; genotypes; cicer arietinum; hybrids; rain; plant nurseries; rotational cropping; agronomic characters; jordan; sowing depth; fertilizer application; weed control; harvesting; losses; trials.

90-050450 Culture and genetics of grain legumes. En. Hartwig, E.E. (ARS, USDA, Stoneville, MS). Matthews,-R.H. (ed.). Legumes : chemistry, technology, and human nutrition. New York (USA). M. Dekker. 1989. p. 1-10. references.
soybeans; arachis hypogaea; phaseolus; pisum sativum; cicer arietinum; cultivation; genetics

90-050632 [Effect of plant density on pod distribution in the system of lentils (Lens culinaris Medik)]. Es. Efecto de la densidad de plantas sobre la distribucion de vainas en el sistema de ramificacion de la lenteja (Lens culinaris Medik.). Penaloza H, Enrique. Agricultura-

Tecnica (Chile). (Oct-Dec 1987). v. 47(4) p. 335-339.12 ref. Summaries (En, Es).
lens culinaris; sowing; seeding rates; plant developmental stages; crop yield.

90-050633 [Seed losses by traditional lentil (Lens culinaris) harvesting systems]. Es. Perdidas de semilla en los sistemas tradicionales de cosecha de lenteja (Lens culinaris).Caullan F, Fernando.Universidad de Concepcion, Chillan (Chile). Fac. de Ciencias Agropecuarias y Forestales. Chillan (Chile). 1987. 69 p. Tesis (Ing Agr). 36 ref. Summaries (En, Es) AVAILABILITY: Biblioteca Central, IIA, CP 439/3, correo 3, Santiago - Chile.
lens culinaris; seed; harvesting; losses

90-050635 International food legume testing program on lentil, faba bean and kabuli chickpea [Lens culinaris; Vicia faba; Cicer arietinum]. En. ICARDA, Aleppo (Syria).Aleppo (Syria). International Center for Agricultural Research in the Dry Areas. 1989. 20 p.3 tables; 2 fig.; 18 ill. AVAILABILITY: ICARDA, POB 5466, Aleppo - Syria RN: ICARDA-156-En. In this book, ICARDA's international testing program with the National Agricultural Research Systems (NARSs) in the region and beyond is presented.
The main objectives are: (a) to provide NARSs with improved genetic material and production practices, so that appropriate cultivars and packages of production technology can be locally identified and adopted: (b) to identify the specific or wide adaptation of different genotypes for higher yield, and resistance/tolerance to biotic (insect, pests), parasitic weeds and diseases) and abiotic stresses (cold and nutrient deficiency, etc.): (c) to assist ICARDA in targeting its breeding efforts towards specific environmental/geographic niches. Types of trials and nurseries, international F3 and F4 trials/nurseries, international screening nursery, international yield trial, international stress tolerance nurseries, international agronomy trials, nursery distribution and generation of information, seed health, monitoring program, and future objectives are also described.
lens culinaris; vicia faba; cicer arietinum; plant nurseries; international cooperation; testing; middle east; north africa; appropriate technology; weeds; methods; yield increase; selection; plant diseases; pest insects; temperature; training; trials.

90-061058 [Is there a future for the lentil?]. It. C' e un futuro per la lenticchia? Bozzini, A.(Food and Agriculture Organization of the United Nations (FAO), Rome (Italy)). Informatore-Agrario (Italy). (16 Jun 1988). v. 44(25) p. 27-31. Special issue.3 tables; 5 ref.
lens culinaris; cultivation; production potential; crop yield; agronomic characters; weed control; nitrogen fixation.

90-061059 [The modality of sowing in the lentil cultivation in semi-arid soil [of Sicily, Italy]]. It. Le modalita di semina nella coltivazione della lenticchia in ambiente semi-arido [della Sicilia]. Stringi, L.; Amato, G.; Cibella, R.; Gristina, L.(Palermo Univ. (Italy). Istituto di Agronomia Generale e Coltivazioni Erbacee). Informatore-Agrario (Italy). (16 Jun 1988). v. 44(25) p. 47-49. Special issue.1 table; 4 graphs.
lens culinaris; cropping systems; arid soils; spacing; sowing; production potential.

90-061060 [The sowing date and the genotype in the lentil cultivation in semi-arid soil [of Sicily, Italy]]. It. L' epoca di semina ed il genotipo nella coltivazione della lenticchia in ambiente semi-arido [della Sicilia].Sarno, R.; Stringi, L.; Amato, G.; Gristina, L.(Palermo Univ. (Italy). Istituto di Agronomia Generale e Coltivazioni Erbacee). Informatore-Agrario (Italy). (16 Jun 1988). v. 44(25) p. 51-54. Special issue. 1 table; 6 graphs; 16 ref.
lens culinaris; cropping systems; sowing date; genotype environment interaction; crop yield.

90-061061 [The reaction of the lentil to the effect of seeding rates in semi-arid soil [of Sicily, Italy]]. It. Reattivita della lenticchia all' effetto della densita di piante in ambiente semi-arido [della Sicilia]. Sarno, R.; Stringi, L.; Amato, G.; Gristina, L.(Palermo Univ. (Italy). Istituto di Agronomia Generale e Coltivazioni Erbacee). Informatore-Agrario (Italy). (16 Jun 1988). v. 44(25) p. 55-58. Special issue.1 table; 8 graphs.
lens culinaris; cropping systems; arid soils; seeding rates; crop yield.

90-061062 [The Castelluccio of Norcia lentil tempts everybody: producers and consumers]. It. La lenticchia di Castelluccio di Norchia tenta tutti: produttori e consumatori.Fanelli, L.Informatore-Agrario (Italy). (29 Dec 1988). v. 44(51) p. 27-29.
lens culinaris; umbria; cultivation; producer cooperatives; farmland; preservation; quality

90-061063 Food legume improvement. Proceedings of the training course. En; Fr. Amelioration des legumineuses alimentaires. Synthese des travaux du stage de formation.International Center for Agricultural Research in the Dry Areas, Aleppo (Syria). Travaux du Stage de Formation. Rabat (Morocco). 11-16 Feb 1985.Aleppo (Syria). International Center for Agricultural Research in the Dry Areas. 1987. 104 p.Tables; fig. RN: ICARDA-122-Fr.
Basic and general information on some aspects of food legume improvement were covered in this introductory course. The following subjects were dealt with, with special reference to the status of food legumes in the Maghreb countries (Morocco, Tunisia and Algeria): importance of food legumes in Morocco, status and improvement of food legumes in Tunisia, food legume experimentation at INRA evolution, domestication and conservation of crops plants with special reference to chickpeas, faba beans and lentils, diseases of food legumes with special emphasis on ascochyta blight of chickpeas and improvement of resistance to such diseases, damaging insects on food legumes in Morocco and ways of control of chickpea leaf miner, weeds and weeding of food legumes, chemical control of orobanche, lights on certain fundamental concepts of experimentation and introduction to statistics with examples of analysis and interpretation of the results.
lens culinaris; vicia faba; cicer arietinum; morocco; tunisia; algeria; plant diseases; disease resistance; weed control; pests of plants.

90-071230 Effect of seeding rates and some herbicides on weeds and yield of lentil crop [Egypt]. En. El Gharib, E.A.; Harb, O.M.; Okaz, A.M.(Azhar Univ., Cairo (Egypt). Faculty of Agriculture). Al-Azhar-Journal-of-Agricultural-Research (Egypt). (Jun 1988). v. 8 p. 295-306. Issued 1990.2 tables; 20 ref. Summaries (Ar, En).
Two experiments were carried out at the Experimental and Agricultural Research Center, Faculty of Agriculture, Al-Azhar University, Mostorod, Egypt during the 1984/1985 and 1985/1986 seasons to study the effect of three seeding rates (40, 50 and 60 kgs/feddan) and four herbicides (Chlorobromuron and linuron at 1.5 kgs as well as prometryne and terbutryne at 1.0 kg/feddan) and their interaction in addition to unweeded (check) on yield and its components of lentils. Giza 9 variety and associated weeds. The results indicate that seeding rates had no significant effect on the dry weight of weeds after 75 days from sowing while the herbicides treatments significantly decreased it compared with the unweeded treatment. Increasing seeding rates from 40 to 60 kgs/fed. laid to significant increase in plant height and seed yield/fed., while decreased number of branches, pods and seed yield/plant significantly. Terbutryne herbicide at 1.0 kg/fed. produced

the greatest values of number of pods and seed yield/plant as well as seed yield/fed. While chlorobromuron herbicide at 1.5 kg/fed. resulted the highest number of branches/plant.
lens culinaris; seeding rates; herbicides; crop yield; yield components; Egypt; weed control.

90-093664 Studies on planting technology of maize facilitating inter and postharvest cropping at zero and minimum tillage. En. Bhutta, A.F.University of Agriculture, Faisalabad (Pakistan). Dept. of Agronomy.Faisalabad (Pakistan). UAF. 1987. 112 p.Thesis (M.Sc. (Hons.)). 8 plates, 3ills., 60 tables, 43 ref., Summary (En), AVAILABILITY: Library, University ofAgriculture, Faisalabad, Pakistan.
zea mays; planting; zero tillage; intercropping; sequential cropping; trifolium alexandrinum; triticum aestivum; lens culinaris; spacing; yield components; cost benefit analysis.

90-093681 Studies on rice planting geometry facilitating inter/relay cropping at zero-tillage. En. Khakhi, A.K.University of Agriculture, Faisalabad (Pakistan). Dept. of Agronomy.Faisalabad (Pakistan). UAF. 1988. 103 p.Thesis (M.Sc. (Hons.)). 18 tables, 63 ref., Summary (En), AVAILABILITY: Library, University of Agriculture, Faisalabad, Pakistan.
oryza sativa; planting; intercropping; zero tillage; varieties; spacing; triticum aestivum; lens culinaris; crop yield; yield components.

90-093682 Studies on rice planting geometry facilitating relay cropping at zero tillage. En. Mahmood, A.University of Agriculture, Faisalabad (Pakistan). Dept. of Agronomy.Faisalabad (Pakistan). UAF. 1988. 132 p.Thesis (M.Sc. (Hons.)). 5 ills., 27 tables, 43 ref., Summary (En), AVAILABILITY: Library, University of Agriculture, Faisalabad, Pakistan.
oryza sativa; planting; intercropping; zero tillage; varieties; crop yield; lens culinaris; triticum aestivum; helianthus annuus.

90-094011 Food legumes in Tunisia: status and improvement. En. Gridley, H.(ICARDA, Aleppo (Syria)). Amelioration des Legumineuses Alimentaires. Travaux du Stage de Formation. Rabat (Morocco). 11-16 Feb 1985.
International Center for Agricultural Research in the Dry Areas, Aleppo (Syria). Food legume improvement. Proceedings of the training course. Amelioration des legumineuses alimentaires. Synthese des travaux du stage de formation. Aleppo (Syria). International Center for Agricultural Research in the Dry Areas. 1987. p. 13-27.9 tables. AVAILABILITY: ICARDA, POB 5466, Aleppo - Syria RN: ICARDA -122-Fr. See Also: 90-061063. Information is presented on the area, prodution, and seed yield of faba beans, chickpeas, lentils, peas, and haricot beans in Tunisia; exports; compound growth rates for population and agricultural production; seed yield of faba bean as a percentage of the local check of five large lines and five small seeded lines at different locations; wilt rating, 100 seed-weight, and seed yield in wilt infested land and free land for superior chickpea lines; seed yield of four ascochyta blight resistant chickpea lines; seed yield as a percentage of the local check of five ascochyta resistant chickpea lines; seed yield of five heaviest yielding chickpea lines; wilt ratings and seed yield for five superior chickpea lines in ICARDA international yield trials; and seed yield of four lines.
vicia faba; lens culinaris; cicer arietinum; pisum sativum; kidney beans; crop yield; tunisia; cultivated land; plant breeding; cultivation; plant diseases.

90-094019 Preliminary yield trial of lentil. En. Khatun, Fatema. 14. Annual Bangladesh Science Conference. Dhaka (Bangladesh). 27-30 Jan 1986. Bangladesh Association for the Advancement of Science, Dhaka (Bangladesh). Proceedings of the 14th Annual Bangladesh Science Conference. Section 1. Dhaka (Bangladesh). BAAS. 1989. p. 113.Summary only.
A preliminary yield trial was conducted during the rabi season, 1937-88 with ten entries including L-5 as local check in randomized complete block design with three replications to find out the advantage of exotic strains over the existing variety L-5. Significant variations were found in respect of days to flowering, days to mature, pods/plant, 1000 seed weight and yield. The entries 113-55, 80018 and 80038 were near to L-5 in respect of maturity period. The entries 80018, 113-55 and 80013 gave higher yield than local check L-5. The yield of the lines 80018 was highest (896.6) kg/ha and significantly different from L-5. On the basis of maturity and yield the lines 113-55, 80018 and 80038 were selected for advance yield trial during the rabi season 1988-89.
lens culinaris; crop yield; trials; rabi season; maturation; flowering

90-094020 Effect of sowing date on lentil seed yield under rainfed conditions. En (English).Bukhtiar, B.A.; Chaudhary, G.A.; Atta, M.; Ramzan, M.(Ayub Agricultural Research Inst., Faisalabad Barani Agricultural Research Inst., Chakwal (Pakistan)). Journal-of-Agricultural-Research (Pakistan). (Jun 1989). v. 27(2) p. 105-112.3 tables, 12 ref., Summary (En).
lens culinaris; sowing date; rain fed farming; crop yield; yield components.

90-094021 Effect of planting geometry on the growth and yield behaviour of lentil (Lens culinaris L.). En. Nadeem, M.A.University of Agriculture, Faisalabad (Pakistan). Dept. of Agronomy.Faisalabad (Pakistan). UAF. 1987. 73 p.Thesis (M.Sc. (Hons.)). 4 plates, 7 ills., 21 tables, 57 ref., Summary (En), AVAILABILITY: Library, University of Agriculture, Faisalabad, Pakistan.
lens culinaris; planting; spacing; growth; crop yield; yield components; protein content.

90-094022 [Food legume improvement in North Africa]. [Proceedings of the training course]. En. Fr. Amelioration des legumineuses alimentaires en Afrique du Nord. Synthese des travaux du stage de formation. International Center for Agricultural Research in the Dry Areas, Aleppo (Syria). Amelioration des legumineuses alimentaires en Afrique du Nord. Travaux du stage de formation. Tunis (Tunisia). 13-20 Apr 1986.Aleppo (Syria). International Center for Agricultural Research in the Dry Areas. 1988. 122 p. Tables; fig. AVAILABILITY: ICARDA, POB 5466, Aleppo - Syria RN: ICARDA-123-Fr.
Basic and general information on some aspects of food legume improvement are covered in this introductory course. The following subjects are dealt with, with special reference to the status of food legumes in North Africa: importance of food legumes, status and improvement of food legumes.
lens culinaris; vicia faba; cicer arietinum; pisum sativum; morocco; tunisia; plant production.

90-094023 Food and agriculture in West Asia and North Africa: projections to 2000. En. Somel, K.ICARDA, Aleppo (Syria). Farm Resource Management Program.Aleppo (Syria). International Center for Agricultural Research in the Dry Areas. 1988. 28 p.8 tables; 3 ref. AVAILABILITY: ICARDA, POB 5466, Aleppo - Syria RN: ICARDA-128-En.
This paper reviews the first version of FAO projections to 2000 produced in 1981 and provides information on which the planning of research priorities in WANA can be based. The plan of discussion presents in one section the projections of demand for major agricultural

commodities followed by a discussion of production, input, and investment requirements. In the next section the problem of meeting the large food deficits in WANA is also discussed. Data are tabulated regarding demand for major agricultural products, demands growth rates, and implicit income elasticities for major agricultural commodities (1983-2000), land resources, crop production, livestock production, agro-ecological distribution of wheat, barley, and pulses production, input requirements, and agricultural investment requirements in WANA.
lens culinaris; vicia faba; cicer arietinum; triticum aestivum; triticum durum; north africa; food policies; planning; plant production.

90-094024 [Importance of improving food legumes in Morocco]. Fr. Importance des legumineuses alimentaires au Maroc.Sakr, B.(Institut National de la Recherche Agronomique, Rabat (Morocco)). Amelioration des Legumineuses Alimentaires. Travaux du Stage de Formation. Rabat (Morocco). 11-16 Feb 1985. International Center for Agricultural Research in the Dry Areas, Aleppo (Syria). Food legume improvement. Proceedings of the training course. Amelioration des legumineuses alimentaires. Synthese des travaux du stage de formation. Aleppo (Syria). International Center for Agricultural Research in the Dry Areas. 1987. p. 7-12.3 tables. AVAILABILITY: ICARDA, POB 5466, Aleppo - Syria RN: ICARDA-122-Fr.See Also: 90-061063.
Le secteur des legumineuses alimentaires au Maroc constitue principalement de feves, pois-chiches, lentilles, et petits pois occupe la seconde place apres le secteur des cereales. Ce rapport rend compte sur les superficies plantees de legumineuses, l'evolution de leur production et de leurs rendements ainsi que leur localisation geographique.
lens culinaris; vicia faba; cicer arietinum; pisum sativum; yield increase; morocco; cultivated land.

90-094025 Lentils: a potential Montana specialty crop. En. Smith, H.A.; Rust, C.H.; Baldridge, D.E.; Welty, L.E.(Montana State University, Extension Service). [1989]. 4 p. references.
In subseries: Agriculture. AVAILABILITY: NAL, USDA, Beltsville, Md. 20705- USA.
lens culinaris; montana; plant production.

90-106992 [Continuous flow and hill sowing using three seeding rates, in lentils (Lens culinaris Medik)]. Es. Siembra de lentejas (Lens culinaris Medik) a chorro continuo y mateado con tres dosis de semilla.Solar N, Jorge Antonio.Universidad Austral de Chile, Valdivia. Fac. de Ciencias Agrarias. Valdivia (Chile). 1987. 58 p. Tesis (Ing Agr). 44 ref.; Summaries (En, Es) AVAILABILITY: Biblioteca Central, IIA, CP 439/3, correo 3, Santiago - Chile.
lens culinaris; seeding rates.

90-106993 Evaluation of different methods of lentil harvesting. En. Papazian, J.American Univ. of Beirut (Lebanon).Beirut (Lebanon). 1982. 89 p.Thesis (Master of Science). AVAILABILITY: l'Universite Americaine de Beyrouth, Faculte d'Agriculture, B.P. 11-236 Liban.
The main objective of the trials was to evaluate six different methods of lentil harvesting under six different types of planting combined of two genotypes of lentils (small and large seeded), and three methods of planting (conventional, drilling and drilling followed by rolling). The six methods of harvesting used were hand pulling, scythe cutting, use of bean cutter, side mower, forage harvester and combine harvester. The interaction of these variables with the following characteristics was studied: lentil grain and straw yields, lentil grain and straw losses, lentil grain breakage, germinability and physical purity, straw quality, protein and fibre content, timeliness, man-power and energy requirements and total harvest cost. The results showed that hand pulling gives the best yields, but number of labourers needed and the cost of harvest were the highest with this method. The bean cutter was the most promising method for harvesting lentils mechanically. Use of scythe resulted in large losses of grain and straw and required skilled labourers. The combine was the cheapest method tested but losses were the highest. The methods using the cutterbar gave 40 to 50% straw loss and large loss of grain, and were more effective on rolled land. However, rolling reduced yields, and planting by drill gave higher yields than conventional planting, and the large seeded lentil yields were higher than those of the small seeded genotype.
lens culinaris; harvesting; genotypes; planting; harvesters; crop yield; straw; grain; trials

90-106994 Population density and row width effects on yield and agronomic attributes of lentils. En. Mozahar, A. American Univ. of Beirut (Lebanon). Beirut (Lebanon). 1986. 83 p. Thesis (Master of Science). AVAILABILITY: l'Universite Americaine de Beyrouth, Faculte d'Agriculture, B.P. 11-236, Liban.
A field experiment was conducted at the ICARDA sub-station in Terbol, Lebanon, to determine the effect of four population densities (100, 200, 300 and 400 plants/m2) and four row widths (20, 30, 40 and 50 cm) in a factorial combination on yield and agronomic attributes of lentils. Increasing the population density caused an increase in the height of the first pod bearing node, plant height, lodging leaf area index (LAI), shoot dry weight, number of nodules per plant and the biological yield of the crop while days to flowering and maturity, number of secondary branches and peduncles per plant, harvest index, relative growth rate (RGR) and net assimilation rate (NAR) decreased. With the higher population densities the crop growth rate (CGR) was higher at the early sampling dates and lower with the late sampling dates. Wider row spacing caused a decrease in all the variables measured except nodule weight per plant, pods per peduncle, seeds per pod, 100-seed weight and the harvest index which remained unaffected. LAI and shoot dry weight increased with a wider row spacing only at the early sampling dates but later on showed a declining trend. A population density of 200 plants/m2 with the lowest row width (20 cm) resulted in the highest grain yield (1.84 t/ha). Peduncles per plant among the primary yield components was highly correlated with grain yield.
lens culinaris; crop yield; syria; plant population; spacing; harvest index; yields; lodging; nodes; plant anatomy; assimilation; agronomic characters.

Plant Propagation

90-050863 Plantlet regeneration from nodal segment and shoot tip derived explants of lentil [Lens culinaris]. En. Singh, R.K.; Raghuvanshi, S.S.(University of Lucknow (India). Dept. of Botany). LENS-Newsletter (ICARDA).
Lentil Experimental News Service. (1988). v. 16(1) p. 33-35.4 fig.; 20 ref. Summaries (Ar, En).
A tissue culture procedure has been developed for plantlet regeneration from nodal segment and shoot tip explants directly, as well as from callus. Direct plantlets were observed on MS basal media, whereas regeneration from callus plantlet was achieved using a two step method. Explants taken from in vitro seeds grown plants of 2n2x and 2n4x lentil, were used to induce callus. Callus, obtained on Murashige and Skoog medium (MS) + Kinetin Kn (1.0 mg/l) + 2,4D (10.0 mg/l), was induced to regenerate shoot buds on media containing Kn (10.0 mg/l) which were transferred to MS basal media for plantlet formation. Upon transfer to soil, normal fertile plants were produced.
lens culinaris; tissue culture; nodes; shoot tip culture; india; diploids; tetraploids

Seed Production

90-030542 Seed production in Algeria. En. Mazari, B.(OAIC, Algiers (Algeria)). Seed Production in and for Mediterranean Countries. Cairo (Egypt). 16-18 Dec 1988.Gastel,-A.J.G.-van (ICARDA, Aleppo (Syria)); Hopkins,-J.D. (eds.). European Community, Brussels (Belgium); ICARDA, Aleppo (Syria). Seed production in and for Mediterranean countries. Proceedings of the ICARDA/EC workshop. Aleppo (Syria). International Center for Agricultural Research in the Dry Areas. 1988. p. 37-45.4 tables; Summaries (En, Ar, Fr, It). AVAILABILITY: ICARDA, POB 5466, Aleppo - Syria RN: ICARDA-114-En.See Also: 90-030558.

The paper describes the activities of Algeria's seed programme and the constraints it faces. The Institute for the Development of Large-scale Farming is responsible for breeding, seed production and seed-quality control of cereals and some food and forage legumes. Seed is produced on state farms and is tested for purity and germination. The rates of rejection for fields and seed lots are high; the quality of the seed produced could be considerably improved. There is a small amount of certified seed produced by private growers. The paper concludes with a discussion of the constraints affecting research, seed production, seed storage and seed-quality control.

triticum aestivum; triticum durum; barley; oats; vicia faba; pisum sativum; lens culinaris; vicia sativa; kidney beans; seed; algeria; harvesting; constraints; processing; research; storage

90-030558 Seed production in and for mediterranean countries. Proceedings of the ICARDA/EC workshop. En. Gastel, A.J.G. van; Hopkins, J.D. (eds.).(ICARDA, Aleppo (Syria)). European Community, Brussels (Belgium). ICARDA, Aleppo (Syria). Seed Production in and for Mediterranean Countries. Cairo (Egypt). 16-18 Dec 1988.Aleppo (Syria). International Center for Agricultural Research in the Dry Areas. 1988. 253 p.34 tables; Summaries (En, Ar, Fr, It). AVAILABILITY: ICARDA, POB 5466, Aleppo - Syria RN: ICARDA-114-En.

This book contains the proceedings of a workshop on seed production in and for Mediterranean countries held in Cairo, Egypt in 1986. The workshop, organized by ICARDA and the Central Administration for seeds of the Ministry of Agriculture and Food Security, Egypt, and sponsored by the General Directorate of the European Community, aimed at reviewing the progress made in building up national seed programmes in the Mediterranean region; identifying constraints to further development; suggesting measures to remove these constraints; and promoting and intensifying collaboration between scientists of both sides of the Mediterranean. The book comprises 28 chapters dealing with seed activities of international organizations and others, country reports on the activities of national seed programmes, and scientific papers on general or crop-specific seed production. Recommendations made at the end of the workshop are also included for further action regarding the institutional, economic, technical and sociological changes needed to strengthen seed programmes for small farmers; the role of the private and semi-private sector in building up a national seed supply; the strengthening of seed production and distribution programmes for food legumes, and pasture and forage crops; and training in seed production. List of paricipants is also included.

vicia faba; seed; lens culinaris; cicer arietinum; wheats; medicago; vicia sativa; seed production; development projects; feed crops; legumes; cereals; constraints

90-030559 Statement on ICARDA's seed activities. En. Gastel, A.J.G. van.(ICARDA, Aleppo (Syria)). Seed Production in and for Mediterranean Countries. Cairo (Egypt). 16-18 Dec 1988. Gastel,-A.J.G.-van (ICARDA, Aleppo (Syria)); Hopkins,-J.D. (eds.). European Community, Brussels (Belgium); ICARDA, Aleppo (Syria). Seed production in and for Mediterranean countries. Proceedings of the ICARDA/EC workshop. Aleppo (Syria). International Center for Agricultural Research in the Dry Areas. 1988. p. 14-17.AVAILABILITY: ICARDA, POB 5466, Aleppo - Syria RN: ICARDA-114-En.See Also: 90-030558.

This paper summarizes the situation of seed production and distribution in North Africa and West Asia. The activities of ICARDA regarding training, consultancies, future activities, and establishment of the seed unit at ICARDA to strengthen the capabilities of national seed programmes and to develop technical skill in seed technology, are also described.

vicia faba; cicer arietinum; medicago; wheats; lens culinaris; seed; barley; development projects; north africa; middle east; seed production; objectives; constraints

90-030560 The seed sector in Morocco. En. Bouzoubaa, A.(SONACOS, Rabat (Morocco)). Seed Production in and for Mediterranean Countries. Cairo (Egypt). 16-18 Dec 1988.Gastel,-A.J.G.-van (ICARDA, Aleppo (Syria)); Hopkins,-J.D. (eds.). European Community, Brussels (Belgium); ICARDA, Aleppo (Syria). Seed production in and for Mediterranean countries. Proceedings of the ICARDA/EC workshop. Aleppo (Syria). International Center for Agricultural Research in the Dry Areas. 1988. p. 46-61.6 tables; Summaries (En, Ar, Fr, It). AVAILABILITY: ICARDA, POB 5466, Aleppo - Syria RN: ICARDA-114-En.See Also: 90-030558.

The paper gives a detailed description of Morocco's seed-production programme. The National Seeds Committee steers the activities of the programme. The National Institute for Agricultural Research is responsible for breeding and maintenance. Before varieties are listed in the official catalogue, tests for distinctness, uniformity and stability, as well as tests for agronomic performance are carried out. Only seed of registered varieties can be produced and marketed. Certified seed is produced and marketed by SONACOS, the national seed-marketing company. Most of the seed produced is of cereals, but substantial amounts of food and forage-legume seed are also produced. Except for winter cereals, there are a number of other companies involved in the marketing of seed. Seed-quality control (seed testing and certification) is carried out by the Service for the Quality Control of Seed and Propagating Material of the Ministry of Agriculture. The paper concludes with a brief description of the constraints in breeding, production and marketing.

vicia faba; lens culinaris; cicer arietinum; triticum durum; triticum aestivum; oats; zea mays; secale cereale; rice; arachis hypogaea; seed; morocco; feed legumes; industrial crops; marketing; constraints; objectives; research; administration

90-030562 The production of seed of leguminous crops in Spain. En. Montoya, J.L.(Regional Agriculture Service of Castilla Leon, Valladplid (Spain)). Seed Production in and for Mediterranean Countries. Cairo (Egypt). 16-18 Dec 1988.Gastel,-A.J.G.-van (ICARDA, Aleppo (Syria)); Hopkins,-J.D. (eds.). European Community, Brussels (Belgium); ICARDA, Aleppo (Syria). Seed production in and for Mediterranean countries. Proceedings of the ICARDA/EC workshop. Aleppo (Syria). International Center for Agricultural Research in the Dry Areas. 1988. p. 136-142.3 tables; Summaries (En, Ar, Fr, It). AVAILABILITY: ICARDA, POB 5466, Aleppo - Syria RN: ICARDA-114-En.See Also: 90-030558.

The paper gives a brief description of the cultivation of leguminous crops in Spain, and a detailed description of the situation regarding the production, utilization and marketing of leguminous seed. Mainly local varieties are grown, but there is a strong breeding programme to

develop improved varieties, especially for Vicia faba. A large number of seed companies are involved in the production of seed of leguminous crops. Although most of these serve a local demand, there is a considerable amount of seed exported, especially of Medicago sativa and Vicia sativa.

vicia faba; lens culinaris; cicer arietinum; pisum sativum; phaseolus vulgaris; vicia sativa; medicago sativa; lupinus albus; seed; spain; seed production.

90-030563 The organization and role of the seed industry in Egypt. En (English).Gaber, S.D.(Central Administration for Seeds, Giza (Egypt)). Seed Production in and for Mediterranean Countries. Cairo (Egypt). 16-18 Dec 1988. Gastel,-A.J.G.-van (ICARDA, Aleppo (Syria)); Hopkins,-J.D. (eds.). European Community, Brussels (Belgium); ICARDA, Aleppo (Syria). Seed production in and for Mediterranean countries. Proceedings of the ICARDA/EC workshop. Aleppo (Syria). International Center for Agricultural Research in the Dry Areas. 1988. p. 28-36.4 tables; Summaries (En, Ar, Fr, It). AVAILABILITY: ICARDA, POB 5466, Aleppo - Syria RN: ICARDA-114-En.See Also: 90-030558.

This paper describes the activities of Egypt's national seed programme. The overall responsibility for executing the programme lies with the Central Administration for Seed (CAS), an undersecretariat of the Ministry of Agriculture and Food Security. Breeder seed, foundation seed and a substantial amount of registered seed are produced by the Agricultural Research Center. The CAS produces registered seed and certified seed, the latter under contract with seed growers. The CAS is responsible for quality control: the supervision of seed processing, which is carried out mainly by the Egyptian Agricultural Authority: and seed distribution. After processing certified seed is moved to the governorates, where it is stored at the facilities of the Principal Bank for Development and Agricultural Credit. As well as distributing seed to the village cooperatives, the Bank also supplies all inputs to farmers and provides them with credit. Private and semi-private seed companies play an important role in the production and distribution of maize, sorghum, vegetable and forage seed.

lens culinaris; vicia faba; wheats; barley; rice; sorghum; arachis hypogaea; trifolium alexandrinum; zea mays; seed industry; egypt; seed production; research; seed certification.

90-030564 Seed multiplication project in Jordan. En. Howell, R.; Quol, A.A.(Jordan/German Seed Project, Amman (Jordan)). Seed Production in and for Mediterranean Countries. Cairo (Egypt). 16-18 Dec 1988. Gastel,-A.J.G.-van (ICARDA, Aleppo (Syria)); Hopkins,-J.D. (eds.). European Community, Brussels (Belgium); ICARDA, Aleppo (Syria). Seed production in and for Mediterranean countries. Proceedings of the ICARDA/EC workshop. Aleppo (Syria). International Center for Agricultural Research in the Dry Areas. 1988. p. 78-83.1 table; Summaries (En, Ar, Fr, It). AVAILABILITY: ICARDA, POB 5466, Aleppo - Syria RN: ICARDA-114-En.See Also: 90-030558.

The paper describes the seed activities in the Hashemite Kingdom of Jordan. The National Center for Agricultural Research and Technology Transfer (NCARTT) is responsible for the development, testing and maintenance of varieties. NCARTT produces the breeder and basic seed and is responsible for quality control. Construction of a seed-testing laboratory has been completed. The Jordan Cooperative Organization multiplies, processes and distributes the seed. The infrastructure for seed production is in place and quality seed of wheat and barley is produced; lentil and chickpea will be included in the near future. A seed act has been drafted.

lens culinaris; cicer arietinum; barley; wheats; seed; jordan; seed production; seed certification; processing; research policies.

90-030565 Seed production of food legumes in the Mediterranean area. En. Erskine, W.; Singh, K.B.; Robertson, L.D.(ICARDA, Aleppo (Syria). Food Legume Improvement Programme). Seed Production in and for Mediterranean Countries. Cairo (Egypt). 16-18 Dec 1988.Gastel,-A.J.G.-van (ICARDA, Aleppo (Syria)); Hopkins,-J.D. (eds.). European Community, Brussels (Belgium); ICARDA, Aleppo (Syria). Seed production in and for Mediterranean countries. Proceedings of the ICARDA/EC workshop. Aleppo (Syria). International Center for Agricultural Research in the Dry Areas. 1988. p. 120-130.1 table; 7 ref.; Summaries (En, Ar, Fr, It). AVAILABILITY: ICARDA, POB 5466, Aleppo - Syria RN: ICARDA-114-En.See Also: 90-030558.

The major food legumes in the Mediterranean region are faba bean (Vicia faba), kabuli chickpea (Cicer arietinum) and lentil (Lens culinaris) sown on 826.000, 735.000 and 887.000 ha respectively in 1984. Lentil cultivation is highest in West Asia, whereas faba bean is more important in southern Europe and North Africa. Chickpea production is spread over all these regions. There are few improved legume varieties in the area and consequently, little current demand for the production of legume seed. However, strong national and international breeding programmes have developed in the last decade, and they are set to produce many new, improved cultivars. Thus, there will be a growing requirement for quality seed of food legumes. Constraints to the seed production of food legumes include the following: 1. lack of improved cultivars. 2. field mechanization in the production of food-legume seed. Most field operations (sowing, weed control and harvest) in the three food legumes can be mechanized by cereal-seed producers, but they require either modification of existing equipment or the purchase of new machinery and herbicides. Large-seeded faba beans (0.8g/seed) are still problematic to sow and harvest mechanically; 3. problems in seed production specific to each food-legume species. Faba bean is a partially outcrossing crop with an average of 35 % cross-pollination, mainly by bees. Spatial isolation remains the only reliable way to minimize genetic contamination between varieties under multiplication. Outcrossing makes varietal description difficult. The major seed-borne pathogens of both crops are the respective ascochyta blights and vascular wilts. 4. lack of economic incentives. Farmers growing certified seed of food legumes are not given a guaranteed price at sowing. The following solutions to constraints in seed production of food legumes are suggested: a continued effort to produce new, improved varieties of food legumes; training of existing seed-production personnel that focuses on what makes the seed production of food legumes different from that of cereals; and a guaranteed price for the legumes

production of certified seed to stimulate seed production in food legumes.

lens culinaris; vicia faba; cicer arietinum; seed; mediterranean countries; distribution; constraints; mechanization; varieties; economics; development projects.

90-030566 Food legumes in Greece. En. Kontsiotou, H.(Fodder Crops and Pastures Inst., Larissa (Greece)). Seed Production in and for Mediterranean Countries. Cairo (Egypt). 16-18 Dec 1988.Gastel,-A.J.G.-van (ICARDA, Aleppo (Syria)); Hopkins,-J.D. (eds.). European Community, Brussels (Belgium); ICARDA, Aleppo (Syria). Seed production in and for Mediterranean countries. Proceedings of the ICARDA/EC workshop. Aleppo (Syria). International Center for Agricultural Research in the Dry Areas. 1988. p. 131-135.1 table; Summaries (En, Ar, Fr, It). AVAILABILITY: ICARDA, POB 5466, Aleppo - Syria RN: ICARDA-114-En.See Also: 90-030558.

The most important food legumes in Greece are Phaseolus vulgaris, Cicer arietinum and Lens culinaris. Vicia faba, Vigna sinensis, Lathyrus

sativus and Pisum sativum are also grown, but on a smaller scale. The area under cultivation, yield, production, and cultivation methods for each crop are briefly discussed.
lens culinaris; vicia faba; cicer arietinum; phaseolus vulgaris; lathyrus sativus; pisum sativum; greece; seed production; cultivation; methods; crop yield.

90-094489 Quality seed production. En. Gastel, A.J.G. van; Kerley, J. (eds.).ICARDA, Aleppo (Syria). Seed technology course. Cairo (Egypt). 15-30 Mar 1986.Aleppo (Syria). International Center for Agricultural Research in the Dry Areas. 1988. 185 p.Tables; fig. AVAILABILITY: ICARDA, POB 5466, Aleppo - Syria RN: ICARDA-124-En.
This book includes only a selection of the papers presented during the Seed Technology course held March 15-30, 1986 in Cairo, Egypt. The course dealt with seed production in Egypt, Sudan, and Ethiopia. The first sections of the book deal with seed production technology to supplement another ICARDA publication, "Seed Production Technology". The papers in the last sections of this book provide an overview of seed production activities in Egypt, Sudan, and Ethiopia. The papers deal with seed production of specific crops and with the history of, progress of, and constraints to seed production in these countries.
lens culinaris; vicia faba; cicer arietinum; triticum aestivum; triticum durum; quality; egypt; sudan; ethiopia; seed production.

90-094490 [Practical seed production]. Proceedings of the training course on seed production technology. Ar. al-jawa:nib/u al-3amaliyyat/u fi: ' inta:j/i al-bid"a:r. al-dawrat/u al-tadri:biyyat/u al-t"a:niyyat/u 3ala tiganiyya:t/i inta:j/i al-bid"a:r.El Sebae Ahmed, S. (ed.).(ICARDA, Aleppo (Syria)). Ministry of Agriculture and Agrarian Reform, Aleppo (Syria). ICARDA, Aleppo (Syria). Seed Production Technology. Aleppo (Syria). 15-26 Feb 1987. Aleppo (Syria). International Center for Agricultural Research in the Dry Areas. 1988. 195 p.Figures; table. Summary (En). AVAILABILITY: ICARDA, POB 5466, Aleppo - Syria RN: ICARDA-126-Ar.
This book is aimed on the lectures presented during the Seed Production Course, 15-26 Feb, 1987 jointly organized and financed by the General Organization and Seed Multiplication (GOSM) in Syria and ICARDA, Aleppo, Syria. The book in Arabic is aimed at making seed technology information easily available to those seed production specialists in countries of West Asia and North Africa involved in seed production and utilization including plant breeders, seed growers, processors, quality control officers, extension specialists, agricultural students, and ICARDA trainees.
lens culinaris; vicia faba; cicer arietinum; triticum aestivum; triticum durum; seed industry; middle east; north africa; quality; seed testing; seed certification; viruses; storage; seed production; marketing; tissue culture.

90-107362 [A hydration-dehydration treatment for vigour improvement of lentils, chickpeas and corn]. Es. Uso de un tratamiento de hidratacion - deshidratacion para mejorar el vigor de lenteja, garbanzo y maiz. Abbruzzese P, Gino Rocco.Universidad de Chile, Santiago. Esc. de Agronomia. Santiago (Chile). 1989. 92 p.Tesis (Ing Agr). 57 ref.; Summaries (En, Es) AVAILABILITY: Biblioteca Central, IIA, CP 439/3, correo 3, Santiago - Chile. LENS
culinaris; cicer arietinum; zea mays; seed treatment; germination; hydration; dehydration

Fertilizing

90-040641 Soil test calibration in West Asia and North Africa. Proceedings of the second regional workshop. En. Matar, A.; Soltanpour, P.N.; Chouinard, A. (eds.).(ICARDA, Aleppo (Syria) Aridoculture Center, Settat (Morocco)). ICARDA, Aleppo (Syria). Second Regional Workshop on Soil Test Calibration in West Asia and North Africa. Ankara (Turkey). 1-6 Sep 1987. Aleppo (Syria). International Center for Agricultural Research in the Dry Areas. 1988. 118 p.Tables; fig. AVAILABILITY: ICARDA, POB 5466, Aleppo - Syria RN: ICARDA-120-En.
This book contains reports of participants in the second meeting in a series on soil test calibration in West Asia and North Africa. The reports are on findings related to correlations between NaHCO3-extractable P in the soil and responses by barley and wheat to applications of fertilizer. The reports clearly reflect the key role played by the two cereal crops in the region and highlight the P-deficient status of most unfertilized agricultural lands. Complementing these reports are studies on response of food and forage legumes to phosphorus fertilization on soils in the region and on correlations between the Olsen method of extracting P(NaHCO3) and other cheaper and less time-consuming methods. Soils are classified according to whether cereals and legumes could be expected to respond to applications of phosphate fertilizer. Recommendations which may result in better allocation of phosphate fertilizer and major savings to the farmers and agricultural departments in the region are also included.
triticum aestivum; triticum durum; lens culinaris; vicia faba; cicer arietinum; soil testing; nitrogen fertilizers; phosphorus; cooperative activities; north africa; soil fertility.

90-040642 Soil test calibration with N and P for wheat under dryland conditions in Syria. En. Pala, M.; Matar, A.(ICARDA, Aleppo (Syria)). Second Regional Workshop on Soil Test Calibration in West Asia and North Africa. Ankara (Turkey). 1-6 Sep 1987.Matar,-A. (ICARDA, Aleppo (Syria)); Soltanpour,-P.N. (Aridculture Center, Settat (Morocco)); Chouinard,-A. (eds.). ICARDA, Aleppo (Syria). Soil test calibration in West Asia and North Africa. Proceedings of the second regional workshop. Aleppo (Syria). International Center for Agricultural Research in the Dry Areas. 1988. p. 55-66.6 tables; 2 fig.; 9 ref. Summary (En). AVAILABILITY: ICARDA, POB 5466, Aleppo - Syria RN: ICARDA-120-En.See Also: 90-040641. Twenty N x P factorial trials with a durum wheat (Sham 1) were conducted during 1986-87 in farmers' fields of northeast and northwest Syria. Four levels of N (0, 40, 80 and 120 kg N/ha) and four levels of P (0, 20, 40 and 80 kg P2O5/ha) were used with two replications. These trials were complemented by trials in three locations in the northwest region to compare methods of P application: (a) broadcasting and incorporating P in the plow layer just before planting, (b) banding P with the seed at sowing and (c) broadcasting P with the seeds on ridges and then splitting the ridges to cover the seeds (farmers' practice). At each site, a rainfall gauge was installed and precipitation recorded daily. Before planting, NH4 and NO3-N in the soil were determined down to 100 cm deep, at 20-cm increments, and NaHCO3-extractable P was determined in the 0-20 and 20-40 cm soil layers. Three common rotations (chickpea-wheat, lentil-wheat, and summer crops-wheat) and four available soil-P levels (poor,4 ppm; medium, 4-7 ppm; high, 7-10 ppm; and very high10 ppm) in each rotation system were studied. Grain and straw responded positively and significantly to N fertilizer at 16 and 19 of the 20 sites respectively. Compared with the control, yield increased 32% and 40% in grain, 36% and 46% in straw by applications of 40 and 80 kg N/ha respectively. Grain and straw responded significantly to P at only 4 and 5 of the sites. Except at one site banding did not differ significantly from broadcasting and incorporating P in the plow layer, but both were significantly better than the farmers' practice with increases being, respectively, 25% and 21% in grain and 20% and 12% in straw. Grain

and straw yields also differed significantly among rotations and were highest for summer crops-wheat. A Cate-Nelson graph of the results showed that the NaHCO3-extractable P in soils that gave 80% of maximum total dry matter was about 5 ppm. The mineral-N and NO3-N in the top 40 cm of soil correlated fairly well with relative yields of dry matter and gave near-maximal yields at 42 and 33 kg/ha, respectively.
triticum aestivum; triticum durum; lens culinaris; cicer arietinum; soil testing; nitrogen fertilizers; phosphorus; syria; dry farming; yield increase; fertilizer application; nutrients; sowing date; soil fertility.

90-040644 Calibration of three tests for determining phosphorus fertility of soils to support cereals, legumes, and oilseeds. En. Rashid, A.; Bughio, N.; Salim, M.(National Agricultural Research Centre, Islamabad (Pakistan). Land Resources Section). Second Regional Workshop on Soil Test Calibration in West Asia and North Africa. Ankara (Turkey). 1-6 Sep 1987. Matar,-A. (ICARDA, Aleppo (Syria)); Soltanpour,-P.N. (Aridculture Center, Settat (Morocco)); Chouinard,-A. (eds.). ICARDA, Aleppo (Syria). Soil test calibration in West Asia and North Africa. Proceedings of the second regional workshop. Aleppo (Syria). International Center for Agricultural Research in the Dry Areas. 1988. p. 86-93.3 tables; 2 fig.; 11 ref. Summary (En). AVAILABILITY: ICARDA, POB 5466, Aleppo - Syria RN: ICARDA-120-En.See Also: 90-040641.
Three soil tests (NaHCO3, NH4HCO3-DTPA, and Mehlich 3) were evaluated for their ability to predict the amount of P that cereals, legumes, and oilseeds could extract from soils in Pakistan. In greenhouse studies, yields and P contents of grain and foliage were determined for five species grown on an alkaline, calcareous, P-deficient (Olsen-P, 3.9 mg P/kg soil) typic ustochrept supplied with 0, 10, 20, 40, and 80 mg P2O5/ha soil. Grain yield without P fertilizer was mustard (Brassica juncea), 14%; wheat (Triticum aestivum), 17%; lentil (Lens culinaris), 19%; barley (Hordeum vulgare), 26%; and chickpea (Cicer arietinum), 42% of the maximum obtained with adequate P. The results were used for calibration of soil tests investigated in an incubation study in the laboratory; samples of the soil were supplied with 0, 10, 20, 40, and 80 mg P2O5/kg and allowed to equilibrate at 25 +/- 1 deg C. Extractable P was determined by the three methods at weekly intervals. The P extracted by all three soil tests correlated well with crop yield and P uptake, and correlation coefficients demonstrated the tests' value in predicting requirements for fertilization with P. As the universal soil tests (NH4HCO3-DTPA and Mehlich 3) are cheaper, easier, and less time-consuming than the NaHCO3 test now used routinely in Pakistan, they could be used for quick, site- and crop-specific recommendations about fertilizer applications.
triticum aestivum; triticum durum; barley; cicer arietinum; lens culinaris; soil testing; phosphorus; pakistan; cooperative activities; methods; ph; nutrients; moisture content; plant habit; crop yield; chemical analysis; plant containers.

90-040646 Program of work for the regional network of soil test calibration study sites in limited rainfall areas. Appendix. En. Soltanpour, P.N.; Matar, A.; Harmsen, K.(MIAC, Settat (Morocco) ICARDA, Aleppo (Syria) Institute for Soil Fertility, Haren (Netherlands)). Second Regional Workshop on Soil Test Calibration in West Asia and North Africa. Ankara (Turkey). 1-6 Sep 1987.Matar,-A. (ICARDA, Aleppo (Syria)); Soltanpour,-P.N. (Aridculture Center, Settat (Morocco)); Chouinard,-A. (eds.). ICARDA, Aleppo (Syria). Soil test calibration in West Asia and North Africa. Proceedings of the second regional workshop. Aleppo (Syria). International Center for Agricultural Research in the Dry Areas. 1988. p. 103-110.3 tables; 1 fig.; 16 ref. Summary (En). AVAILABILITY: ICARDA, POB 5466, Aleppo - Syria RN: ICARDA-120-En.See Also: 90-040641.
This paper is written as a guideline for a regional soil test calibration study in limited winter rainfall areas (200-500 mm) of West Asia and North Africa. In arid and semi-arid regions, nitrogen and phosphorus are usually the main nutrients limiting the yield of crops. In this paper we concentrate on these two nutrients. The strategy of researchers in limited rainfall areas should be to maximize yield per unit of precipitation. Research results show that using optimum rates of fertilizers increases yields and water use efficiency and, consequently, income of farmers. To find out what is the optimal rate, one can conduct soil tests and calibrate them with crop responses, but the studies require a team of scientists with laboratory and field experience and an adequate budget so regional cooperation is essential.
triticum aestivum; triticum durum; barley; lens culinaris; vicia faba; soil testing; nitrogen fertilizers; phosphorus; middle east; north africa; water use; nutrients; economic analysis; arid zones; cooperative activities.

90-040647 Nitrogen and phosphorus soil-test calibration studies in the Chaouia region of Morocco. En. Soltanpour, P.N.; El Gharous, M.; Azzaoui, A.; Abdelmonem, M.(Institut National de la Recherche Agronomique and Mid America International Agricultural Consortium, Settat (Morocco)). Second Regional Workshop on Soil Test Calibration in West Asia and North Africa. Ankara (Turkey). 1-6 Sep 1987. Matar,-A. (ICARDA, Aleppo (Syria)); Soltanpour,-P.N. (Aridculture Center, Settat (Morocco)); Chouinard,-A. (eds.). ICARDA, Aleppo (Syria). Soil test calibration in West Asia and North Africa. Proceedings of the second regional workshop. Aleppo (Syria). International Center for Agricultural Research in the Dry Areas. 1988. p. 67-81.7 tables; 8 fig.; 10 ref. Summary (En). AVAILABILITY: ICARDA, POB 5466, Aleppo - Syria RN: ICARDA-120-En. See Also: 90-040641.
A series of on-farm factorial N and P studies for use in soil test calibration were initiated in the fall of 1985 to determine the critical level of NaHCO3-extractable P for wheat crops grown in soils of the Chaouia region in the province of Settat, Morocco; the effect of previous crop, yield level, initial soil nitrate, and N mineralization potential on the N requirement of wheat crops grown in the region; and the efficiency of banding as compared with broadcasting superphosphate. Three different soil types were selected based on their potential productivity, namely shallow (rendolls), moderately deep (calcixerolls), and deep (chromoxererts and their intergrades). The previous crops were wheat or barley and legumes in all soils, weedy fallow in shallow soils, and corn in deep soils. The details of experimental methods are given elsewhere (Soltanpour 1987). No interaction between applied N and P fertilizers on the yield of wheat was observed. In 1985-86, rainfall was 300 mm with an excellent distribution. In 1986-87, rainfall was 200 mm for calcixeroll and chromoxerert sites and 240 mm for the rendoll site. The distribution in the later year was poor. The results showed that for rendolls no nitrogen fertilization was required when wheat followed a legume crop or weedy fallow, but about 30 kg/ha was required after cereals. In these shallow soils, N uptake or yield was not related to residual soil NO3-N, probably because of variability in soil depth or other factors. Nitrogen uptake in check plots was well correlated with soil NO3-N in 20-, 40-, and 60-cm profiles of calcixerolls and chromoxererts indicating the importance of a NO3-N soil test. Relative yield was a linear function of nitrate content in the soil profile. For a grain yield of 2 t/ha, 18, 31, and 50 kg NO3-N/ha was required in 0-20, 0-40, and 0-60 cm profiles. An N model based on critical level of NO3-N in the profile, soil NO3-N, apparent efficiencies of fertilizer N and soil NO3-N yield goal and previous crop was developed and will be verified under farmers' conditions of management.
triticum durum; barley; lens culinaris; triticum aestivum; medicago; soil testing; phosphorus; rotational cropping; morocco; precipitation; crop yield; fallow systems; rain fed farming; soil fertility; calcareous soils; nutrients; superphosphate

90-040714 Soil testing as a guide to phosphate fertilization of five legumes in Syria. En. Matar, A.E.; Saxena, M.; Silim, S.N. (ICARDA, Aleppo (Syria)). Second Regional Workshop on Soil Test Calibration in West Asia and North Africa. Ankara (Turkey). 1-6 Sep 1987. Matar,-A. (ICARDA, Aleppo (Syria)); Soltanpour,-P.N. (Aridculture Center, Settat (Morocco)); Chouinard,-A. (eds.). ICARDA, Aleppo (Syria). Soil test calibration in West Asia and North Africa. Proceedings of the second regional workshop. Aleppo (Syria). International Center for Agricultural Research in the Dry Areas. 1988. p. 94-102. 4 tables; 5 fig.; 7 ref. Summary (En). AVAILABILITY: ICARDA, POB 5466, Aleppo - Syria RN: ICARDA-120-En. See Also: 90-040641.

The relationship between P available in the soil and response of food and forage legumes to phosphate fertilization was investigated in Syria. In 1986-87, pea, chickpea, faba bean, lentil, and vetch were grown at the main agricultural station of ICARDA at Tel Hadya on soils having 2-21 ppm of NaHCO3-extractable (Olsen) P. In the previous season, the plots had been fertilized with P at 0, 50, 100, 150, and 200 kg P2O5/ha and had been cultivated with barley. At planting time the crops received 0, 50, or 100 kg P2O5/ha. At harvest, grain and total biological yields were determined. The results were analysed according to Cate-Nelson methods - graphical representation and analysis of variance - for the estimation of critical levels of P in soil (i.e., levels beyond which crops are unlikely to respond to P fertilization). For two of the crops - chickpea and lentil - the analysis was extended to include data from trials the previous year. In these 18 trials, conducted on farmers' fields where Olsen-P ranged from 4 to 24 ppm, the crops were fertilized with 0, 50, 100, and 150 kg P2O5/ha (three replications). Findings were that the critical levels were 6 ppm for pea, 5.5-7 ppm for chickpea, 7 ppm for faba bean, 7-8 ppm for lentil, and 5.5-7 ppm for vetch. These values suggest that all five legumes will thrive on soils with available P at 8 ppm, although testing under other soil and environmental conditions is required for confirmation.

vicia faba; pisum sativum; lens culinaris; cicer arietinum; soil testing; syria; soil chemicophysical properties; cooperative activities; evaluation; calcareous soils.

90-040716 Establishment of fertilizer recommendations on the basis of soil tests. En. Smilde, K.W. (Institute of Soil Fertility, Haren (Netherlands)). Second Regional Workshop on Soil Test Calibration in West Asia and North Africa. Ankara (Turkey). 1-6 Sep 1987. Matar,-A. (ICARDA, Aleppo (Syria)); Soltanpour,-P.N. (Aridculture Center, Settat (Morocco)); Chouinard,-A. (eds.). ICARDA, Aleppo (Syria). Soil test calibration in West Asia and North Africa. Proceedings of the second regional workshop. Aleppo (Syria). International Center for Agricultural Research in the Dry Areas. 1988. p. 1-11. 7 fig.; 28 ref. Summary (En). AVAILABILITY: ICARDA, POB 5466, Aleppo - Syria RN: ICARDA-120-En. See Also: 90-040641.

Developing a basis for fertilizer recommendations involves choosing an effective soil extractant in pot experiments and calibrating soil tests against yield responses to applied nutrient in field experiments. Soils used in pot and field experiments should vary in concentration of the nutrient and in relevant factors affecting plant response. Using the results from experiments and taking into consideration the price ratio of nutrient (fertilizer) to marketable product per unit of weight, one can establish fertilizer rates that are economically optimal for various soiltest classes ranging from low to high fertility. When fertilizer is expensive and not generally used, one may recommend rates that result in a benefit (economic return) to cost ratio of at least 2. When fertilizer use is common and its price moderate, one should recommend rates that increase fertility status (P, K) as well as satisfying the crop's direct needs. In recommendations to farmers, one also must consider the effects of stress factors, like salinity and drought, in relation to fertilizer response. Methods other than soil calibration cannot determine the nutrient status of soils in specific climatic conditions. Plant analysis for example, is seldom a substitute for soil tests, although some investigators have suggested the use of "critical" tissue levels as a guideline to fertilizer application. Where facilities for soil testing are lacking or soil tests cannot be readily interpreted, the so-called double-pot technique, though largely qualitative, is a useful tool for assessing soil-nutrient availability.

lens culinaris; vicia faba; cicer arietinum; barley; triticum aestivum; soil testing; fertilizer application; north africa; middle east; crop yield; nutrient availability; soil fertility; salinity; stress; soil water; economics; soil deficiencies; soil chemicophysical properties; cooperative activities.

90-051077 Effect of the application of phosphorus fertilizer on grain yield of lentil [Lens culinaris]. En. Azad, A.S.; Gill, A.S. (Punjab Agricultural Univ., Gurdaspur (India). Regional Research Station). LENS-Newsletter (ICARDA). Lentil Experimental News Service. (1988). v. 16(1) p. 28-30. 1 table; 1 fig.; 9 ref. Summaries (Ar, En).

The response to different applications of phosphorus fertilizer (0, 10, 20, 30 and 40 kg P2O5/ha) was measured at three sites in the Gurdaspur district of Punjab during the 1982/83 season. All phosphate treatments yielded significantly more than the control. The response to phosphate fertilizer was linear. The maximum mean yield of 758 kg/ha was recorded with the 40 kg P2O5/ha treatment producing 12 kg grain yield/kg NPK fertilizer with a return of RS 12/rupee invested in fertilizer. The response to the application of phosphorus fertilizer was greatest in soils with a low available phosphorus status.

lens culinaris; phosphorus; fertilizer application; plant response; npk fertilizers; soil fertility; grain; crop yield; economics

90-051078 Effect of zinc on lentil yield and yield components [Lens culinaris]. En. Islam, M.S.; Miah, M.C. (Bangladesh Agricultural Univ., Mymensingh (Bangladesh)). LENS-Newsletter (ICARDA). Lentil Experimental News Service. (1988). v. 16(1) p. 30-32. 1 table; 6 ref. Summaries (Ar, En).

A field experiment was carried out during the 1987/88 winter season to determine the effect of different forms, rates, and methods of zinc application on lentil yield, and yield components in Bangladesh. There was a significant difference either in yield or in yield components due to the application of zinc in different forms, rates or methods of application. The soil of the region was rich enough in available zinc for lentil production and thus the farmers of the region need not to apply any zinc fertilizer for optimum lentil production.

lens culinaris; zinc; yield components; soils; bangladesh; crop yield; height; fruit; seeds; grain; seed treatment.

90-061515 Performance studies of some isolated native rhizobial inocula on the production and nodulation of lentil with and with out nitrogen fertilizer [in Bangladesh]. En. Podder, A.K.; Sattar, M.A.; Marshed, G. 6. National Botanical Conference. Chittagong (Bangladesh). 18-19 Jan 1989. Bangladesh Botanical Society, Dhaka (Bangladesh); Chittagong Univ. (Bangladesh). Proceedings of the 6th National Botanical Society, Chittagong (Bangladesh). Chittagong (Bangladesh). BBS. 1989. p. 23. Summary only.

A field trial was conducted during the Rabi-season at Bangladesh Jute Research Institute farm, Faridpur. Soil was calcareous Dark Grey Floodplain with PH 7.7. L-5 a recommended variety of Bangladesh Agricultural Research Institute was used as test crop. On the basis of their morphological cultural and screening tests, five isolates of lentil, were finally selected for trial. Nitrogen rate was 0.25 and 50 kg N/ha. Maximum nodulation was recorded with the isolates L(1) and L(5) which became 47.14% increase over control but N application showed negative results in nodule production. The hay yield was found significantly influenced by rhizobium inoculation. Maximum mean hay

yield was recorded with L(7) followed by A(NIL) and L(1) Maximum grain mean yield was found with L(5) 461 kg/ha) followed by L(DIN) (414 kg/ha) which become 42 and 28 percent increase over control.
lens culinaris; crop yield; root nodulation; rhizobium; inoculum; bangladesh

90-061516 Effect of irrigation, pyrites and phosphobacteria on the efficiency of rock phosphate applied to lentils. En. Sharma, S.N.; Ray, S.B.; Pandey, S.L.; Prasad, R. (Water Technology Centre, Indian Agricultural Research Institute, New Delhi-110012 (India)). Journal-of-Agricultural-Science (UK). (1983). v. 101(2) p. 467-472. 22 ref., 5 tab.
lens culinaris; phosphate fertilizers; rock phosphate; irrigation; pyrites; inoculation; bacteria

90-094811 Utilization of biofertilizers in field crop production. 3.- Effect of biofertilizer phosphate of elemental sulphur application on nutrients content of lentil plants [Egypt]. En. Saber, M.S.M.; Kabesh, M.O. (National Research Centre, Cairo (Egypt)). Journal-of-Agricultural-Sciences,-Mansoura-Univ. (Egypt). (1988). v. 13(4A) p. 504-509. Issued 1990. 3 ill. 1 table; 19 ref. Summaries (Ar, En).
Nutrients uptake by lentil plants (grown in an alluvial soil in pots in the greenhouse at the N.R.C.) increased with increasing the rate of rockphosphate application with slight differences between the highest (400 kg/ fed.) and the lowest (50 kg/ fed.) rates. It is worthy to state that both chemical (elemental sulphur) and biological (biofertilizers) treatments increased nutrients availability compared to the sole effect of rockphosphate fertilization.
lens culinaris; phosphate fertilizers; nutrient content; egypt; greenhouses; alluvial soils.

90-094812 Response of lentil (Lens culinaris Medic.) to nitrogen and phosporus fertilization under changing rainfall conditions. En. Hattar, B.; Haddad, N. (Jordan Univ., Amman (Jordan)). Dirasat (Jordan). (May 1986). v. 13(5) p. 107-119. 7 tables; 39 ref. Summaries (Ar, En).
The effect on N and P fertilization on lentil crop was studied in three locations of different annual rainfall in Jordan: Ramtha, M'shagar and Maru. The application of P resulted in improving the biological and grain yield of lentil. The effect was more clear under drought condition (low and/or inappropriate distribution of rainfall), such as in Ramtha and M'shagar locations, where P application might have improved and developed good root system. The increase in biological and grain yield at M'shagar was about 40% during the 1982/83 season in response to P application of 120 kg P2O5/ha. At Ramtha, P application resulted in 80% increase in nodule number. Besides, the addition of P to lentil crop has maintained an adequate level of soil available P for the succeeding crops. Moreover the P fertilization has significantly affected the root nodulation and some other agronomic characters. Nitrogen, on the other hand, did not affect or slightly decreased the yield of lentil crop.
lens culinaris; rain; ammonium sulphate; superphosphate; application rates; crop yield; jordan; nitrogen phosphorus fertilizers; agronomic characters; soil testing.

90-094813 Seed yield and protein contents of lentil (Lens culinaris medic.) as influenced by NPK application. En. Mahmood, M.A. University of Agriculture, Faisalabad (Pakistan). Dept. of Agronomy. Faisalabad (Pakistan). UAF. 1988. 91 p. Thesis (M.Sc. (Hons.)). 21 tables, 71 ref., Summary (En), AVAILABILITY: Library, University of Agriculture, Faisalabad, Pakistan.
lens culinaris; nitrogen fertilizers; phosphate fertilizers; potash fertilizers; crop yield; protein content.

90-094814 Effect of pre-sowing seed treatment of lentil with micro-nutrients on seed yield and protein contents. En. Akhtar, M.A. University of Agriculture, Faisalabad (Pakistan). Dept. of Agronomy. Faisalabad (Pakistan). UAF. 1988. 87 p. Thesis (M.Sc. (Hons.)). 48 tables, 54 ref., Summary (En), AVAILABILITY: Library, University of Agriculture, Faisalabad, Pakistan.
lens culinaris; seed treatment; zinc sulphate; manganese sulphate; soaking; crop yield; protein content.

90-094815 Effect of phosphorus on grain yield and protein contents of lentil (Lens culinaris medic). En. Yar, A. University of Agriculture, Faisalabad (Pakistan). Dept. of Agronomy. Faisalabad (Pakistan). UAF. 1988. 85 p. Thesis (M.Sc. (Hons.)). 22 tables, 57 ref., Summary (En), AVAILABILITY: Library, University of Agriculture, Faisalabad, Pakistan.
lens culinaris; phosphate fertilizers; crop yield; maturation; protein content.

90-094816 Effect of potassium in different proportions with nitrogen and phosphorus on the yield and quality of lentil (Lens culinaris Medic). En (English). Afzal, M. University of Agriculture, Faisalabad (Pakistan). Dept. of Agronomy. Faisalabad (Pakistan). UAF. 1989. 83 p. Thesis (M.Sc. (Hons.)). 10 ills., 21 tables, 75 ref., Summary (En), AVAILABILITY: Library, University of Agriculture, Faisalabad, Pakistan.
lens culinaris; potash fertilizers; nitrogen fertilizers; phosphate fertilizers; growth; height; crop yield; yield components.

Irrigation

90-023264 Studies on some factors, influencing the productivity of lentil (Lens esculenta; Moench) [Egypt]. En. El Naggar, H.M.M. Zagazig Univ., Moshtohor (Egypt). Faculty of Agriculture. Moshtohor (Egypt). 1988. 143 p. Thesis (Ph.D. in Agronomy). 30 tables; ref. p. 117-137; Summaries (Ar, En); AVAILABILITY: Library, Faculty of Agriculture, Zagazig Univ., Moshtohor, Egypt.
lens culinaris; plant production; irrigation; weed control; egypt; weeds; seeds; crop yield; proteins

90-095006 Effect of the second irrigation time and nitrogen fertilizer rates on the productivity of two lentil varieties [Egypt]. En. Eisa, M.E.; El Ghareib, E.A.; Harb, O.M.S. (Ministry of Agriculture, (Egypt). Gemmeiza Agricultural Research Station). Annals-of-Agricultural-Science,-Ain-Shams-Univ. (Egypt). (1988). v. 33(2) p. 1067-1078. Issued 1990. 2 tables; 15 ref. Summaries (Ar, En).
lens culinaris; nitrogen fertilizers; irrigation; timing; egypt; crop yield; seeds; foliar application.

90-095007 Response of some lentil varieties to different irrigation frequencies at certain growth stages [Egypt]. En. Mohamed, Z.M.E. Cairo Univ. (Egypt). Faculty of Agriculture. 1989. 80 p. Thesis (M.Sc. in Agronomy). 17 tables; ref. p. 67-72; Summaries (Ar, En); AVAILABILITY: Library, Faculty of Agriculture, Cairo Univ., Egypt.
lens culinaris; irrigation; growth; crop yield; egypt; seed; weight

Soil Cultivation

90-014414 Lentil residue and nitrogen application effects on succeeding barley crop [effects of various lentil harvesting techniques, management of residues and type of preparatory tillage on the response of succeeding barley crop to nitrogen fertilizer application]. En. Nanish, N.M.A. Jordan Univ., Amman (Jordan). Dept. of Plant Production. Amman (Jordan). Feb 1989. 169 leaves. Thesis (M.Sc. in plant production). 43 tables; 98 ref.; Summaries (Ar, En).

AVAILABILITY: JORDOC, Jordan University, Library, Amman - Jordan.
The experiment was initiated during lentil harvest June 1987 by comparing a hand harvest with harvests by double-knife mower and combine both with and without lentil stubble and residue grazing by sheep. The five methods comprised the main plot treatments, upon which deep tillage by sweep cultivator and chisel plow and shallow tillage by sweep cultivator alone were superimposed as subplots to incorporate lentil residue at different depths. Thereafter, barley was sown by Oyord plot drill and the split-split-plot arrangement was completed by two rates N fertilizer application (0 kg N/ha and a total of 60 kg N/ha in split application). Residual lentil N incorporated into the soil was the highest for combine harvest. The application of 60 kg N/ha increased barley biomass and grain yields by 2.9 and 1.2 t/ha, as compared to no N application. Concentration and total amount of N increased too in both grains and straw. The interaction of harvest method and fertilizer was significant only for number of grains/sub (m2) and the highest number was from hand and mower harvest; the same treatments showed the largest response to N fertilizer, while combine harvest showed the lowest response. Only the interaction of harvest method and tillage was significant for biomass, straw yield, straw N-yield, spikes/sub (m2), grains/sub (m2). Tillage, harvest method, tillage x N fertilizer, harvest method x tillage x N fertilizer interaction did not have significant effect on yield of barley. Total soil N content (measured before sowing of barley), mineral soil N content (measured after harvest) were not significantly affected by any of the experimental treatments and their interactions.
barley; lens culinaris; crop residues; harvesting; tillage; depth; application rates; crop yield; biomass; grain; spikes; straw; rotational cropping.

90-014428 Effect of tillage and water harvesting techniques on the yield of cereals and food legume under rainfed conditions. En. Khan, B.R.; Raza, S.H. (Arid Zone Research Inst., Quetta (Pakistan)). Sarhad-Journal-of-Agriculture (Pakistan). (Aug 1989). v. 5(4) p. 331-335. 1 ill., 4 tables, 11 ref., Summary (En).
triticum aestivum; barley; lens culinaris; tillage; water harvesting; crop yield.

Cropping Patterns and Systems

90-014481 Crop rotation and cultural practices on moisture conservation, harvesting and yields of wheat, lentil and chickpea in the rainfed areas of Jordan. En. Qusous, A.A. Jordan Univ., Amman (Jordan). Dept. of Plant Production. Amman (Jordan). Mar 1989. 169 leaves. Thesis (M.Sc. in plant production). 11 fig.; 85 tables; 34 ref.; Summaries (Ar, En). AVAILABILITY: JORDOC, Jordan University, Library, Amman - Jordan.
A two year experiment was conducted in Jordan by using the split-split plot design with three and four replications respectively, to evaluate the influence of different crop rotations plus different seedbed preparation and sowing methods on the potential yield of wheat. It also evaluates the influence of different seedbed preparation, sowing and harvesting methods on the yield of lentil and chickpea grain and straw. Total moisture depletion and plant height of both crops were also studied as affected by the different seedbed preparation and sowing methods. An economical evaluation for the production of the three crops was also carried out. The results of the first year experiment indicated that the different crop rotation systems and the different seedbed preparation methods used did cause significant differences in the potential yield of wheat. However, the potential yield of wheat did not differ significantly from each other as a result of employing different sowing methods. The second year results indicated that only the harvesting methods used were the sole reason for any significant differences on the yield of chickpea and lentil grains and straw. The different seedbed preparation and sowing methods did not cause any significant differences in the total moisture depletion nor the plant height of both crops.
triticum aestivum; lens culinaris; cicer arietinum; rotational cropping; sowing; combine harvesters; crop yield; income; jordan; superphosphate; application rates; soil water content; rain fed farming.

90-083208 Development of contingency options for flood rehabilitation [Bangladesh]. En. Shahjahan, M.; Ahmed, M.; Rahman, H.; Kalimuddin, M.; Hossain, M. 14. Annual Bangladesh Science Conference. Dhaka (Bangladesh). 27-30 Jan 1986. Bangladesh Association for the Advancement of Science, Dhaka (Bangladesh). Proceedings of the 14th Annual Bangladesh Science Conference. Section 1. Dhaka (Bangladesh). BAAS. 1989. p. 85. Summary only.
In a field trial conducted at the multilocation site, Gabtali of Bogra, Bangladesh maize was intercropped with mustard, lentil, Khesari and chickpea to supply food for human and feed for livestock including fuel in the flood affected area at the same time to evaluate the better crop combination, intercropping maize with pulses and oilseed crops at zero tillage condition and to popularize this new crop among the farmers. Maize was intercropped successfully with mustard but other three crop combination could not be established due to bird damage and excessive soil moisture immediately after seeding. Maize yield (46,527 cob/ha) from maize + khesari combination was second best as compared to sole maize (53,500 cob/ha). Lowest maize yield (38,000 cob/plant) was recorded from maize + mustard combination with 987 kg additional mustard/ha. Highest benefit cost ratio(4.17) was found from sole maize.
zea mays; brassica; lens culinaris; lathyrus sativus; cicer arietinum; intercropping; flooding; bangladesh

90-083251 Performance of mixed cropping pattern under high land phase of rainfed condition at Kanaipur, Faridpur [Bangladesh]. En. Asuduzzaman, S.M.; Kashem, Abul; Morshed, G.; Sikder, F.S. 14. Annual Bangladesh Science Conference. Dhaka (Bangladesh). 27-30 Jan 1986. Bangladesh Association for the Advancement of Science, Dhaka (Bangladesh). Proceedings of the 14th Annual Bangladesh Science Conference. Section 1. Dhaka (Bangladesh). BAAS. 1989. p. 53. Summary only.
In the year 1987-88 a farmer alternative cropping pattern jute-fallow-lentil + mustard was tested against farmer existing predominant cropping pattern jute-fallow-lentil under high land phase of rainfed condition at farming system research site, Kanaipur, Faridpur, Bangladesh. In the tested pattern jute var. 0-9897 yielded 2.43 t/ha of fibre but farmer variety (0-4) gave only 1.90 t/ha on the other hand lentil and mustard mixed cropping gave. 0.59 t/ha and 1.51 t/ha of grain respectively but lentil in farmers existing pattern yielded only 0.72 t/ha due to lower fertilization and management practices. Considering economic analysis it has been observed that the gross return of alternative pattern was Tk. 56,605 and for existing one Tk. 23,783 which was 138% higher total variable cost was increased 72% in alternative pattern due to recommended doses of fertilizer, insecticide, management and labour cost for Jute cultivation. The marginal benefit cost ratio for alternative cropping pattern which indicated economically viable if SS-75 grown in rainfed condition. In that year mustard received sufficient rainfall during its growing period.
corchorus; lens culinaris; brassica; mixed cropping; rain fed farming; bangladesh

90-083268 Study on lentil-linseed mixed cropping at varying seeding rations [Bangladesh]. En. Islam, M.N. 14. Annual Bangladesh Science Conference. Dhaka (Bangladesh). 27-30 Jan 1986. Bangladesh Association for the Advancement of Science, Dhaka

(Bangladesh). Proceedings of the 14th Annual Bangladesh Science Conference. Section 1. Dhaka (Bangladesh). BAAS. 1989. p. 91. Summary only.
Lentil and linseed mixed cropping at varying seeding ratios was carried out in the grey flood plain soils of Regional Agricultural Research Station, Ishurdi, Bangladesh under rainfed condition during rabi season of 1987-88. The seeding ratios included 100% lentil (L) + 75% linseed (Li), 100% Li, 100% L + 25% Li, 75% L + 75% Li, 75% L + 50% Li, 75% L + 25% Li, sole lentil (100%) and sole linseed (100%). Highest lentil yield (1.04 t/ha) was obtained from monoculture lentil and highest linseed yield (0.6 t/ha) was obtained from 100% L + 50% Li mainly through highest number of head per plant. Highest total grain yield was obtained from 100% L + 50% Li which also gave highest LER (1.67), highest net return (TK. 5,900/ha) and highest benefit cost ratio (2.99).
lens culinaris; linum usitatissimum; mixed cropping; rain fed farming; crop yield; bangladesh

90-083269 Plant population and spatial arrangement in lentil-mustard intercopping. En. Rahman, A.; Karim, M.A. 14. Annual Bangladesh Science Conference. Dhaka (Bangladesh). 27-30 Jan 1986. Bangladesh Association for the Advancement of Science, Dhaka (Bangladesh). Proceedings of the 14th Annual Bangladesh Science Conference. Section 1. Dhaka (Bangladesh). BAAS. 1989. p. 104. Summary only.
A field experiment was conducted at the regional Agricultural Research Station, Jamalpur during rabi seasons of 1986-87 and 1987-88 to compare the inter, mixed, strip or parallel cropping of lentil and mustard under rainfed situation. The treatment composed of strip cropping (lentil 5 rows and mustard 4 or 3 rows or 50% mustard seed broadcast), mustard 3 rows and lentil 4 rows, mixed cropping comprising broadcasting 100% mustard into 7 rows of lentil, lentil 100% broadcast in 5 rows or 50% seed rate of mustard. Lentil and mustard yields were markedly affected due to different planting geometry. Monoculture crops produced higher yields (lentil 767 kg/ha and mustard 558 kg/ha) than those in the crop combinations. In different planting geometry lentil was more competitive in 1286-7 while mustard showed its more competitive performance during 1987-88. Mustard when grown in association was able to achieve 40 to 79% while lentil produced 42 to 60% of monoculture. Higher relative yield total (1.32) as well as lentil equivalent yield (750) was noticed when lentil 700% was mixed with 50% mustard.
lens culinaris; brassica; intercropping; mixed cropping; plant population; bangladesh

90-095120 Multilocation testing of cropping pattern (F1) b. aus - fallow -lentil + mustard in the extrapolation area of FSR site, Kalikapur [of Bangladesh]. En. Basak, N.C.; Miah, M.G.; Karim, M.M.A. 14. Annual Bangladesh Science Conference. Dhaka (Bangladesh). 27-30 Jan 1986. Bangladesh Association for the Advancement of Science, Dhaka (Bangladesh). Proceedings of the 14th Annual Bangladesh Science Conference. Section 1. Dhaka (Bangladesh). BAAS. 1989. p. 147. Summary only.
Agronomic and economic performance of farmers improved cropping pattern (F1) B. aus - fallow - lentil + mustard was evaluated against farmers existing cropping pattern (F) B. aus - fallow -mustard at multilocation testing site, Chatmohar under rainfed condition in 1987-88. Agronomically the pattern was found viable in terms of yield performance and management point of view. Economically the pattern was found profitable with gross margin Tk. 13,285/ha.
rice; lens culinaris; brassica; cropping patterns; crop yield; performance; bangladesh

90-095127 Studies on wheat-lentil intercropping under irrigated conditions. En (English). Fayyaz ul Hassan. University of Agriculture, Faisalabad (Pakistan). Dept. of Agronomy. Faisalabad (Pakistan). UAF. 1988. 71 p. Thesis (M.Sc. (Hons.)). 29 tables, 46 ref., Summary (En), AVAILABILITY: Library, University of Agriculture, Faisalabad, Pakistan.
triticum aestivum; lens culinaris; intercropping; irrigated farming; crop yield; cost benefit analysis.

90-095171 Performance of chickpea, barley, lentil, and linseed as mixed crop at varying seeding ratios [in Bangladesh]. En. Aziz, M.A. 14. Annual Bangladesh Science Conference. Dhaka (Bangladesh). 27-30 Jan 1986. Bangladesh Association for the Advancement of Science, Dhaka (Bangladesh).Proceedings of the 11th Annual Bangladesh Science Conference. Section 1. Dhaka (Bangladesh). BAAS. 1989. p. 127-28. Summary only.
The experiment was conducted at the regional agricultural Research Station, Ishurdi during the rabi season of 1986-87 to find out the best crop combination and their proper seeding ratios. A randomized complete block design with 3 replications was followed to test four crop combinations viz. (1) chickpea + barley (2) chickpea + linseed (3) lentil + barley and (4) lentil + linseed and four seeding rations viz. 100:0, 100:33, 75:50 and 0:100. The results are indicated that the best combination of crop was chickpea + barley followed by lentil + barley and the best seeding ratio was 7 : 50. The highest LER was obtained from chickpea + barley combination (1.68) at 75 : 50 seeding ratio followed by lentil + barley (1.43) at 75 : 50 seeding ratio.
cicer arietinum; barley; lens culinaris; linum usitatissimum; mixed cropping; performance; seeding rates; rabi season; bangladesh

90-095172 Studies on gram-lentils intercropping relationship under different geometrical patterns. En. Iqbal, M. University of Agriculture, Faisalabad (Pakistan). Dept. of Agronomy. Faisalabad (Pakistan). UAF. 1987. 120 p. Thesis (M.Sc. (Hons.)). 10 ills., 38 tables, 78 ref., Summary (En), AVAILABILITY: Library, University of Agriculture, Faisalabad, Pakistan.
cicer arietinum; lens culinaris; intercropping; spacing; crop yield; yield components; cost benefit analysis.

90-095174 Studies on gram-lentil intercropping relationships. En. Qadeer, A. University of Agriculture, Faisalabad (Pakistan). Dept. of Agronomy. Faisalabad (Pakistan). UAF. 1989. 98 p. Thesis (M.Sc. (Hons.)). 22 tables, 75 ref., Summary (En), AVAILABILITY: Library, University of Agriculture, Faisalabad, Pakistan.
cicer arietinum; lens culinaris; intercropping; crop yield; yield components; cost benefit analysis.

90-095175 Studies on agro-economic relationship of component crops in gram-linseed intercropping system. En. Khan, Z. University of Agriculture, Faisalabad (Pakistan). Dept. of Agronomy. Faisalabad (Pakistan). UAF. 1989. 109 p. Thesis (M.Sc. (Hons.)). 8 plates, 12 ills., 30 tables, 78 ref., Summary (En), AVAILABILITY: Library, University of Agriculture, Faisalabad, Pakistan.
cicer arietinum; lens culinaris; intercropping; crop yield; yield components; height; cost benefit analysis.

90-095177 Studies on agro-economic relationship of component crops in a lentil-wheat intercropping system. En. Ahmad, N. University of Agriculture, Faisalabad (Pakistan). Dept. of Agronomy. Faisalabad (Pakistan). UAF. 1989. 100 p. Thesis (M.Sc. (Hons.)). 41 tables, 69 ref., Summary (En), AVAILABILITY: Library, University of Agriculture, Faisalabad, Pakistan.

lens culinaris; triticum aestivum; intercropping; crop yield; yield components; cost benefit analysis.

90-095178 Studies on agro-economic relationship of component crops in a lentil-linseed intercropping system. En. Ali, L. University of Agriculture, Faisalabad (Pakistan). Dept. of Agronomy. Faisalabad (Pakistan). UAF. 1989. 106 p. Thesis (M.Sc. (Hons.)). 1 ill., 33 tables, 86 ref., Summary (En), AVAILABILITY: Library, University of Agriculture, Faisalabad, Pakistan.
lens culinaris; linum usitatissimum; intercropping; crop yield; yield components; cost benefit analysis.

90-123021 [The agricultural environment of upper Valnerina [Italy]]. It (Italian). L' ambiente agricolo dell' alta Valnerina [Italy]. D'Antuono, L.F.; Lucidi, A. (Universita della Tuscia, Viterbo (Italy). Istituto di Agrotecnica). Monti-e-Boschi (Italy). (Nov-Dec 1989). v. 40(6) p. 17-25. 4 tables; 1 graph; 8 ref. Summaries (En, It).
feed crops; umbria; farmland; climatology; geomorphology; scrublands; transhumance; lens culinaris; triticum dicoccum.

Plant Genetics and Breeding

90-014767 [Seed health testing and treatment of germplasm at the International Center for Agricultural Research in the Dry Areas (ICARDA)]. Ar (Arabic). 'ih*tiba:r/u s*ih"h"at/i al-bud"u:r/i wa mu3a:malat/u al-' us*u:l/i al-wira:t"iyyat/i fi: al-markaz/i al-dawli: lilbuh"u:t"/i al-zira:3iyyat/i fi: al-mana:t*iq/i al-j*a:ffat/i (' ika:rda:). Diekmann, M. ICARDA, Aleppo (Syria). Aleppo (Syria). International Center for Agricultural Research in the Dry Areas. 1987. 27 p. 3 tables; 2 fig.; 13 ref. AVAILABILITY: ICARDA, POB 5466, Aleppo - Syria RN: ICARDA-118-Ar.
At ICARDA, each year more than 4000 different lines of wheat, barley, lentils, faba beans, chickpeas, and pasture and forage crops are distributed to about 70 countries. New accessions are added to the germplasm collections in the Center's genebank and utilised in the breeding programmes. The risk of spreading pests and pathogens with germplasm is well recognised, and precautionary measures are taken to minimise this risk. These include seed multiplication under conditions unfavourable for disease development, optimum crop protection during multiplication, field inspection, seed health testing, and seed treatment. The procedures followed, and some of the problems encountered with germplasm in contrast to commercial seed lots, are described in this paper.
triticum durum; triticum aestivum; barley; lens culinaris; vicia faba; feed crops; seed; seed testing; seed treatment; germplasm; syria; plant breeding.

90-023707 New released lentil varieties Giza 29 and Giza 370 [Egypt]. En (English). Hassan, M.W.A.; Rizk, M.A.M.; Khattab, A.M.A.M.; Hussein, A.H.A.; Amer, M.I.A. (Ministry of Agriculture, Cairo (Egypt). Faculty of Agriculture). Annals-of-Agricultural-Science,-Ain-Shams-Univ. (Egypt). (1988). v. 33(1) p. 261-276. Issued 1989. 1 ill. 8 tables; 7 ref. Summaries (Ar, En).
lens culinaris; selection; agronomic characters; crop yield; disease resistance.

90-041377 Plant breeding of lentil [Hudeiba, Sudan]. En. Sheikh Mohamed, A.I. Annual-Report-of-the-Hudeiba- Research-Station (Sudan). 1985-1986. (Oct 1989). p. 28-34. 3 tables. Summary (En). AVAILABILITY: ARC, POB 126, Wad Medani - Sudan.
lens culinaris; plant breeding; sudan; hybridizing; varieties; yield increase.

90-051625 Stela [lentil]. Bg (Bulgarian). Stela [leshcha]. Mikhov, M. (Institut po Pshenitsata i Sl"nchogleda "Dobrudzha", General Toshevo (Bulgaria)). Selskostopanska Akademiya, Sofia (Bulgaria). Rasteniev"dni-Nauki (Bulgaria). Plant Science. (1989). v. 26(10) p. 25-28. 5 ref. Summaries (En, Ru).
lens culinaris; selection; disease resistance; drought resistance; bulgaria; varieties; flavour

90-051626 Transgressive segregation for early flowering through conventional breeding in lentil [Lens culinaris]. En. Tyagi, M.C.; Sharma, B. (Indian Agricultural Research Inst., New Delhi (India). Division of Genetics). LENS-Newsletter (ICARDA). Lentil Experimental News Service. (1988). v. 16(1) p. 3-6. 2 tables; 2 fig.; 3 ref. Summaries (Ar, En).
The cultivar Precoz (ILL-4605) is an early flowering and moderately bold seeded macrosperma variety of lentil with different and independent gene(s) controlling early flowering than the early flowering indigenous Indian cultivars namely L-3991, JLS-3, and Sehore-74-3. The gene(s) controlling early flowering in the Indian varieties are in-common. Transgressive recombinants for extra-early flowering have been isolated from the crosses of Precoz with L-3991, JLS-3, and Sehore-74-3.
lens culinaris; segregation; flowering; india; maturation; quality; yield increase; varieties; plant breeding; genes; plant developmental stages.

90-051627 Inheritance of some quantitative traits in lentil [Lens culinaris]. En (English). Waldia, R.S.; Chabra, A.K. (Haryana Agricultural Univ., Hissar (India). Dept. of Plant Breeding). LENS-Newsletter (ICARDA). Lentil Experimental News Service. (1988). v. 16(1) p. 6-8. 1 table; 3 ref. Summaries (Ar, En).
Inheritance of plant height, numbers of fruiting branches/plant, clusters/plant, pods/plant, and seed yield were studied in two crosses of lentil using the analysis of generation means. The results indicated the presence of both additive and non-additive type of gene effects for all characters except the number of pods/plant, where only additive effects were significant. The methods, through which both additive and non-additive gene effects can be exploited, are likely to be effective for lentil improvement.
lens culinaris; inheritance genetics; yield components; yield increase; india; fruit; branches; height; seeds; crop yield; genes; plant breeding.

90-051628 Induced polygenic variation in lentils [Lens culinaris]. En (English). Kalia, N.R.; Gupta, V.P. (Himachal Pradesh Krishi Vishwa Vidyalay, Bajaura (India). Regional Research Station Himachal Pradesh Krishi Vishwa Vidyalay, Palampur (India). Dept. of Plant Breeding). LENS-Newsletter (ICARDA). Lentil Experimental News Service. (1988). v. 16(1) p. 8-16. 7 tables; 8 ref. Summaries (Ar, En).
In a study at the Himachal Pradesh Krishi Vishwa Vidyalay, India microsperma and macrosperma types of lentil seeds were irradiated with 5, 10, 15, 20 and 25 kR of gamma rays to study the nature and magnitude of induced variation in various polygenic traits in both lentil types. Data were recorded for seed yield, biological yield, harvest index, number of pods/plant, 100-seed weight, plant height, time to 50% flowering (days), and time to maturity (days). A sufficient genetic variability was induced for most polygenic traits in both lentil types. However, macrosperma type was found more radio-sensitive.
lens culinaris; varieties; genetic variation; seed; gamma radiation; india; harvest index; behaviour; crop yield; fruit; weight; height; maturation; genes

90-051629 Variability and correlation studies in local germplasm of lentil in Bangladesh [Lens culinaris]. En. Zaman, M.W.; Rahman, M.M.; Mian, M.A.K. (Regional Agricultural Research Station, Ishurdi (Bangladesh) Institute of Post-Graduate Studies in Agriculture,

Salna (Bangladesh)). LENS-Newsletter (ICARDA). Lentil Experimental News Service. (1988). v. 16(1) p. 17-19. 2 tables; 8 ref. Summaries (Ar, En).
Variability and correlation studies were carried out on yield and eight component characters of 190 germplasm accessions of lentil (Lens culinaris Medik.) collected in Bangladesh. The characters showing the highest coefficients of variation were seed yield per plant, number of pods/plant, number of primary and secondary branches/plant, while the lowest values for coefficient of variation were shown by time to maturity and number of seeds/pod. Correlation studies showed that seed yield per plant had a highly significant positive correlation with number of pods/plant, number of seeds/pod, number of primary and secondary branches/plant and time of 50%
flowering. These characters were also significantly correlated among themselves except for the association between the number of seeds/pod and time to 50% flowering. The result indicated that profusely branched plants with a high number of pods tend to have a higher yield potential.
lens culinaris; germplasm; genetic variation; yield components; seed; bangladesh; branching; fruit; flowering

90-051630 Variability and correlations of grain yield and other quantitative characters in lentil [Lens culinaris]. En. Ramgiry, S.R.; Paliwal, K.K.; Tomar, S.K. (Jawaharlal Nehru Agriculturml Univ., Jabalpur (India). Dept. of Plant Breeding and Genetics). LENS-Newsletter (ICARDA). Lentil Experimental News Service. (1988). v. 16(1) p. 19-21. 2 tables; 10 ref. Summaries (Ar, En).
The genotypic variability, heritability and correlations for different characters were measured in 21 lentil varieties at the livestock farm, Department of Plant Breeding and Genetics, Jabalpur in the 1982/83 season. The yield per plant, number of branches/plant, and harvest index showed high heritability with high genetic gain, making these characters valuable to breeders. Grain yield showed a high positive correlation with plant weight, number of branches/plant, number of pods/plant, and harvest index. Similarly, harvest index showed positive correlation with plant weight, number of branches/plant, and number of pods/plant. However, 100 seed-weight showed a negative correlation with number of pods/plant.
lens culinaris; varieties; inheritance genetics; genetic variation; yield components; india; heritability; genetics; height; branching; fruit; harvest index.

90-062065 [Lentil genetical improvement. A proposal of ideotype]. It (Italian). Miglioramento genetico della lenticchia. Una proposta di ideotipo. Bozzini, A.; Rossi, L. (Food and Agriculture Organization of the United Nations (FAO), Rome (Italy) Comitato Nazionale per la Ricerca e per lo Sviluppo dell' Energia Nucleare e delle Energie Alternative (ENEA), Rome (Italy)). Informatore-Agrario (Italy). (16 Jun 1988). v. 44(25) p. 35-36. Special issue.
lens culinaris; plant breeding; varieties; plant anatomy.

90-062066 [Evaluation of autochthonous germplasm of lentil in Centre-South [of Italy]]. It (Italian). Valutazione di germoplasma autoctono di lenticchia del centro-sud [d' Italia]. Iannelli, P. (Basilicata Univ., Potenza (Italy)). Informatore-Agrario (Italy). (16 Jun 1988). v. 44(25) p. 37-38. Special issue. 2 tables.
lens culinaris; italy; germplasm; evaluation; land races; selection; biological development.

90-062067 [Evaluation of germplasm of recently introduced lentil [in Italy]]. It (Italian). Valutazione di germoplasma di lenticchia di recente introduzione [in Italia]. Bozzini, A.; Rossi, L.; Iannelli, P. (Food and Agriculture Organization of the United Nations (FAO), Rome (Italy) Comitato Nazionale per la Ricerca e per lo Sviluppo dell' Energia Nucleare e delle Energie Alternative (ENEA), Rome (Italy) Basilicata Univ., Potenza (Italy)). Informatore-Agrario (Italy). (16 Jun 1988). v. 44(25) p. 39-45. Special issue. 3 tables; 3 graphs.
lens culinaris; germplasm; evaluation; selection; agronomic characters; varieties; trials; crop yield; plant introduction.

90-083404 Screening of wheat, barley and lentil cultivars against different degrees of soil salinity [at Bangladesh Institute of Nuclear Agriculture, Mymensingh, Bangladesh]. En. Rahman, S.M.; Khalil, M.I. 14. Annual Bangladesh Science Conference. Dhaka (Bangladesh). 27-30 Jan 1986. Bangladesh Association for the Advancement of Science, Dhaka (Bangladesh). Proceedings of the 14th Annual Bangladesh Science Conference. Section 1. Dhaka (Bangladesh). BAAS. 1989. p. 34. Summary only.
Experiments were conducted in the glass house of Bangladesh Institute of Nuclear Agriculture, Mymensingh to screen out salt tolerant plant species and cultivars of wheat, barley and lentil. There plant species such as wheat, barley and lentil with three cultivars each were included in this study. Bulk soil samples were collected from saline and non-saline area. Different levels of salinity were achieved by mixing the non-saline and saline soils in various proportions. Results indicated that all the three plant species (wheat, barley and lentil) can withstand varying degrees of salinity and can be successfully grown in the salt-affected soils. The wheat cultivar 'Akbar' and 'Kanchan' the barley cultivar 'L-1' and the lentil cultivar 'V-81149' produced higher dry matter yield in the soils of varying salinity levels. There were considerable decrease in the salinity levels (EC values) and the amount of soluble ions in the soils after cropping due to continuous watering of the experimental pots with normal water having low EC values.
barley; triticum; lens culinaris; selection; salt tolerance; saline soils; bangladesh

90-083745 Correlation studies and path analysis in lentil [Egypt]. En (English). Nigem, S.A.; Rabie, H.A.; Mohamed, M.A.; Mohamed, M.M. (Zagazig Univ. (Egypt). Faculty of Agriculture). Zagazig-Journal-of-Agricultural-Research (Egypt). (Dec 1983). v. 10(2) p. 141-155. Issued 1990. 1 ill. 3 tables; 13 ref. Summaries (Ar, En).
The interrelationships between yield and yield attributes as well as yield analysis were studied in eight intervarietal crosses and their parents during 1981/1982 and 1982/1983 seasons. The important results can be summarized as follows: Positive and highly significant correlation coefficient was found between seed yield/ plant on one hand and number of pods as well as number of seeds/ plant on the other hand. Also, positive correlation coefficients were noticed between seed yield and each of plant height, number of branches/ plant and number of days to first flower appearance but, the coefficients did not reach the significance level. Insignificant negative correlation coefficient was recorded for seed index related to seed yield/ plant.
lens culinaris; genetics; crop yield; yield components.

90-083746 Efficiency of early generation selection for induced polygenic mutations in lentil (Lens culinaris Medik). En. Sarker, A.; Sharma, B. (Indian Agricultural Research Inst., New Delhi). Indian-Journal-of-Genetics-and-Plant-Breeding (India). (Jul 1988). v. 48(2) p. 155-159. 3 tables, 9 ref. Summary (En).
lens culinaris; selection; induced mutation; genetic variation; breeding methods.

90-095610 Variance study of F2 generation in lentil. En. Sarker, W.A.; Rahman, M.M. 14. Annual Bangladesh Science Conference. Dhaka (Bangladesh). 27-30 Jan 1986. Bangladesh Association for the Advancement of Science, Dhaka (Bangladesh). Proceedings of the 14th Annual Bangladesh Science Conference.

Section 1. Dhaka (Bangladesh). BAAS. 1989. p. 110. Summary only.
The present investigation comprised of 8 F2 populations derived from the reciprocal crosses of 4 parental lines during 1985-86 cropping season. The data of the 3 most important characters viz. seed yield/plant, number of pods/plant and 100 seed weight of these F2 populations were used for variance study. The maximum variability for seed yield/plant was obtained from the cross L-5 x 79542 (CV 45.18%), for number of pods/plant from 79542 x L-5 (CV 40.06%) and for 100 seed weight from L-5 x 79666 (CV 18.04%). There was no maternal effect of the parents for the characters studied.
lens culinaris; f2 hybrids; genetic variation; agronomic characters; crop yield.

90-095611 Varietal performance of lentil [Bangladesh]. En. Rahman, M.A.; Rahman, A.R.M.S. 14. Annual Bangladesh Science Conference. Dhaka (Bangladesh). 27-30 Jan 1986. Bangladesh Association for the Advancement of Science, Dhaka (Bangladesh). Proceedings of the 14th Annual Bangladesh Science Conference. Section 1. Dhaka (Bangladesh). BAAS. 1989. p. 138. Summary only.
Nine strains of lentil were evaluated in a randomized complete block design at Regional Agricultural Research Station, Jessore to select short duration high yielding lines. Data were taken on yield and different yield contributing characters. The lines 113-55, 8 018 and L-5 were identified as short duration and high yielding lines (produced 1.46 t, 1.51 t and 1.72 t per hectare respectively).
lens culinaris; high yielding varieties; yield factors; bangladesh

90-095612 Correlation studies and path analysis in lentil [Egypt]. En (English). Nigem, S.A.; Rabie, H.A.; Mohamed, M.A.; Mohamed, M.M. (Zagazig Univ. (Egypt). Faculty of Agriculture). Zagazig-Journal-of-Agricultural-Research (Egypt). (Jun 1985). v. 12(1) p. 313-331. Issued 1990. 1 ill. 3 tables; 13 ref. Summaries (Ar, En).
The interrelationships between yield and yield attributes as well as yield analysis were studied in eight intervarietal crosses and their parents during 1981/1982 and 1982/1983 seasons. The important results can be summarized as follows: Positive and highly significant correlation coefficient was found between seed yield/ plant on the one hand and number of pods as well as number of seeds/plant on the other hand. Also, positive correlation coefficients were noticed between seed yield and each of plant height, number of branches/plant and number of days to first flower appearance but, the coefficients did not reach the significance level. Insignificant negative correlation coefficient was recorded for seed index related to seed yield /plant. Path analysis revealed that the main sources of lentil seed yield variation according to their importance were number of pods/plant and number of seeds/plant and their interaction which contributed about 99% for seed yield variation.
lens culinaris; genetics; crop yield; yield components; Egypt

90-095613 Correlation and path coefficient between seed yield and its attributes in lentil [Egypt]. En. Ali, A.A.; Ramadan, I.E.; El Bana, A.Y. (Zagazig Univ. (Egypt). Faculty of Agriculture). Zagazig-Journal-of-Agricultural-Research (Egypt). (Dec 1986). v. 13(2) p. 219-237. Issued 1990. 3 tables; 13 ref. Summaries (Ar, En).
lens culinaris; genetics; crop yield; yield components; Egypt

90-095614 Isolation and culture of Lens culinaris Medik. cv. Eston epicotyl protoplasts to calli. En. Rozwadowski, K.L.; Saxena, P.K.; King, J. (Saskatchewan Univ., Saskatoon (Canada). Dept. of Biology). Plant-Cell,-Tissue-and-Organ-Culture (Netherlands). (1990). v. 20(1) p. 75-79. 13 refs.; Summary (En).
lens culinaris; in vitro culture; protoplasts; plant breeding.

90-095673 Directory of germplasm collections. 1.I. Food legumes: Arachis, Cajanus, Cicer, Lens, Lupinus, Phaseolus, Pisum, Psophocarpus, Vicia and Vigna. En (English). Bettencourt, E.; Konopka, J.; Damania, A.B. Rome (Italy). IBPGR. 1989. 193 p. AVAILABILITY: FAO Accession No: XF9092809 (Available on Microfiche).
arachis; cajanus cajan; cicer; lens culinaris; lupinus; phaseolus; psophocarpus; vigna; pisum; plant collections; germplasm; countries

90-108575 Induction and screening of polygenic variability for multiple characters in lentil (Lens culinaris Medik). En. Sarkar, A.; Sharma, B. (Regional Agricultural Research Station, Ishurdi (Bangladesh) Indian Agricultural Research Inst., New Delhi. Div. of Genetics). Indian-Journal-of-Genetics-and-Plant-Breeding (India). (Jul 1987). v. 47(2) p. 179-182. 3 tables, 10 ref. Summary (En).
lens culinaris; induced mutation; selection; breeding methods; ems; mutagens; yield components.

90-108576 Mutagenic efficiency of gamma rays, NMU and their combinations in lentil (Lens culinaris Med.) var. T. 36. En. Dixit, P.; Dubey, D.K. (Janata Mahavidyalaya, Ajitmal (India). Dept. of Botany). Indian-Journal-of-Genetics-and-Plant-Breeding (India). (Nov 1986). v. 46(3) p. 501-505. 3 tables, 12 ref. Summary (En).
lens culinaris; mutagens; gamma radiation; efficiency

Plant Physiology and Biochemistry

90-015511 Biochemical and nutritional evaluation of some important varieties of pulses [chickpea, lentil and mash]. En. Shah, H.; Niaz, R.; Mohammad, N. (NWFP Agricultural Univ., Peshawar, Dept. of Human Nutrition Islamia Coll., Peshawar (Pakistan)). Sarhad-Journal-of-Agriculture (Pakistan). (Dec 1988). v. 4(6) p. 751-756. 3 tables, 15 ref., Summary (En).
cicer arietinum; lens culinaris; vigna radiata; amino acids; composition; nutritive value.

90-024188 Water use by legumes and its effect on soil water status. En (English). Badaruddin, M.; Meyer, D.W. (North Dakota State Univ., Fargo, ND). Crop-science (USA). (Sep-Oct 1989). v. 29(5) p. 1212-1216. references.
To make informed decisions on whether to include legumes in cropping systems, information is needed on water use by legumes and its effect on soil water availability to subsequent crops. The objectives of this study were to determine the water use, water use efficiency (WUE), and soil water depletion pattern of four grain legumes and three green-manure or forage legumes. Field studies were conducted on a Fargo silty clay (fine, montmorillonitic, frigid Vertic Haplaquoll) at Fargo and on a Perella-Bearden silty clay loam (fine-silty, mixed, frigid Typic Haplaquoll; fine-silty, frigid Aeric Calciaquoll) at Prosper, ND in 1986 and 1987. Soil water to a depth of 2.2 m was determined by the neutron attenuation method at 15-d intervals. Legume crops used 10 to 25% more seasonal water than wheat (Triticum aestivum L.) across environments, but WUE (kg dry matter ha-1 mm-1 of water) of legumes was 0 to 25% greater than that of wheat. Green-manure and forage legumes generally had greater water use and WUE than grain legumes, and this was associated with their longer growing season and higher dry matter production. Cumulative water depletion during June to September by green-manure, forage, and grain legumes was 70, 63, and 43 mm greater, respectively, than that of a fallow check, and was not significantly different from that of wheat in two of four environments. However, an increase in soil water content occurred at the 0- to 0.3-m soil depth for all treatments in the following spring across three environments. Soil water content in the spring following a

legume was not significantly different from that following wheat and was only about 30 mm greater than that of fallow across environments. These results indicate that growing some legumes in cropping systems may not substantially affect the soil water content compared to continuous cereal cropping or to fallow.
melilotus officinalis; north dakota; trifolium pratense; vicia villosa; lens culinaris; medicago sativa; triticum aestivum; efficiency; water use; cropping systems; water availability; soil water balance; dry matter content.

90-084467 Auxin activity of phenylacetic acid in tissue culture. En (English). Leuba, V.; LeTourneau, D. (University of Idaho, Moscow, ID). Journal-of-plant-growth-regulation (USA). (Spr 1990). v. 9(2) p. 71-76. references.
nicotiana tabacum; helianthus annuus; pisum sativum; glycine max; lens culinaris; organic acids; callus; photoperiodicity

90-096325 Protein, amino acids and nutrients content of lentil as affected by nitrogen fertilizers during the seed maturity stage [Egypt]. En. El Hadidi, E.M.; Hassan, R.A.; Taha, A.A. (Mansoura Univ. (Egypt). Faculty of Agriculture). Journal-of-Agricultural-Science-Mansoura-Univ. (Egypt). (1988). v. 13(1) p. 367-374. Issued 1990. Summaries (Ar, En).
Protein, amino acids and some nutrients such as phosphorus, potassium, calcium, magnesium, iron and manganese were determined in seed and straw. Mainly fifteen amino acids were detected in lentil seed and straw samples. The amino acids serine and cysteine were not changed during maturity of seeds, but lysine, arginine, glycine, phenylalanine and aspartic acid increased with seed development. The amino acids tyrosine, valine, threonine and glutamic acid were greatly affected by all N levels, particularly within the last period of seed formation (full mature seed).
lens culinaris; nitrogen fertilizers; proteins; composition; egypt; seeds; maturation

90-096326 Isolation and characterization of two trypsin-chymotrypsin inhibitors from lentil seeds (Lens culinaris Medik.). En. Mueller, R.; Weder, J.K.P. (Maizena GmbH, FRG). Journal-of-food-biochemistry (USA). (1989). v. 13(1) p. 39-63. references.
lens culinaris; seeds; composition; trypsin; enzyme inhibitors; isolation

90-109059 The roles of calcium and manganese ions in the in vitro conversion of 1-aminocyclopropane-1-carboxylic acid to ethylene by lentil root membranes. En (English). Penel, C.; Gaspar, T.; Crevecoeur, M.; Kevers, C.; Greppin, H. (Geneve Univ. (Switzerland). Lab. of Plant Physiology). Physiologia-Plantarum (Denmark). (Jun 1990). v. 79(2) p. 250-254. 37 ref. Summary (En).
vicia; calcium; manganese; roots; cytoplasmic organelles; ethylene; peroxidases.

90-125019 Salt-soluble lectins of corn grain. En. Jankovic, M.; Cuperlovic, M.; Hajdukovic, L. (Institute of Endocrinology, Immunology and Nutrition-INEP, Zemun, Yugoslavia). Plant-physiology (USA). (Aug 1990). v. 93(4) p. 1659-1662. references.
Lectins extracted from corn (Zea mays L.) kernel with Tris-HCl buffer pH 7.5 were isolated from the crude extract by affinity chromatography on Sepharose 6B-N-acetyl-D-galactosamine and Sepharose 6B-methyl-alpha-D-mannoside, and also by lectin affinity chromatography using concanavalin A and Lens culinaris lectin as ligands. According to preferential monosaccharide specificity, salt-soluble lectins of corn seed comprise at least tow distinct types: N-acetyl-D-galactosamine-interactive and mannose-interactive lectins. The extracted lectins are unstable, with a tendency to form aggregates during storage.
zea mays; seeds; composition; lectins; sodium chloride; solubility; purification; analysis

Plant Physiology - Nutrition

90-096626 Response of lentil to irrigation and foliar nutrition treatments [Egypt]. En. Attia, A.N. (Mansoura Univ. (Egypt). Faculty of Agriculture). Journal-of-Agricultural-Sciences,-Mansoura- Univ. (Egypt). (1988). v. 13(4A) p. 497-503. Issued 1990. 4 tables; 8 ref. Summaries (Ar, En).
The present investigation was carried out during 1985/87 seasons to study the effect of number of irrigations and foliar nutrition treatments, as well as their interactions on growth, yield and quality of lentil. The main findings of this study could be summarized as follows: 1. Irrigation treatments had a significant effect on all the studied traits, except seed yield (kg/ fad). Meanwhile, the highest seed yield was obtained when lentil plants received one irrigation, on the other hand, seed protein content reached its maximum value when lentil plants were irrigated three times. 2. Foliar nutrition treatments had a significant effect on number of pods/ plant, 1000 seed weight and seed yield (kg/ fad) in both seasons. Adding Urea (1%) as foliar nutrition exerted a significant increase in seed yield. 3. Under the conditions of this experiments, irrigating lentil plants once at 30 days and foliar nutrition with Urea (1%) could maximize lentil seed yield.
lens culinaris; urea; irrigation; foliar application; egypt; growth; crop yield; protein content.

90-125788 Appraisal of the nitrogen-15 natural-abundance method for quantifying dinitrogen fixation. En. Bremer, E.; Van Kessel, C. (Univ. of Saskatchewan, Saskatoon, SK, Canada).
Soil-Science-Society-of-America-journal (USA). (Mar-Apr 1990). v. 54(2) p. 404-411. references.
Several investigators have questioned the use of the 15N natural-abundance method of estimating N2 fixation because of variability in soil delta 15N and small differences between the delta 15N of soil N and atmospheric N. Investigations were conducted to compare the 15N natural-abundance and 15N-isotope-dilution methods for estimating N2 fixation of field-grown pea (Pisum sativum L.) and lentil (Lens culinaris Medik.). Spatial variability was assessed at three sites by determining the delta 15N of non-N2-fixing plants. Seasonal variation in delta 15N for spring and winter wheat (Triticum aestivum L.), flax (Linum usitatissimum L.), barley (Hordeum vulgare L.), rape (Brassica napus L.) and lentil was determined at one site. Comparisons between delta 15N and 15N-enriched isotope-dilution methods for estimating fixation by lentil were conducted at several sites over a 3-yr period. Variability in delta 15N of the reference plant was site dependent: the delta 15N ranged from 2.8 to 9.3 at the first site, 3.4 to 8.8 at the second site, and 3.5 to 6.2 at the third site. The average delta 15N of four of the five non-N2-fixing plants increased from 5.4 at 42 d after planting to 6.9 at the final harvest. The fifth non-N2-fixing plant, rape, accumulated most of its N during the first 42 d after planting, and its delta 15N value declined from 8.1 at 42 d after planting to 7.3 at the final harvest. The delta 15N values for lentil were similar at 42 and 63 d after planting to the delta 15N values of the four reference plants, but did not increase after 63 d. Estimates of N2 fixation were not significantly different in 18 out of 21 comparisons; in two comparisons the delta 15N method and in one comparison the 15N-enriched method provided higher estimates of N2 fixition. Overall, both methods appeared to provide equally reliable estimates of N2 fixation for lentil.
lens culinaris; saskatchewan; pisum sativum; triticum aestivum; linum usitatissimum; brassica napus; nitrogen fixation; nitrogen; isotope labelling; nutrient content; seed; inoculation; seasonal development; varieties

Plant Physiology - Growth and Development

90-052167 Effect of some phenolic compounds on yield components in lentil [Lens culinaris]. En. Setia, N.; Setia, R.C.; Malik, C.P. (Punjab Agricultural Univ., Ludhiana (India). Dept. of Botany). LENS-Newsletter (ICARDA). Lentil Experimental News Service. (1988). v. 16(1) p. 36-39. 3 tables; 23 ref. Summaries (Ar, En).
Field experiments were conducted on lentil (Lens culinaris) during the 1985-87 seasons to determine the effect of some phenolic compounds (G-salt, H-acid, R-salt, and 1,2,4-acid) at 100 or 200 microg/ml on vegetative growth and development. All the compounds enhanced pod number and seed yield per plant at harvest, but 1,2,4-acid was the most effective. None of the treatments caused any significant increase in 1000-seed weight. Except with G-salt, the dry matter accumulation in plants was enhanced with all the treatments, but was highest with 1,2,4-acid. Partitioning coefficients increased with G-salt and 1,2,4-acid. Analyses of the harvest seeds indicated enhancement in the level of the total soluble sugar, starch, amino acid contents, and protein contents (both buffer and alkali soluble) at either of the concentration of the four phenolic compounds.
lens culinaris; phenolic compounds; yield components; india; fruit; seeds; crop yield; flowering; quality; phenolic acids; height

90-073617 The mode of action of Glyphosate: the effect on seedling development and the amino acid content of germinated lentils (Lens esculenta L.) [Egypt]. En (English). Hassan, E.A. (National Research Centre, Cairo (Egypt). Botany Lab.).
Al-Azhar- Journal-of-Agricultural-Research (Egypt). (Jun 1988). v. 8 p. 403-414. Issued 1990. 2 fig. 3 tables; 17 ref. Summaries (Ar, En).
Treating lentil seeds with glyphosate caused significant reduction in mean seedling shoot and root lengths. The reduction increased proportionally by increasing glyphosate concentration. Cultivars and soaking periods significantly influenced the response of lentils to glyphosate. High concentration treatment of glyphosate 16.25 g ai/fed., increased glutamic acid, ammonia, aspartic acid and threonine. The other amino acids on the other hand were decreased. At the low concentration treatment (2.00 g ai/fed.) total amino acid content proximated that of the control.
lens culinaris; pesticides; germination; seedlings; composition; amino acids; Egypt

90-096725 Response of field-grown lentil to pre-sowing seed enrichment with pyridoxine. En. Ansari, S.A.; Samiullah; Afridi, M.M.R.K.; Khan, N.A. (Aligarh Muslim Univ., Aligarh, UP (India). Dept. of Botany). Field-Crops-Research (Netherlands). (1990). v. 23(1) p. 45-53. 24 refs.; Summary (En).
lens culinaris; pyridoxine; seed treatment; growth; crop yield; quality

Plant Physiology - Reproduction

90-032257 Cytomixis in the pollen mother cells of Lens culinaris raised from irradiated seeds. En. Sinha, S.S.N.; Kumar Singh, V. Genetica- Iberica (Spain). (1988). v. 40(3-4) p. 189-193. Received at the Input Centre Sep 1989. Ill.; 15 ref.
lens culinaris; pollen; chromosomes; mitosis; seed; gamma radiation; in vitro experimentation.

90-052210 [Drop of reproductive structures in lentils, in the central south of Chile]. Es (Spanish). Caida de organos reproductivos de lentejas, en la zona centro sur de Chile. Paredes C, Mario; Tay U, Juan; Parra R, Cecilia. Agricultura-Tecnica (Chile). (Apr-Jun 1989). v. 49(2) p. 92-96. 18 ref. Summaries (En, Es).
lens culinaris; reproductive organs; abscission; chile; crop yield; varieties

PLANT PROTECTION

Protection of Plants - General Aspects

90-126484 The influence of temperature on germination and attachment of the parasitic weed orobanche spp. on lentil and sunflower. En. Zum Einfluss der Temperatur auf Keimung und Befallsverlauf der parasitischen Bluetenpflanze Orobanche spp. an Linse und Sonnenblume. Sauerborn, J. Angewandte-Botanik (Germany, F.R.). (1989). v. 63(5-6) p. 543-550. 7 ill., 12 ref. Summaries (De, En).
helianthus annuus; lens culinaris; orobanche; germination; temperature; growth

Pests of Plants

90-032831 Comparison of sweep net, D-vac, and absolute sampling, and diel variation of sweep net sampling estimates in lentils for pea aphid (Homoptera: Aphididae), nabids (Hemiptera: Nabidae), lady beetles (Coleoptera: Coccinellidae), and lacewings (Neuroptera: Chrysopidae). En. Schotzko, D.J.; O'Keeffe, L.E. (University of Idaho, Moscow, ID). Journal-of-economic-entomology (USA). (Apr 1989). v. 82(2) p. 491-506. references.
lens culinaris; acyrthosiphon pisum; chrysopa; coleoptera; pest insects; hosts; population density; sampling

90-042787 Apion arrogans, a weevil vector of broad bean mottle virus [Vicia faba]. En. Makkouk, K.M.; Kumari, S. (ICARDA, Aleppo (Syria)). FABIS-Newsletter (ICARDA). Faba Bean Information Service. (Aug 1989). (no.24) p. 26-27. 1 fig.; 8 ref. Summaries (Ar, En).
Apion arrogans Wencker is a weevil which infests naturally crops of faba bean and lentil in Syria. In a glasshouse experiment two field collections of A. arrogans, one originating from faba bean and the other from lentil plants, were found to transmit broad bean mottle virus (BBMV).
vicia faba; lens culinaris; apion; viroses; syria; greenhouses

90-042793 Geostatistical description of the spatial distribution of Lygus hesperus (Heteroptera: Miridae) in lentils. En. Schotzko, D.J.; O'Keeffe, L.E. (University of Idaho, Moscow, ID).
Journal-of-economic-entomology (USA). (Oct 1989). v. 82(5) p. 1277-1288. references.
The spatial distribution of Lygus hesperus Knight (Heteroptera: Miridae) in lentils was evaluated at five locations over two years using geostatistical methods. Geostatistics uses temporal or spatial variation to determine the degree of association and dependence of temporally or spatially related data. These analyses revealed unique spatial distributions for adults and nymphs, which varied as the growing season progressed and population densities changed. After immigrating into lentil fields, adults were aggregated. During the middle of the growing season, adult distributions were clumped at low densities and were uniform or random at higher densities. At the end of the growing season, newly emerged adults again had a clumped distribution. Nymphs showed random to uniform distributional patterns until late in the growing season when, as population densities increased, their spatial distribution became clumped.
lens culinaris; idaho; lygus; population density; sampling; statistical analysis.

90-052843 Injuriousness of lentil gall midge Contarinia lentis Aczel (Diptera, Cecidomyiidae) and its distribution in Czechoslovakia. De (German). Schaedlichkeit der Linsenbluetengallmuecke Contarinia lentis Aczel (Diptera, Cecidomyiidae) und ihre Verbreitung in der CSSR. Kolesik, P.; Kolesik,

M. Anzeiger-fuer-Schaedlingskunde-Pflanzenschutz- Umweltschutz (Germany, F.R.). (1989). v. 62(8) p. 150-156. 5 ill., 2 tables; 12 ref. Summaries (De, En).
There has been an outbreak of lentil gall midge C. lentis on lentil in Czechoslovakia since 1984. Its extent and cause are given below. Infestation symptoms - the gall - is described. The level of damage is defined as percent rate of the amount of galls and flower buds containing eggs of C. lentis from the amount of pods, flower, galls, flower buds containing eggs and flower buds not containing eggs. As estimation is taken mostly at the end of lentil vegetation the level of damage is simplified to percent rate of the amount of galls from the amount of galls and pods. The level of damage of small parts of lentil stands can achieve 80 per cent. Single plants with 95 per cent level of damage were found. Proportional dependence of thousand-kernel weight on the level of damage was found out. Two functions of dependence of yield of the level of damage were compared: a simple linear one and a quadratic one which included dependence of thousand-kernel weight on the level of damage. The generally valid linear function of dependence of yield y on the level of damage x is recommended: y 0.01 e (100 - x) where e means yield at 0 per cent damage level. Recent distribution area of this species in Czechoslovakia is given. In 1985-1988 the average level of damage of lentil stands from outbreak centre ranged from 3.08 to 52.05 per cent. The average yield losses in Czechoslovakia were 5.49 per cent in 1985, 4.98 per cent in 1986, 2.87 per cent in 1987 and 3.97 per cent in 1988. Concentration of lentil fields in a small area was recognized as the main cause of the outbreak of C. lentis in Czechoslovakia.
lens culinaris; contarinia; natural distribution; czechoslovakia.

90-074048 Some observations on Aphis craccivora Koch with special reference to its host range. En. Ahmad, M. (Department of Agriculture, Punjab, Lahore (Pakistan)). Pakistan-Entomologist (Pakistan). (1983). v. 5(1-2) p. 57-60. Published in January, 1987. 10 ref., Summary (En).
pest insects; aphis; hosts; pakistan; cowpeas; cicer arietinum; lens culinaris.

90-097672 Fecundity and damage inflicted by Callosobruchus maculatus (F.) in certain leguminous seeds [Egypt]. En. El Zohairy, M.M.; Hegab, A.M.; Darwish, E.T.E. (Zagazig Univ. (Egypt). Faculty of Agriculture). Zagazig-Journal-of-Agriucultural-Research (Egypt). (Jun 1985). v. 12(1) p. 773-782. Issued 1990. 2 tables; 6 ref. Summaries (Ar, En).
Fecundity and amount of loss inflicted by the bean weevil (Callosobruchus maculatus (F.) on lentils, chickpeas and peas was studied, within an investigation period of 120 days during which three generations were recorded. The results obtained indicated that the rate of reproduction on certain quantity of food is seriously reduced by continuous infestation. The amount of food consumed due to the progeny of one pair of beetles varied according to the types of food and the insect generations.
legumes; seeds; callosobruchus; pest insects; biology; Egypt

90-110504 Ceraphron flaviventris (Hym., Ceraphronoidea), a new parasitoid of Contarinia lentis (Dipt., Cecidomyidae). En. Pitonakova, I. (Slovenska Akademia Vied, Ivanka pri Dunaji (Czechoslovakia). Ustav Experimentalnej Fytopatologie a Entomologie). Biologia (Czechoslovakia). (Jun 1989). v. 44(6) p. 523-531. 4 graphs, 2 tables; Summaries (En, Ru, Sk).
lens culinaris; contarinia; parasites; czechoslovakia; biological control.

90-127390 Effect of pea and lentil development on reproduction and longevity of Thyanta pallidovirens (Stal) (Hemiptera: Heteroptera: Pentatomidae). En (English). Schotzko, D.J.; O'Keeffe, L.E. (University of Idaho, Moscow, ID).
Journal-of-economic-entomology (USA). (Aug 1990). v. 83(4) p. 1333-1337. references.
The effects of pea, Pisum sativum L., and lentil, Lens culinaris Medik., development on reproduction and longevity of Thyanta pallidovirens (Stal) were evaluated in the laboratory. Stink bug reproduction and longevity were both significantly affected by the host plants' developmental stage. The greatest number of eggs, with the highest number of viable eggs and eggs per clutch, were laid and the longest life span occurred on peas or lentils with mature pods. Insects given peas or lentils with flowers and immature pods had shorter life spans and produced significantly fewer total eggs, eggs per clutch, and viable eggs. Almost no eggs were produced by females given seedlings or only flowering host plants.
lens culinaris; pisum sativum; hemiptera; parasitism; longevity; oviposition; fecundity

90-127392 Ovipositional rhythms of Thyanta pallidovirens (Hemiptera: Pentatomidae). En. Schotzko, D.J.; O'Keeffe, L.E. (University of Idaho, Moscow, ID). Environmental-entomology (USA). (Jun 1990). v. 19(3) p. 630-634. references.
The complete ovipositional rhythms of Thyanta pallidovirens (Stal) fed peas, beans, or lentils and the diel ovipositional rhythms when fed beans were determined in the laboratory. The ovipositional response of these insects was significantly affected by the food provided; T. pallidovirens that were provided peas produced significantly more eggs (mean 295) than those provided beans (mean 165) or lentils (mean 122). T. pallidovirens fed peas had constant eggs per clutch (E/C) and number of days between clutches (DBC) over the ovipositional period; whereas those fed beans or lentils had significant negative slope when E/C or DBC were predicted by either days from first oviposition or number of clutches already laid. T. pallidovirens that were fed beans had a consistent diel ovipositional cycle with 1500 and 1700 hours having significantly more oviposition than 400, 1600, 1800, and 1900 hours, which were significantly greater than 200, 2200, 2000, 1400, and 2100 hours, which were significantly greater than the remaining hours. There was also a consistent diel mating cycle for this insect, with 400, 500, 600, and 700 hours having significantly more mating than 800, 900, 2200, 2100, and 1100 hours, which were significantly greater than the remaining hours.
pisum sativum; lens culinaris; phaseolus vulgaris; hemiptera; oviposition; fecundity

Plant Diseases

90-016739 Field evaluation of fungicides for ascochyta blight in lentil. En (English). Iqbal, S.M.; Bakhsh, A.; Ahmad, S.; Bashir, M. (NWFP Agricultural Univ., Peshawar National Agricultural Research Centre, Islamabad (Pakistan)). Sarhad-Journal-of-Agriculture (Pakistan). (Jun 1989). v. 5(3) p. 307-309. 1 table, 11 ref., Summary (En).
lens culinaris; blights; fungicides; fungus control; ascochyta

90-016740 [Pathology and entomology of food legumes]. Ar (Arabic). amra:d/u wa h"as"ara:t/u al-buku:liyya:t/i al-g"id"a:' iyyat. Ministry of Agriculture and Agrarian Reform, Damascus (Syria). International Center for Agricultural Research in the Dry Areas, Aleppo (Syria). ICARDA, Aleppo (Syria). Collaborative research and training program. Annual report for 1985-86 season. barna:maj"/u al-ta3a:wn/i al-3ilmi: al-mus"tarak. al-taqri:r/u al-sanawi:/u limawsim/i 1985/86. Aleppo (Syria). International Center for Agricultural Research in the Dry Areas. 1987. p. 108-126. Tables. AVAILABILITY: ICARDA,

POB 5466, Aleppo - Syria RN: ICARDA-116-Ar,En. See Also: 90-012276.
lens culinaris; cicer arietinum; vicia faba; syria; plant diseases; mycoses; nematodes; orobanche; cuscuta; aphids; cooperative activities; research

90-053217 Inheritance of resistance to rust in lentil [Lens culinaris]. En (English). Sinha, R.P.; Yadav, B.P. (Tirhut College of Agricultue, Dholi (India)). LENS-Newsletter (ICARDA). Lentil Experimental News Service. (1988). v. 16(1) p. 41. Summaries (Ar, En).
lens culinaris; inheritance genetics; gamma radiation; disease resistance; rusts; india; disease control; maturity; yield increase; uromyces

90-063470 Effect of Ascochyta blight on seed yield and quality of lentils. En (English). Gossen, B.D.; Morrall, R.A.A. (Univ. Saskatchewan, Saskatoon, Sask. (Canada)).
Canadian-Journal-of-Plant- Pathology (Canada). (1983). v. 5(3) p. 168-173. 11 ref., 2 fig., 4 tab.
lens culinaris; ascochyta; saskatchewan; crop losses; seeds; quality; blights

90-063471 Pathogenicity of soil fungi associated with a root rot of lentils. En (English). Bhalla, M.K.; Nozzolillo, C.; Schneider, E.F. (Dep. Biol., Univ. Ottawa, Ont. K1N 9B4 (Canada)).
Canadian-Journal-of-Plant-Pathology (Canada). (1984). v. 6(1) p. 21-28. 30 ref., 4 fig., 5 tab.
lens culinaris; fusarium oxysporum; ontario; fusarium; soilborne organisms; root rots.

90-075119 Studies on virus diseases in leguminous plants [Egypt]. En (English). Attia, M.A.Kh. Zagazig Univ. (Egypt). Faculty of Agriculture. Zagazig (Egypt). 1988. 238 p. Thesis (Ph.D. in Plant Pathology). 48 fig. 14 tables; Bibliography p. 202-233; Summaries (Ar, En); AVAILABILITY: Library, Faculty of Agriculture, Zagazig Univ., Egypt.
legumes; viroses; Egypt; vicia faba; soybeans; cowpeas; lens culinaris; plant viruses; disease transmission.

90-098227 Pectolytic and cellulolytic enzyme activities of damping off and root rot fungi of lentil in Egypt. En. Yehia, A.H.; Abd El Kader, D.A.; Barakat, M.A.; Soliman, G.I. (Zagazig Univ. (Egypt). Faculty of Agriculture). Zagazig-Journal-of-Agricultural-Research (Egypt). (Dec 1985). v. 12(2) p. 351-367. Issued 1990. 3 tables; 16 ref. Summaries (Ar, En).
Fusarium solani, F. oxysporum, Rhizoctonia solani and Pythium dabaryanum were the most destructive fungi, which cause damping-off and root rot diseases of lentil in Egypt. The fungi were isolated from diseased lentil plants, which collected from different governorates of Egypt. Cultural filtrates of tested fungi differed in pectinmethylestrase (PME), polypalacturonase (PG) and cellulase (Cx) activities, but the PG activity was more pronounced in filtrates of F. solani and F. oxysporum the more pathogenic fungi causing root rot compared with P. debaryanum, and R. solani the middle virulent.
lens culinaris; rots; damping off; fungi; enzymic activity; glycosidases; Egypt; fusarium; rhizoctonia; pythium

90-111104 Studies on the biological control [by Arachniotus, Trichoderma, Penicillium, Aspergillus and Paecilomyces] of collar rot of lentil caused by Sclerotium rolfsii Sacc. En. Hussain, M. University of Agriculture, Faisalabad (Pakistan). Dept. of Plant Pathology. Faisalabad (Pakistan). UAF. 1989. 85 p. Thesis (M.Sc. (Hons.)). 22 plates, 11 ills., 25 tables, 42 ref., Summary (En), AVAILABILITY: Library, University of Agriculture, Faisalabad, Pakistan.
lens culinaris; rots; sclerotium; biological control; biological control organisms; trichoderma; penicillium; aspergillus; paecilomyces

90-111105 Studies on the physiology of Sclerotium rolfsii causing collar rot of lentil. En. Ali, S. University of Agriculture, Faisalabad (Pakistan). Dept. of Plant Pathology. Faisalabad (Pakistan). UAF. 1988. 91 p. Thesis (M.Sc. (Hons.)). 27 tables, 44 ref., Summary (En), AVAILABILITY: Library, University of Agriculture, Faisalabad, Pakistan.
lens culinaris; rots; sclerotium; growth; temperature; ph; fungicides; fungus control.

90-111106 Studies on the chemical control of collar rot of lentil caused by Sclerotium rolfsii Sacc. En. Shahid, M.A. University of Agriculture, Faisalabad (Pakistan). Dept. of Plant Pathology. Faisalabad (Pakistan). UAF. 1989. 91 p. Thesis (M.Sc. (Hons.)). 17 ills., 33 tables, 35 ref., Summary (En), AVAILABILITY: Library, University of Agriculture, Faisalabad, Pakistan.
lens culinaris; rots; sclerotium; fungicides; fungus control.

90-111107 Studies on the biological control [by Arachniotus, Aspergillus, Penicillium and Trichoderma] of lentil wilt caused by Fusarium solani (Mart.) Sacc. En. Aslam, M.S. University of Agriculture, Faisalabad. (Pakistan). Dept. of Plant Pathology. Faisalabad (Pakistan). UAF. 1989. 103 p. Thesis (M.Sc. (Hons.)). 30 plates, 19 ills., 41 tables, 31 ref., Summary (En), VAILABILITY: Library, University of Agriculture, Faisalabad, Pakistan.
lens culinaris; wilts; fusarium; biological control; biological control organisms; penicillium; trichoderma; antagonism

Miscellaneous Plant Disorders

90-053383 [Effect of manganese on growth and nutrient composition in lentils (Lens culinaris) [blackish brown spots]]. Es (Spanish). Efecto el manganeso sobre el crecimiento y contenido de nutrientes en lenteja (Lens culinaris). Sadzawka R, Angelica. Agricultura-Tecnica (Chile). (Oct-Dec 1987). v. 47(4) p. 350-354. 6 ref. Summaries (En, Es).
lens culinaris; phytotoxicity; mineral deficiencies; manganese; growth; nutrient content.

90-086070 Effect of AC 222,293 soil residues on rotational crops. En (English). Fellows, G.M.; Fay, P.K.; Carlson, G.R.; Stewart, V.R. (Mont. State Univ., Bozeman, MT).
Weed-technology-:-a-journal- of-the-Weed-Science-Society-of-America (USA). (Jan-Mar 1990). v. 4(1) p. 48-51. references.
triticum aestivum; montana; hordeum vulgare; helianthus annuus; lens culinaris; brassica napus; beta vulgaris; avena fatua; residues; herbicides; residual effects; pesticide persistence; phytotoxicity

90-098427 Response of peas and lentils to sublethal doses of sulfonylureas, 2,4-D and bromoxynil. En. Halstead, S.J.; Gealy, D.R.; Ogg, A.G. Jr. (USDA, ARS, Pullman, WA).
Proceedings-Western-Society-of-Weed-Science (USA). (1989). v. 42 p. 147-148. Meeting held on March 13-16, 1989, Honolulu, Hawaii. Summary (En).
pisum sativum; lens culinaris; herbicides; phytotoxicity

Weeds and Weed Control

90-005939 Soil residual properties of DPX-A7881 under laboratory conditions. En (English). Beckie, H.J.; McKercher, R.B. (Univ. Saskatchewan, Saskatoon, SK, Canada). Weed-science (USA). (May 1989). v. 37(3) p. 412-418. references.
Growth chamber studies were conducted to examine the soil residual

properties of DPX-A7881, a new sulfonylurea herbicide. The phytotoxic residue levels in the soil were determined by a lentil radicle bioassay. The duration of activity was prolonged in soil adjusted to pH 7.6 and 8.1 relative to more acidic levels. The rate of breakdown in the soil was enhanced with increased temperature and soil moisture content; a significant temperature by moisture interaction was noted over the duration of the incubation period. The dissipation of DPX-A7881 in soil obeyed first-order kinetics in both studies. An accelerated rate of breakdown in unsterilized versus sterilized soil (pH 7.6) indicated that microbial degradation was an important factor affecting the persistence in alkaline soils. Herbicide residues in the soil caused a reduction in taproot length and number of primary lateral roots of canola seedlings 15 days after planting but there were no other morphological effects observed on the root. The secondary laterals, however, had generally recovered by this time.
brassica campestris; saskatchewan; brassica napus; urea; residues; herbicides; ph; soil chemistry; edaphic factors; phytotoxicity; roots; lens culinaris; incubation; duration; microbial degradation.

90-017113 Weed management in pulse crops. En. Singh, G. (G.B. Pant Univ. of Agriculture and Technology, Pantnagar (India). Dept. of Agronomy). Pak - Indo - US Weed Control Workshop. Islamabad (Pakistan). 11-14 Mar 1987. Shad,-R.A. (ed.). Pakistan Agricultural Research Council, Islamabad (Pakistan); United States Dept. of Agriculture, New Delhi (India). Far Eastern Regional Research Office. Advances in weed sciences: A case of Indo - Pakistan subcontinent. Islamabad (Pakistan). PARC. 1987. p. 249-258. 3 tables, 51 ref., Summary (En). AVAILABILITY: National Agricultural Research Centre, POB NARC, Park Road, Islamabad - Pakistan.
mung beans; urd; cajanus cajan; cicer arietinum; lens culinaris; weed control; cultural control.

90-025126 Herbicide control of broomrape in peas and lentils. En. Arjona Berral, A.; Mesa Garcia, J.; Garcia Torres, L. (Department of Plant Protection, Cordoba (Spain). Agrarian Research Service). FAO-Plant-Protection-Bulletin (FAO). Bulletin Phytosanitaire de la FAO (FAO); Boletin Fitosanitario de la FAO (FAO). (1988). v. 36(4) p. 175-178. Summaries (En, Es, Fr) - AVAILABILITY: FAO Accession No: XF8987345 (Available on Microfiche).
pisum sativum; lens culinaris; orobanche; weed control; herbicides

90-033510 Dicamba, chlorsulfuron, and clopyralid as sprayer contaminants on sunflower (Helianthus annuus), mustard (Brassica juncea), and lentil (Lens culinaris), respectively. En. Derksen, D.A. (Agric. Canada Res. Stn., Indian Head, Saskatchewan, Canada). Weed-science (USA). (Jul 1989). v. 37(4) p. 616-621. references.
Simulated sprayer tank residues of the broadleaf weed herbicides dicamba, chlorsulfuron, and clopyralid applied alone and with the grass weed herbicides sethoxydim and diclofop on sunflower, tame mustard, and lentil, respectively, caused visible crop injury and reduced dry weight and yield. Dry weight production in the greenhouse and crop tolerance ratings in the field indicated that the grass weed herbicides enhanced crop injury from dicamba, chlorsulfuron, and clopyralid. Yield reductions in field experiments were also greater when dicamba and clopyralid were mixed with grass weed herbicides and applied on sunflower and lentil, respectively. This did not occur with chlorsulfuron applied to mustard. When mixed with simulated broadleaf weed herbicide residues, diclofop enhanced dry weight reductions and crop injury and reduced yield to a greater extent than sethoxydim. Crop tolerance ratings differentiated treatments and rates but were not a good estimate of the extent of yield loss. When broadleaf weed herbicides were applied at rates simulating sprayer tank residues alone or combined with grass weed herbicides, yield losses ranged up to 40% in sunflower, 70% in mustard, and 95% in lentil, compared to the untreated check.
brassica juncea; saskatchewan; lens culinaris; herbicides; dicamba; residues; crop yield; losses

90-053575 Studies on weed control in lentil sown after rice under zero tillage [Lens culinaris]. En. Singh, S.; Gautam, K.C.; Prasad, R. (Indian Agricultural Research Inst., New Delhi (India). Division of Agronomy). LENS-Newsletter (ICARDA). Lentil Experimental News Service. (1988). v. 16(1) p. 22-27. 1 table; 1 fig.; 22 ill.; 3 ref. Summaries (Ar, En).
In a field study, the bio-efficacy and crop selectivity of six promising herbicides Alachlor, Metribuzin, Oxadiazon, Pendimethalin, Fluazifop-butyl, and Acifluorfen were evaluated in lentil sown after rice under zero tillage. Metribuzin, Oxadiazon, and Pendimethalin controlled most weeds and significantly reduced their number and dry matter. However, Oxadiazon and Pendimethalin were found phytotoxic to lentil. The grain yield obtained under Metribuzin compared well with that obtained with repeated weedings.
lens culinaris; rice; herbicides; zero tillage; rotational cropping; india; weeding; weed control; saline alkali soils; grain; phytotoxicity

90-063770 [The lentil weeding and first results obtained in semi-arid soil [of Sicily, Italy]]. It (Italian). Il diserbo della lenticchia e primi risultati ottenuti in ambiente semi-arido [della Sicilia]. Stringi, L.; Amato, G.; Gristina, L.; Cibella, R. (Palermo Univ. (Italy). Istituto di Agronomia Generale e Coltivazioni Erbacee). Informatore-Agrario (Italy). (16 Jun 1988). v. 44(25) p. 59-63. Special issue. 3 tables; 4 graphs; 18 ref.
lens culinaris; arid soils; weed control; herbicides

90-075528 LRB(sn) bioassay for detecting residues of GLEAN, ALLY and EXPRESS in Danish soils. Da (Danish). Biologisk metode til analyse for residues of GLEAN, ALLY and Express i jord. Jensen, P.G.; Buhr, K.; Petersen, E.F. 7. Danish Plant Protection Conference: Side Effect of Pesticides: Weeds. Copenhagen (Denmark). 7 Mar 1990. Statens Planteavlsforsoeg, Lyngby (Denmark). Plantevaernscentret. 7th Danish plant protection conference: Side effect of pesticides: Weeds. 7. Danske plantevaernskonference: Pesticider og miljoe: Ukrudt. Lyngby (Denmark). SPF. 1990. p. 243-247. 3 ill., 3 ref. Summaries (Da, En).
lens culinaris; rape; herbicides; soil testing; denmark; bioassay

90-098599 Study on grain yield and weed flora in wheat as influenced by various weed management strategies. En. Aslam, M. University of Agriculture, Faisalabad (Pakistan). Dept. of Agronomy. Faisalabad (Pakistan). UAF. 1988. 83 p. Thesis (M.Sc. (Hons.)). 21 tables, 57 ref., Summary (En), AVAILABILITY: Library, University of Agriculture, Faisalabad, Pakistan.
triticum aestivum; weeds; weed control; weeding; herbicides; crop yield; intercropping; lens culinaris; trifolium alexandrinum; protein content.

90-098664 The comparative study of various chemical weed control practices in lentils (Lens culinaris). En. Abid, S.A. University of Agriculture, Faisalabad (Pakistan). Dept. of Agronomy. Faisalabad (Pakistan). UAF. 1989. 101 p. Thesis (M.Sc. (Hons.)). 85 tables, 35 ref., Summary (En), AVAILABILITY: Library, University of Agriculture, Faisalabad, Pakistan.
lens culinaris; weeds; herbicides; weed control; weeding; application rates; yield components.

90-111504 [Chemical weed control in lentils (Lens culinaris Medik.)].

Es (Spanish). Control quimico de malezas en lenteja (Lens culinaris Medik.). Diaz G, Juan Ramon. Universidad Austral de Chile, Valdivia. Fac. de Ciencias Agrarias. Valdivia (Chile). 1987. 55 p. Tesis (Ing Agr). 51 ref.; Summaries (En, Es). AVAILABILITY: Biblioteca Central, IIA, CP 439/3, correo 3, Santiago - Chile.
lens culinaris; weed control; chemical control; herbicides control; crops; dicotyledons; economic plants; foods; grain crops; grain legumes; leguminosae; lens genus; papilionoideae; pest control; pest control methods; plants; rosales.

POSTHARVEST TECHNOLOGY

Storage and Protection of Plant Products

90-017153 [Harvest and post-harvest grain losses]. Ar (Arabic). al-faqid fiy h"ubwb al-mah"a:s"yl al-h"aqlyt h°ilal al-h"aza:d wa-maba3d al-h"aza:d. Al Rawi, M.F. Jordan Univ., Amman (Jordan). Dept. of Plant Production. Amman (Jordan). May 1989. 152 leaves. Thesis (M.Sc. in plant production). 8 fig.; 42 tables; 68 ref.; Summaries (Ar, En). AVAILABILITY: JORDOC, Jordan University, Library, Amman - Jordan.
This study was carried out by using wheat, barley, lentil, chickpeas and corn in different locations of Jordan, to estimate the grain losses during harvesting, transportation and storage. The results indicated that: In Mushagar, (in farm field) the losses for barley and wheat were 7.87 % due to mechanical harvesting, 1 % due to natural causes, while at the research station they were 0.15 % of wheat due to cleaning, 0.36 % due to handling and 0.24 % due to birds. At Ramtha station, for barley, 7.4 % and 6.79 % due to hand and mechanical harvesting, 8.2% due to threshing, 0.8 % due to transportation. At Al-Shajarah site, for lentil 12.46 % and 5.21 % due to mechanical and hand harvesting, respectively and 15.6 % due to threshing. At Al-Sarih lentil grain losses were 49.5 % and 5.5 % due to mechanical and hand harvesting, respectively. In Jureynet-Alflahat, chickpeas losses were 23.75 % due to mechanical harvesting and 4.6 % on ground before harvesting. In Howarah chickpeas grain losses were 5 % on the ground. In Juedeh siloes the grain losses by transportation were 0.23 % of wheat, 1.45 % of barley and 0.65 % of corn, the losses due to storage were 0.66 % for wheat, 2.37 for corn. Several suggestion and recommendations were made to reduce those losses.
grain crops; jordan; harvesting losses; postharvest losses; handling losses; wheats; barley; lens culinaris; cicer arietinum; zea mays; stored products pests.

90-053674 Varietal resistance in pulses to mung dhora (Callosobruchus analis F.). En. Rasul, G.; Ali, A.; Ulfat, M. (Ayub Agricultural Research Inst., Faisalabad (Pakistan). Entomology Section).
Journal-of-Agricultural-Research (Pakistan). (Jan 1989). v. 27(1) p. 61-64. 1 table, 7 ref., Summary (En).
vigna radiata; vigna mungo; lens culinaris; callosobruchus; pest resistance; varieties

90-063856 Insect infestation and distribution in bagged lentils. En (English). Ho, S.H.; Zaing, Z. (Singapore National Univ., Lower Kent Ridge Road (Singapore). Zoology Dept.). 8. ASEAN Technical Seminar on Grain Post-Harvest Technology. Manila (Philippines). 6-9 Aug 1985. Semple,-R.L.; Frio,-A.S. (eds.). ASEAN Crops Post-Harvest Program, College, Laguna (Philippines); ASEAN Food Handling Bureau, Kuala Lumpur (Malaysia); National Post-Harvest Inst. for Research and Extension, Taguig, Metro Manila (Philippines). Research and Development Systems and Linkages for a Viable Grain Post-Harvest Industry in the Humid Tropics: Proceedings of the Eighth ASEAN Technical Seminar on Grain Post-Harvest Technology. College, Laguna (Philippines). 1985. p. 21-25. Received Jul 1987. 1 ill.; 4 tables; 4 ref. Summary (En). AVAILABILITY: UPLB, College, Laguna 3720 - Philippines.
Samples of lentils were taken from bags in a typical shop selling pulses to determine the relative abundance of insects and their distribution with the bags. Sitophilus spp. were the predominant insects infesting lentils, comprising 76.5% of all insect samples. The average infestation rate of Sitophilus spp. was 110 adults/kg of lentils. Psocids and other pests formed only a small proportion of the samples. Parasitic hymenopterans and predaceous anthrocarid bugs were also found. Insect density increased with storage time. There was a significantly larger number of insects (P0.05) in the upper half of the bag than in the lower half after 14 days of storage in the shop. After seven days of storage, the insect population displayed a lateral dispersion towards the corners of the bag. Such a dispersion pattern suggests the presence of centers of aggregation at higher insect densities. Higher temperature and moisture levels could result in these centers, thus promoting fungal growth. Control measures, if any, are limited to fumigation with methyl bromide in warehouses and spraying the shop premises with aerosol insecticides when insects are detected on the surfaces of the bags and in the storage area. Suchin spection and control methods are inadequate, since migration of insects to the upper layers and the surface of the bag indicate heavy infestation.
lens culinaris; pest insects; infestation; sitophilus; stored products pest control; singapore

ANIMAL SCIENCE, PRODUCTION AND PROTECTION

Animal Diseases

90-065982 Meat inspectional importance of streptococcal dermatitis in swine. Hu (Hungarian). A sertesek streptococcusok okozta borgyulladasanak husvizsgalati jelentosege. Nador, A. (Baranya Megyei Allategeszsegugyi es Elelmiszerellenorzo Allomas, Pecs (Hungary)). Magyar-Allatorvosok-Lapja (Hungary). (1989). v. 44(4) p. 245-247. 1 table; 1 ill.; 12 ref. Summaries (De, En, Hu, Ru).
Characteristic dermatitis has been reported that was observed in pigs during normal slaughtering. Dark red - blue red areas with the size of lentils to forint piece, covered with brown red crust on the central part were observed partly in the bright red, erythematous or partly in normal skin. In some cases, signs of septicaemia (haemorrhages in the renal cortex, splenomegaly, swelling and reddening in the lymph nodes) also accompanied the dermatitis. During the complementary laboratory meat investigation of 46 cases, streptococci were isolated in 23 (50 per cent) and staphylococci in 10 cases (21.73 per cent). Meat of 35 pigs (76.09 per cent) was subjected to conditions for the free consumption.
swine; dermatitis; meat inspection; streptococcus; animal health.

AGRICULTURAL MACHINERY AND ENGINEERING

Agricultural Machinery and Equipment

90-138844 A roller-type postive feed mechanism for seed metering. En (English). Bansal, R.K.; El Gharras, O.; Hamilton, J.H. (Cent. Regional de la Recherche Agron. (CRRA), Settat (Morocco)). Journal-of-Agricultural-Engineering-Research (UK). (1989). v. 43(1) p. 23-31. 5 ref.
seed; wheats; drills; developing countries; barley; lens culinaris.

NATURAL RESOURCES AND ENVIRONMENT

Soil Chemistry and Physics

90-010129 The effect of soil pH on wheat and lentils grown on an agriculturally acidified northern Idaho soil under greenhouse conditions. En (English). Mohebbi, S.; Mahler, R.L. (University of Idaho, Moscow, ID). Communications-in-soil- science-and-plant-analysis (USA). (Feb 1989). v. 71(3/4) p. 359-381. references.
idaho; triticum aestivum; lens culinaris; acid soils; ph; germination; energy; nutrient uptake; growth; seed production; crop yield; protected cultivation; greenhouses

90-103133 Replenishment and depletion of soil moisture in the northern rainfed areas of East Jordan. III-Soil Series 15. En. Battikhi, A.M.; Saimeh, M.H. (Jordan Univ., Amman (Jordan)). Dirasat (Jordan). (Feb 1987). v. 14(2) p. 33-53. 10 fig.; 3 tables; 12 ref. Summaries (Ar, En).
A study to determine the amount of water stored in the root and the amounts removed by evapotranspiration under different management systems was carried out over a two year period. Observation was made on seven different farms on two slope classifications (0-3%, 3-8%) of soil series 15 in the Bishra-Irbid area. Crop management systems studied were: wheat-fallow; fallow-fallow; lentil-fallow. One system, tobacco-fallow, was discontinued because of uncontrolled experimental errors. During the first season fallow soils, 0.3% slope, stored 44 mm more water than the lentil planted area and 15 mm more than the wheat planted area. A field left fallow for two consecutive years accumulated and additional 22 mm water for the second year; 192 mm and 224 mm were the depths of total soil moisture at the end of the first season for the fields left fallow. During the second season the depths for the same sites under fallow were 181; 214 mm. Considering the texture of those very heavy soils (70% clay), nearly all this moisture won't be available for plant consumption. Soil moisture depletion in the fallow treatment was 208 mm (this value was obtained by subtracting moisture content at the end of the season, or at harvest from max. moisture attained during the season) during the first season, and 120 mm during the second season. The depletion from wheat planted areas during the first season was 178 mm. The higher depletion value in the fallow (208 vs. 187 mm) when compared to wheat is probably due to the greater abundance of weeds in the fallow land, where they have a longer growing season than wheat. Evapotranspiration for wheat was found to be 164 to 182 mm; for lentils was 135 mm; for tobacco was 122 mm. In general storage during the first season ranged from 109-13 mm; in the second-from 75-142 mm, for fallow lands. None or very little amount of this water was available to plant in the next season since depletion in this fields was 144-208 mm, first season; 91-120 mm in the second. This implies that moisture stored from the previous years has also been depleted in this season.
jordan; rain; soil water retention; soil water balance; soil water content; wheats; lens culinaris; tobacco; soil chemicophysical properties; water depletion.

Soil Biology

90-068022 Isolation of the rhizobium strains from the nodules of the eleven legume crops [in Bangladesh]. En. Chanda, M.C.; Sattar, M.A. 14. Annual Bangladesh Science Conference. Joydebpur (Bangladesh). 27-30 Jan 1986.
Bangladesh Association for the Advancement of Science, Dhaka (Bangladesh). Proceedings of the 14th Annual Bangladesh Science Conference. Section 1. Dhaka (Bangladesh). BRRI. 1989. p. 6-7. Summary only. Eleven legume crops such as Chickpea, Lentil, Pea, Pigeon pea, Cowpea, Grasspea, Groundnut, Mungbean, Blackgram ans Soybean were grown in the BINA Experimental field during rabi season, 1987-88. After 35 to 45 days of seed sowing matured nodules were collected from the primary, secondary and tertiary roots of the respective crops. Different morphological characters of the nodules were studied in the laboratory and Rhizobium strains isolated for inoculation and preserved to study on further nodulation and nitrogen fixation.
legumes; rhizobium; root nodulation; isolation; bangladesh

90-068029 Effect of soil acidity factors on nodulation, active iron content of nodules and relative efficiency of symbiotic N2-fixation by mutant strains of Lens esculenta Rhizobium. En. Rai, R.; Prasad, V. (Rajendra Agricultural University, Dholi Campus, Dholi, Muzaffarpur-843121, Bihar (India)). Journal-of-Agricultural-Science (UK). (1983). v. 100(3) p. 607-611. 8 ref.
lens culinaris; root nodulation; ph; nitrogen fixation.

90-068030 Selection of Rhizobium leguminosarum strains for lentil (Lens culinaris) under growth room and field conditions. En. Bremer, E.; Kessel, C. van; Nelson, L.; Rennie, R.J.; Rennie, D.A. (Saskatchewan Univ., Saskatoon (Canada). Dept. of Soil Science). Plant-and-Soil (Netherlands). (1990). v. 121(1) p. 47-56. 29 refs.; Summary (En).
lens culinaris; rhizobium; acetylene; crop yield; nitrogen fixation.

90-089915 Quantitative estimation of residual-N supply by grain legume to succeeding rice crop using A-Value technique. En. Patwary, S.U.; Huq, Q.; Badruddin. 14. Annual Bangladesh Science Conference. Dhaka (Bangladesh). 27-30 Jan 1986. Bangladesh Association for the Advancement of Science, Dhaka (Bangladesh). Proceedings of the 14th Annual Bangladesh Science Conference. Section 1. Dhaka (Bangladesh). BAAS. 1989. p. 35. Summary only.
The contribution of biologically fixed nitrogen from the preceding chickpea and lentil to the following rice crop was determined using an extension of "A-Value". Results showed that the crop following the legumes yielded significantly higher total nitrogen than that following the cereal (wheat). The N uptake in rice was increased by about 10 kg/ha following chickpea and lentil in relation to preceding wheat. Results from "A-value" also showed that the available soil-N pool was increased by about 32 to 40 kg/ha following chickpea and lentil compared to preceding wheat in units equivalent to the N fertilizer applied to rice crop. These results would suggest that the "A-value" method provides a good estimate of residual-N to the cereal from the preceding legume crops.
rice; cicer arietinum; wheats; lens culinaris; nitrogen; nitrogen fixation; residual effects.

90-103219 Response of lentil to inoculation with Rhizobium leguminosarum [in Bangladesh]. En. Hoque, M.S. 14. Annual Bangladesh Science Conference. Dhaka (Bangladesh). 27-30 Jan 1986. Bangladesh Association for the Advancement of Science, Dhaka (Bangladesh). Proceedings of the 11th Annual Bangladesh Science Conference. Section 1. Dhaka (Bangladesh). BAAS. 1989. p. 131. Summary only.
Two field experiments were carried out at Bangladesh Agricultural University farm during 1987-88 rabi season, one on the response of lentil (Lens culinaris Med) to Rhizobium inoculation and the other on the response of lentil to inoculation with different strains of R. leguminosarum. There was distinct favourable effects of inoculation on nodule number, nodule weight and grain yield of the crop. Application of NPK and PK fertilizers significantly increased the grain yield but the effect of their application in presence of R. inoculation was more

pronounced. The treatment NPK + inoculation produced the highest grain yield of 484 kg per ha (106% increase over control) while Rhizobium inoculation alone gave 400 kg of grain yield (70% increase over control). All the 7 strains of lentil rhizobia produced higher nodule number, nodule weight, pod number and grain yield of the crop compared to uninoculated control. The nif tal strain TAL 638 produced 368 kg per ha of grain yield (70% increase over control) which was significantly higher than the results recorded in 6 local isolates and the uninoculated control treatment. The results indicate that the use of a suitable Rhizobium inoculant can replace the use of costly urea fertilizer for getting higher yield of lentil.
lens culinaris; crop yield; inoculation; rhizobium; npk fertilizers; rabi season; bangladesh

90-103220 Effect of rhizobium inoculation and phosphorus on nodulation and yield of lentil (Lens culinaris medic). En. Ahmad, M. University of Agriculture, Faisalabad (Pakistan). Dept. of Agronomy. Faisalabad (Pakistan). UAF. 1989. 94 p. Thesis (M.Sc. (Hons.)). 24 tables, 101 ref., Summary (En), AVAILABILITY: Library, University of Agriculture, Faisalabad, Pakistan.
lens culinaris; rhizobium; inoculation; phosphate fertilizers; application rates; crop yield; yield components.

90-116023 [Lipopolysaccharides of Rhizobium leguminosarum strains cross-infecting broad beans, pea, vetch and lentil]. Ru (Russian). Lipopolisakharidy kluben' kovykh bakterij, perekrestno zarazhayushchikh kormovye boby, gorokh, viku i chechevitsu. Kosenko, L.V.; Kovalevskaya, T.M. Mikrobiologiya (USSR). (1989). v. 58(6) p. 927-933. Summary (En). 20 ref.
vicia faba; pisum sativum; vicia; lens culinaris; rhizobium; nitrogen fixation; symbiosis

90-140308 Plant growth-promoting rhizobacteria: effects on growth and nitrogen fixation of lentil (Lens esculenta Moench) and pea (Pisum sativum L.). En (English). Chanway, C.P.; Hynes, R.K.; Nelson, L.M. (National Res. Council Canada, Plant Biotech. Inst., Saskatoon, Sask. (Canada)). Soil-Biology-and-Biochemistry (UK). (1989). v. 21(4) p. 511-517. 20 ref.
pisum sativum; rhizobiaceae; nitrogen fixation; saskatchewan; lens culinaris; in vitro experimentation.

Soil Fertility

90-020568 Degradation and rehabilitation of agricultural land in North Syria. Ar (Arabic); En (English). tadahwuru/u al-' ara:d*i: al-zira:3iyyat/i fi: s"ama:l/i su:riyyat wa ' imka:niyyat/u mu al:laj"at iha:. Cocks, P.S.; Thomson, E.F.; Somel, K.; Abd El Moneim, A. ICARDA, Aleppo (Syria). Aleppo (Syria). International Center for Agricultural Research in the Dry Areas. 1988. 28 p. RN: ICARDA-119-Ar,En.
The farming systems of north Syria are described with emphasis on small farms in the north west. The farmers are mainly producers of cereal and livestock, the latter increasing in importance as rainfall decreases. Most cereals are grown in rotations although there is a tendency for continuous cropping in the drier areas. Other components of the rotations are fallow, lentils, summer crop (watermelon and sesame) and chickpeas. Livestock graze non-arable (marginal) lands, crop stubbles, and the dry steppe, and are fed a wide variety of energy and protein supplements including barley grain, barley straw and by-products of cotton. Cereal yields range between 100 kg/ha and 2 t/ha and are strongly dependent on rainfall. There is evidence of degradation in both arable and marginal lands. Original tree and shrub vegetation disappeared to be replaced mainly by annual plants. Productivity of marginal lands is related to number of plants and the presence or absence of annual legumes. Legumes in dry areas are rare and plant numbers are substantially below optimum. Soils on marginal land are substantially more fertile than arable soils, indicating very severe reduction of soil fertility in the latter. Continuous barley growing is detrimental to yield and this practice is becoming increasingly common. Rehabilitation of dry marginal lands is possible by planting edible shrubs, especially several species of Atriplex and the return of capital invested in edible shrubs may exceed 20%. In wetter areas use of phosphate on native pasture may also be economically viable. Productivity of arable land can be increased both by applying fertilizers to cereals and replacing fallows with legumes. The use of either forage (Vicia sativa) and pasture (Medicago spp) legumes will result in substantial economic benefits. Superphosphate on cereals, tested widely in Syria is a relatively simple way of increasing productivity and profitability.
triticum aestivum; triticum durum; sesamum indicum; lens culinaris; barley; sheep; medicago; vicia; farming systems; soil deterioration; soil fertility; reclamation; fertilizers; syria; semiarid zones; land use; marginal land; arable soils; plant production; vegetation; grazing; rangelands; phosphorus; nitrogen

90-089961 Influence of iron-enriched organic wastes on crop yield and iron nutrition of crops in calcareous soils. En. Prasad, B.; Prasad, J.; Prasad, R. (Rajendra Agricultural Univ., Pusa (India). Dept. of Soils). Indian-Journal-of-Agricultural-Sciences (India). (Jun 1989). v. 59(6) p. 359-364. 3 tables, 8 ref. Summary (En).
oryza sativa; lens culinaris; varieties; iron; agricultural wastes; calcareous soils; crop yield.

Meteorology and Climatology

90-079564 Meteorological reports for ICARDA experiment stations in Syria: 1986/87 season. En. Abdelnour, M. ICARDA, Aleppo (Syria). Aleppo (Syria). International Center for Agricultural Research in the Dry Areas. 1988. 150 p. Tables. AVAILABILITY: ICARDA, POB 5466, Aleppo - Syria RN: ICARDA-125-En.
Data collected on precipitation and temperature, monthly climatic data, weekly climatic data, and climatic data at five sites in Syria during the 1980-87 seasons are tabulated.
syria; lens culinaris; vicia faba; cicer arietinum; triticum aestivum; triticum durum; feed crops; meteorology; weather reports; meteorological observations.

PROCESSING OF AGRICULTURAL PRODUCTS

Food Science and Technology

90-068333 Food uses of whole oil and protein seeds. En. Lusas, Edmund W.; Erickson, David R.; Nip, Wai Kit. American Oil Chemists' Society (USA). Short Course on Food Uses of Whole Oil and Protein Seeds. Makaha, Hawaii (USA). 1986. Champaign, Ill. (USA). American Oil Chemists' Society. 1989. 401 p. ill. bibliographies. Proceedings of the Short Course on Food Uses of Whole Oil and Protein Seeds held at Makaha, Hawaii, May 11-14, 1986, sponsored by the American Oil Chemists' Society. AVAILABILITY: US (DNAL TP347.F66).
This collection of proceedings from a conference on food uses of whole oil and protein seeds discusses the role of whole plant seeds in the world's diet. Topics include: production, availability, and varieties of soybeans; uses of soybeans; uses of peanuts; food uses of coconuts, topical nuts, and palm fruits; food uses of cottonseed kernels, sunflower seeds, peas, lentils, and chickpeas; and nutrition progress in vegetable protein diet societies.

nut products; seeds; plant products; oil crops; soybeans

90-103483 Functional properties and applications of HPP prepared from tomato seeds, orange seeds, peaspod wastes and corn gluten [Egypt]. En. Gafar, H.; Shehata, A.E.; Mostafa, E.K.; El Iraki, S.M. (Alexandria Univ. (Egypt). Faculty of Agriculture). Journal-of-Agricultural-Sciences,-Mansoura-Univ. (Egypt). (1988). v. 13(4A) p. 1695-1705. Issued 1990. 9 tables; 15 ref. Summaries (Ar, En).
The functional properties of the hydrolyzed plant proteins (HPP) are influenced by the source of protein used, method and condition of preparation. The particular functionality required varied from one food product to another and no one protein hydrolyzate will possos all the desired functional properties. The increase in popularity of natural food may prompt more food manufactures to achieve the functional properties required using natural HPP. Four hydrolyzed plant proteins were prepared using tomato seeds, orange seeds, peaspod wastes and corn gluten. The function properties studied were, anti-oxidant activity-fat absorption capacity, emulsification capacity and foaming properties. The prepared HPPs were used as flavour improver in dehydrated lentil soup as well as canned green peas. The products obtained were sensory evaluated.
tomatoes; sweet oranges; seeds; zea mays; proteins

Food Processing and Preservation

90-079622 The effect of processing on essential amino acids of soybeans, broad beans and lentils [Egypt]. En. El Bana, N.; El Bohy, A.; Ali, S. (Helawa Univ., Cairo (Egypt). Faculty of Home Economics). Zagazig-Veterinary-Journal (Egypt). (Jun 1987). v. 15(2) p. 166-178. Issued 1990. 4 tables; 14 ref. Summary (En).
soybeans; vicia faba; lens culinaris; processing; amino acids; egypt; boiling

90-103606 World uses of domestically: produced dry field peas, lentils, and chickpeas. En. Auld, D.L.; Brady, D.R.; Field, L.A.; Blain, H.L. (University of Idaho, Moscow, ID). Lusas,-E.W.; Erickson,-D.R.; Wai-Kit-Nip (eds.). Food uses of whole oil and protein seeds. Champaign, Ill. (USA). American Oil Chemists' Society. 1989. p. 306-316. ill. ref. Presented at the Short Course on "Food Uses of Whole Oil and Protein Seeds," May 11-14, 1986, Makaha, Hawaii.
pisum sativum; lens culinaris; cicer arietinum; dried products; food production; nutritive value; uses

Food Composition

90-028323 Rice-Lentil blends: Chemical composition, nutritional value and functional properties [Egypt]. En. Moharram, Y.G. (Alexandria Univ. (Egypt). Faculty of Agriculture). Alexandria-Journal-of-Agricultural-Research (Egypt). (1987). v. 32(2) p. 225-232. Issued 1989. 2 tables; 12 refs. Summaries (Ar, En).
rice; lens culinaris; mixing; composition; nutritive value; Egypt

90-028340 Proximate composition and mineral and phytate contents of legumes grown in Sudan. En. El Tinay, A.H.; Mahgoub, S.O.; Mohamed, B.E.; Hamad, M.A. (Faculty of Agriculture, Shambat, Sudan). Journal-of-food-composition-and-analysis (USA). (Mar 1989). v. 2(1) p. 69-78. charts. 44 references.
Several cultivars of chickpea, white bean, lentil, broad bean, and soybean were analyzed for protein, fat, carbohydrate, minerals and phytate. The effects of soaking and cooking on mineral retention and phytate content were determined. The minerals studied were calcium, copper, iron, manganese, phosphorus, potassium, sodium and zinc.
kidney beans; sudan; lens culinaris; soybeans; analysis; minerals; phytic acid; cooking

90-028342 Protein quality of lentils, rice and their mixture (Koshary) as affected by cooking [Egypt]. En. Shekib, L.A.E.; Youssef, M.M.; Zouil, M.E.; Mohammed, M.S. (Alexandria Univ. (Egypt). Faculty of Agriculture). Alexandria-Journal-of-Agricultural-Research (Egypt). (1987). v. 32(1) p. 193-201. Issued 1989. 4 tables; 12 ref. Summaries (Ar, En).
lens culinaris; rice; proteins; quality; cooking; egypt; rats; weight; casein

90-058313 Iron foods + vitamin C a great combo. En. Alaska (USA). Division of Public Health. Section of Family Health--Nutrition Services. [Juneau, AK (USA)]. Alaska Dept. of Health and Social Services, Division of Public Health, Section of Family Health-Nutrition Services. [1984]. 1 sheet. AVAILABILITY: US (DNAL TX553.I75I72).
Recipes that combine foods that are high in iron with foods that are good sources of vitamin C to enhance iron absorption are introduced in this brochure from the Alaska Department of Health and Social Services. Recipe items include Alaska goulash, tabouli, lentil chili, fruit soup, garbanzo salad, and salmon-broccoli casserole. "Mini-recipes" suggested simple food combinations that provide both iron and vitamin C.
foods; vitamin content; ascorbic acid; iron; nutrient uptake.

90-104104 Fatty acids composition and unsaponifiable matter constituents [Egypt]. En. Hallabo, S.A.S.; El Sharkawy, A.A.; Ismael, A.I.; Raouf, M.S. (Cairo Univ. (Egypt). Faculty of Agriculture). Egyptian-Journal-of-Food-Science (Egypt). (1987). v. 15(2) p. 203-210. Issued 1990. 2 tables; 22 ref. Summaries (Ar, En).
Fatty acids composition and unsaponifiable matter constituents of bean, cowpea, lentils and lupin crude oils were studied. The results showed that oil content in bean, cowpea, lentils and lupin seeds was 2.11%, 3.45%, 2.72% and 7.72% respectively. Higher percentage of saturated fatty acids was present in lentils oil than in other samples. Palmitic acid was the major saturated fatty acid more in all samples. Oleic acid represents the major unsaturated fatty acid in lupin oil (54.33%) however, linoleic acid represents the major unsaturated fatty acid in bean, cowpea and lentils oils (36.75%, 50.82% and 39.93% respectively). Arachidonic acid was only present in lupin oil (3.83%). The unsaponifiable matter percentages in bean, cowpea, lentils and lupin seed oils were 8.32%, 7.84%, 7.6% and 3.30% respectively. The major hydrocarbon compound in cowpea seed oil was C30, while in lentils and lupin seed oils it was C22. B-sitosterol was the predominant compound in the investigated oils except for lupin seed oil where the predominant one was fucosterol.
legumes; composition; seeds; oils; egypt; fatty acids; lipid content.

90-116754 [Legumes]. De (German). Huelsenfruechte. Nichterlein, K. (Giessen Univ. (Germany, F.R.). Inst. fuer Pflanzenbau und Pflanzenzuechtung). Auswertungs- und Informationsdienst fuer Ernaehrung, Landwirtschaft und Forsten, Bonn (Germany, F.R.). Bonn (Germany, F.R.). AID. 1989. 15 p. 29 ill., 2 tab.; 12 ref. AVAILABILITY: Zentralbibliothek der Landbauwissenschaft, Bonn (Germany, F.R.).
grain legumes; nutritive value; pisum sativum; phaseolus vulgaris; lens culinaris; soybeans

90-141983 Chemical and enzymatic modification of the pasting properties of legume starches. En. Sosulski, F.; Waczkowski, W.; Hoover, R. (Univ. of Saskatchewan, Saskatoon (Canada). Department of Crop Science). Starch-Staerke (Germany, F.R.). (1989). v. 41(4) p. 135-140. 5 graphs, 2 tables; 16 ref. Summaries (De, En).
DEUTSCH: Gereinigte Leguminosenstaerken wurden bezueglich ihrer Brabender-viskoamylographischen Eigenschaften sowohl in ihrer nativen

Form als auch nach chemischer und enzymatischer Vorbehandlung wachrend einer 20stuendigen Inkubation bei Raumtemperatur bewertet. Trotz der charakteristischen begrenzten Kleisterviskositaetsparameter von Leguminosenstaerken zeigte native Linsenstaerke viel hoehere Viskositaetsparameter als Bohnenstaerke, waehrend die Felderbsenstaerke sehr niederige, stabile Viskositaeten zeigte. Vorbehandlungen mit Mineralsaeure, Alkali oder Enzymen veraenderten die Viskogramme der 8 %igen Suspensionen (w/v) nicht merklich. Die Entfernung der Oberflaechenlipide der gereinigten Staerkekoerner mit Propanol/Wasser (3:1 v/v) oder Chloroform/Methanol (2:1 v/v) erhoehte die PastenViskositaeten betraechtlich, ebenso wie die Komplexierung der Staerken mit Palmitinsaeure oder Glycerylmonopalmitat. Keine der Behandlungen fuehrte zur vollstaendigen Aufloesung der Staerkekoerner. [S-89-03183].
legumes; starch; rheological properties; viscosity; stickiness; lens culinaris; vicia faba; grain; composition; acids; enzymes; palmitic acid; alkali treatment.

90-142167 Evaluation of cooked macaroni. 1.- Physical properties [Egypt]. En (English). Hallabo, S.A.; Salem, S.A.; Makhlouf, S.K.; Ramy, A. (Cairo Univ. (Egypt). Faculty of Agriculture). Bulletin-of-Faculty-of-Agriculture,-Cairo-Univ. (Egypt). (1986). v. 37(1) p. 223-234. Issued 1990. 3 ill. 1 table; 17 ref. Summaries (Ar, En).
Macaroni samples supplemented with maize gluten, lentils, ungerminated lupin and chick peas and germinated lupins and chick peas were evaluated physically in comparison with those made from 100% semolina. Results showed that addition of lentils or maize gluten flours in all levels of supplementation improved cooking quality by increasing both weight and volume of cooked macaroni. Addition of lupins flour to semolina caused the highest total solids losses during cooking, while, macaroni supplemented with lentils flour reduced cooking losses. The incorporation of germinated lupins or chick peas flour to semolina flour improved the cooking quality of the produced macaroni more than addition of the ungerminated flour. The effect of chick peas flour was much more pronounced in this respect than that of lupins.
pasta; soft maize; chemicophysical properties; flours; egypt; cooking; quality; weight

90-142168 Evaluation of cooked macaroni. 2.- organoleptic properties. [Egypt]. En (English). Hallabo, S.A.; Mohamed, S.K.; El Magoli, S.B.; Salem, E.A. (Cairo Univ. (Egypt). Faculty of Agriculture). Bulletin-of-Faculty-of-Agriculture,-Cairo-Univ. (Egypt). (1986). v. 37(1) p. 235-244. Issued 1990. 4 tables; 8 ref. Summaries (Ar, En). See Also: 90-142167.
Macaroni samples supplemented with maize gluten, lentils, ungerminated lupins and chick peas and germinated lupins and chick peas were cooked, then organoleptically evaluated with regard to flavour, colour, appearance, tenderness, stickiness in comparison with cooked samples made from 100% semolina. Results showed that supplementation of semolina with germinated lupins flour produced a product with the highest flavour scores. Supplementation with maize gluten flour caused maximum improvement in colour of the cooked macaroni samples. However, the colour of the cooked macaroni prepared from semolina and lentils flour was rejected organoleptically when supplementation level was 16%.
pasta; organoleptic properties; yields; quality; weight; colour; egypt; lupinus.

Feed Composition

90-048145 Effect of cooking and amino acid supplementation on the nutritive value of lentils (Lens culinaris M.). En. Savage, G.P.; Scott, S.K. (Canterbury Univ. (New Zealand). Lincoln Coll., Dept. of Biochemistry). 1. International Workshop on ' Antinutritional Factors (ANF) in Legume Seeds'. Wageningen (Netherlands). 23-25 Nov 1988. Huisman,-J. (Instituut voor Veevoeding en Dierfysiologie ILOB-TNO, Wageningen (Netherlands)); Poel,-T.F.B.-van-der; Liener,-I.E. Recent advances of research in antinutritional factors in legume seeds: animal nutrition, feed technology, analytical methods. Wageningen (Netherlands). Pudoc. 1989. p. 243-248. 14 refs.; Summary (En).
lens culinaris; nutritive value; cooking; amino acids.

90-080400 Variation in lentil straw quality. En. Erskine, W.; Rihawi, S.; Capper, B.S. (International Centre for Agricultural Research in the Dry Areas, Aleppo (Syria)). Animal-Feed-Science-and-Technology (Netherlands). (1990). v. 28(1) p. 61-69. 10 refs.; Summary (En).
lens culinaris; nutritive value; straw; seasons; genetic variation.

Processing of Agricultural Wastes

90-028511 Dynamics of crop residue incorporation [lentil, India] for nutrient cycling. En. Seth, Jagdish; Balyan, J.S. 13. Annual Bangladesh Science Conference. Dhaka (Bangladesh). 29-31 May 1988. Bangladesh Association for the Advancement of Science, Dhaka (Bangladesh). Proceedings of the 13th Annual Bangladesh Science Conference. Dhaka (Bangladesh). BAAS. 1988. p. 134. Summary only.
Continuous cropping year after year is likely to exhaust soil for certain nutrients. Incorporation of crop residues in the soil may help to some extent in replenishing some of the nutrients. Information is very limited on the utilization of crop residues after harvest of crops for nutrient cycling. A field experiment was conducted to study the effect of incorporation of residues of lentil (Lens esculenta Moench), gram (Cicer arietinum Linn.) and pea (Pisum sativum Linn.) in soil during winter season on growth and yield of maize (Zea mays Linn.) grown in the subsequent rainy season at the experimental farm of Indian Agricultural Research Institute, New Delhi. The experimental results indicated that out of the three legume crops tried, incorporation of gram straw gave the maximum increase in grain yield of subsequent maize crop. Similarly, highest soil nitrogen was observed in plots where gram straw was turned into the soil.
lens culinaris; cicer arietinum; pisum sativum; crop residues; soil fertility; cycling; india

HUMAN NUTRITION

General Aspects

90-069288 [Food habits and trends in consumption of beans, faba beans, peas, lupines, lentils and cereals]. Es (Spanish). Habitos alimentarios y tendencias en el consumo de frejol, habas, arvejas, chochos, lentejas y cereales. Larrea Fiero, S. Quito (Ecuador). Jan 1989. 35 p. AVAILABILITY: FAO Accession No: XF9089953 (Available on Microfiche). RN: FAO-AG-PCT-ECU-6754.
grain legumes; cereals; food consumption; feeding habits; ecuador

Diet and Diet-Related Diseases

90-058827 Responses to legumes in NIDDM subjects: lower plasma glucose and higher insulin levels. En. Viswanathan, M.; Ramachandran, A.; Indira, P.; John, S.; Snehalatha, C.; Mohan, V.; Kymal, P.K. (M.V. Hospital for Diabetes, Madras, India). Nutrition-reports-international (USA). (Oct 1989). v. 40(4) p. 803-812. charts. 15 references.

The blood glucose and corresponding insulin responses to five different isocaloric--300 K. cals.--legume preparation 'adai' were assessed in nine NIDDM subjects and nine normal controls and the values were compared with that of 75 gm--300 K. cal of glucose. The preparation contained 40.3 to 41.2 gms of carbohydrate, 12.9 to 14.7 gms of proteins, 9 gms of fat and 8.8 to 9.3 gms of dietary fibre. The glycaemic responses of legumes in controls were 0.85 Bengal gram (BG), 0.83 black gram (BL.G), 0.84 green gram (G.G.), 0.79 red gram (R.G.) and 0.84 lentil (L) and the corresponding values in diabetics were 0.67 (B.G.), 0.66 (BL.G.), 0.73 (G.G.), 0.70 (R.G.) and 0.72 (L) respectively. Thus it was seen that the legumes produced low glycaemic responses in normal controls and lower values in diabetic patients. There was no statistical difference, however, between different legumes in the controls and diabetic subjects. In normal controls, the legumes produced lower plasma insulin responses compared to glucose. The delta I and delta I/delta G values for all the legumes were lower than that produced by glucose in control subjects. On the other hand in the NIDDMs the delta I values in response to legumes were comparable to that produced by glucose. The delta I/delta G ratios gave higher values when compared to that given by glucose. Thus the study indicates that the legume preparations are useful in the management of diabetes on account of the lower glycaemic and higher insulin responses produced. The factors responsible for these changes need to be evaluated in greater detail.

legumes; diet; experiments; diabetes; therapeutic diets; blood composition; insulin; men; women

Contributors' Style Guide

The LENS newsletter publishes the results of recent research on lentil, in English with Arabic abstracts. (Letters written in Arabic or French will be accepted for publication.) Articles should be brief, confined to a single subject and be of primary interest to researchers, extension workers, producers, administrators and policy makers in the field of lentil research. Articles submitted to LENS should not be published or submitted to other journals or newsletters.

The views expressed and the results presented in LENS are those of the author(s) and not the responsibility of ICARDA or the University of Saskatchewan. Similarly, the use of trade names does not constitute endorsement of or discrimination against any product by ICARDA.

Manuscript

Contributions should be sent to LENS/CODIS, ICARDA, P.O. Box 5466, Aleppo, Syria. The name, address, and telex or fax number of the corresponding author should be included in the covering letter. One good-quality original of the text should be submitted, typed double-spaced on one side of the paper only. Figures should be original drawings, good-quality computer prints, or black and white photographs of good quality. Photographs and figures should be suitable for reduction to a printed size of 8.5 or 17.4 cm wide. Photocopies are not acceptable for publication in LENS. Authors may submit color photographs to be considered for the cover.

All articles must have an abstract (maximum 250 words) and usually the following sections: Introduction, Materials and Methods, Results, Discussion, Conclusions and References. Articles will be edited to maintain uniform style, but substantial editing will be referred to author(s) for approval. Papers requiring extensive revision will be returned to the author(s) for correction. Authors can refer to a recent issue of LENS for format. The following guidelines should be followed:

Include the authority name at the first mention of scientific names.

Present measurements in metric units, e.g., t/ha, kg, g, m, km, ml. Where other units are used (e.g., quintal), the metric equivalent should be provided in parentheses.

Define in footnotes or legends any unusual abbreviations or symbols used in the text or figures.

Provide the full name of journals and book titles. Use the following formats for references.

Journal article: Vandenberg, A. and A.E. Slinkard. 1989. Inheritance of four new qualitative genes in lentil. *Journal of Heredity* 80(4):320-322.

Article in book: Erskine, W. and F.J. Muehlbauer. 1990. Effects of climatic variations on crop genetic resources and plant breeding aims in West Asia and North Africa. Pages 148-157 *in* Climatic Change and Plant Genetic Resources (M. Jackson, B.V. Ford-Lloyd and M.L. Parry, eds.). Belhaven Press, London, UK.

Article in proceedings: Montoya, J.L. 1988. The production of seed of leguminous crops in Spain. Pages 136-142 *in* Seed Production in and for Mediterranean Countries. Proceedings of the ICARDA/EC Workshop, 16-18 Dec 1988, Cairo, Egypt (A.J.G. van Gastel and J.D. Hopkins, eds.). ICARDA, Aleppo, Syria.

Book: Agarwal, V.K. and J.B. Sinclair. 1987. Principles of Seed Pathology. CRC Press, Boca Raton, Florida, USA.

Thesis: Tahir, Muhammad. 1990. Use of isozyme polymorphisms in lentil for gene mapping and detection of quantitative trait loci. Thesis. Washington State University, Washington, USA.

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