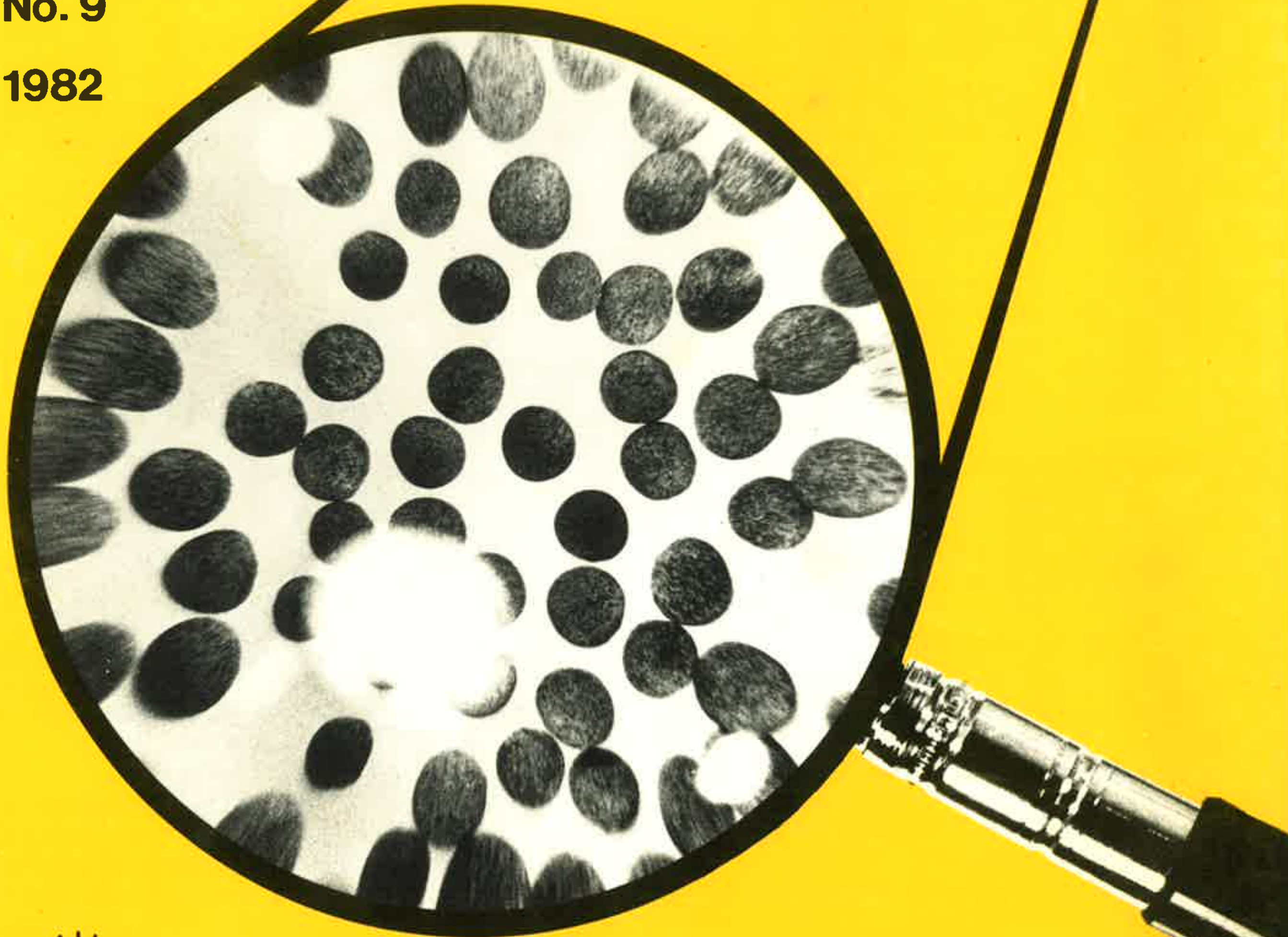
LENS

Lentil Experimental News Service

Newsletter
No. 9
1982



THE INTERNATIONAL CENTER FOR AGRICULTURAL RESEARCH IN THE DRY AREAS (ICARDA)

UNIVERSITY OF SASKATCHEWAN

Contents

LENS

Introduction

The **Lentil Research Association** was conceived by a small international group of lentil scientists for the purpose of improving communications among lentil researchers throughout the world. The Association publishes a newsletter to facilitate the exchange of research information. The first newsletter, The **Lentil Letter,** was published in 1974. At the suggestion of Dr. B. Sharma, the newsletter was subsequently renamed **LENS (Lentil Experimental News Service).**

LENS volumes 1-8 were produced at the **Crop Development Centre, University of Saskatchewan,** Saskatoon, Canada. From volume 9 onwards, **LENS** will be provided as a joint service by the **University of Saskatchewan** and by the **International Center for Agricultural Research in the Dry Areas (ICARDA).** This service has been the subject of grant from the **International Development Research Centre (IDRC)** in Ottawa, Canada to enable its expansion and production at **ICARDA.**

Subscriptions

Following the grant from the **International Development Research Centre (IDRC)** to the **LENS,** the newsletter is available free of charge to lentil researchers. However, subsequent issues of **LENS** will only be sent to those researchers who confirm their continued interest by completing the enclosed questionnaire form and sending it to:

LENS,
Documentation Unit,
ICARDA,
P.O.Box 5466,
Aleppo, SYRIA

Failure to complete and return the questionnaire may lead to the removal of names from the LENS mailing list.

Contributions to LENS Vol. 10

You are invited to make contributions to the **LENS** Newsletter. Please send your research contribution on any aspect of lentil research or production. Your contribution need not be longer than one or two paragraphs, but more comprehensive research or review articles are welcomed.

LENS will be published twice a year starting with the **LENS** Newsletter No. 10(1) onwards. Contributions for Newsletter No. 10(1) should reach **LENS** at the latest by March 31st 1983. Contributions for Newsletter No. 10(2) should reach **LENS** at the latest by September 30th 1983.

Late contributions will be held over until the following issue.

All contributions should be sent to:

LENS
Documentation Unit,
ICARDA,
P.O.Box 5466,
Aleppo,
SYRIA

Editing

Welcome to Dr. Willie Erskine, ICARDA lentil breeder, as he joins Dr. Al Slinkard and Dr. F.J. Muehlbauer on the **LENS** editorial panel.

What does LENS provide ?

Information on all aspects of lentil research work free of charge.

Access to a collection of documents, theses, journal articles and reports covering all kinds of research information on lentils.

Please write for more details and fill in the enclosed questionnaire if you are interested in participating in LENS.

REMINDER

To receive your free personal copy of **LENS** just complete in full the enclosed **QUESTIONNAIRE** and return it to:

LENS
Documentation Unit,
ICARDA
P.O. Box 5466
Aleppo
SYRIA

All contributions to the LENS Newsletter should be sent to the above address.

LENS Coordinating Committee Members

Members of the Coordinating Committee are responsible for soliciting research reports and membership in their respective areas of the world. The sooner research reports are submitted to LENS, the easier it is to edit and assemble the newsletter. Please send research reports to LENS as soon as possible.

Coordinating Committee Members:

CANADA
Dr. A.E. Slinkard
Chairman and Co-Editor,
Crop Development Centre,
University of Saskatchewan,
Saskatoon,
Saskatchewan S7N 0W0

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Agropecuaria - San Pedro,
Casilla de Corres 43,
San Pedro

Announcements

Special Request for Seed of *Lens* species

Several researchers would like to receive seed of the wild lentil species: *L. monbretii, L. nigricans, L. orientalis* and *L. ervoides.* If you have seed of any of these species, please send 10 seeds of each to:

Dr. A.E. Slinkard
Crop Development Centre,
University of Saskatchewan,
Saskatoon,
Saskatchewan S7N 0W0,
CANADA

Seed of *Lens* species available

Samples of 20 seeds (more by special request) of the following collections of *Lens* species are now available from Dr. A.E. Slinkard, at the above address.

A. Lens orientalis

1. No. 26 from Ladizinsky
2. No. 24 from Ladizinsky
3. No. 23 from Ladizinsky
4. No. 22 from Ladizinsky
5. No. 166 from Lehmann
15. NEWL No.1 from ICARDA (Cyprus)
17. NEWL No.3 from ICARDA (Antalya Province, Turkey)
18. NEWL No.4 from ICARDA (Gaziantep Province, Turkey)
19. NEWL No.6 from ICARDA (Elazig Province, Turkey)
20. NEWL No.7 from ICARDA (Turkey)
23. No.42 from Ladizinsky (Iran)

B. Lens ervoides

6. No. 28 from Ladizinsky
7. No. 30 from Ladizinsky
8. No. 32 from Ladizinsky
9. B45 from Lehmann (Jalta, USSR)
16. NEWL No.2 from ICARDA (Adana Province, Turkey)

C. Lens nigricans

27. Muehlbauer No. 3 (Fontaine de Vancluse, France)
28. Muehlbauer No. 4 (Rodes, France)

WANTED FOR LENS

If you have any news items, announcements of meetings or conferences, letters to the editors or suggestions, please send them to:

LENS
Documentation Unit,
ICARDA, P.O. Box 5466,
Aleppo, SYRIA

Genetic Nomenclature for Lentils

Since the genetics of lentils is still in the initial stages, it is appropriate that a standardised system of genetic nomenclature be followed. Vavilov's Law of Homologous Series suggests that there will be many genes with similar effects in genera as closely related as *Pisum* and *Lens*. Since the Pisum Genetics Association has published lists of genes and gene symbols (Volume 1, The Pisum Newsletter) and has developed a system for naming genes in peas (Volume 9, suppl., The Pisum Newsletter), it is suggested that these serve as the basis for naming genes in lentils. Likewise, it is proposed that all new gene symbols be cleared through the Lentil Research Association,

c/o Dr. A.E. Slinkard
Crop Development Centre,
University of Saskatchewan,
Saskatoon,
Saskatchewan, S7N 0W0,
CANADA

in order to prevent unnecessary and confusing duplication.

Formation of Lentil Gene Bank

As genetic information on lentils increases, the need for a central gene bank arises. Accordingly, the Crop Development Centre, University of Saskatchewan is initiating a Lentil Gene Bank to serve as a repository for lentil genes. Thus, as soon as a researcher describes a gene in the literature, determines its mode of inheritance and assigns a gene symbol, he is requested to send 20 seeds carrying the gene and 20 seeds carrying its contrasting allele to the Lentil Gene Bank. Each issue of LENS will carry a listing of the genes in the Lentil Gene Bank and all of these genotypes will be available to interested researchers within the limits of available seed.

Genes in the Lentil Gene Bank to date are:

1. *Sbv* (susceptibility) and *sbv* (resistance) to Pea borne Mosaic Virus (cited in Crop sci. 18: 613-615, 1978).
2. *Yc* (red) and *yc* (yellow) cotyledon color (cited in J. Heredity 69: 139-140, 1978).
3. *I-yc* (non-inhibitor) and *i-yc* (inhibitor) of cotyledon color genes such that inhibition gives green cotyledon color (cited in J, Heredity 69: 139-140, 1978).
4. *Fn* (2 flowers per inflorescence) and *fn* (3 flowers per inflorescence) (cited in LENS 7: 15-19, 1980).

As soon as you have described a gene in lentils, determined its mode of inheritance and assigned a gene symbol, please submit seed samples to:

Lentil Gene Bank
c/o Dr.A.E. Slinkard
Crop Development Centre,
University of Saskatchewan,
Saskatoon,
Saskatchewan, S7N 0W0,
CANADA

Request for Isogenic or Near-Isogenic Lines of Lentils

Isogenic or near-isogenic lines provide a powerful tool for genetic, breeding and physiological studies. They may be developed by (1) repeated backcrossing to the recurrent parent, concurrently selecting for the desired gene from the donor parent, (2) selecting for the heterozygote until nearly homozygous for other genes (F6 to F8) and then selfing to produce the two contrasting homozygotes, or (3) induced mutations in a mother line.

I am in the process of assembling a diverse array of near-isogenic lines of lentils. The genes that I am interested in are for monogenic qualitative traits. I will maintain, increase and list the lines in **LENS** and small quantities of seed of each line will be made available to interested researchers upon request.

An excellent source of isogenics is from genetic studies. Many geneticists have seed from heterozygous F2 or F3 plants or from segregating F3 plant rows. If these involve a monogenic qualitative trait, please send a small seed sample to me. Testcross progenies also provide an excellent source of heterozygous plants. I will then complete development of the isogenic lines.

Please send at least 20 seeds of both forms of each near-isogenic set of lines along with a notation as to the contrasting trait, its source, the generation and the method used in isolating the isogenic lines to:

Dr. A.E.Slinkard,
Crop Development Centre,
University of Saskatchewan,
Saskatoon,
Saskatchewan, S7N 0W0,
CANADA

WANTED FOR LENS

If you have any articles or short communications on lentil research or any news items, announcements of meetings or conferences, letters to the editors or suggestions, please send them to:

LENS
Documentation Unit,
ICARDA, P.O. Box 5466,
Aleppo, SYRIA

Lentil Abstracts

CAB (The Commonwealth Agricultural Bureaux) and ICARDA (The International Center for Agricultural Research in the Dry Areas), based at Aleppo in Syria, are cooperating to produce Lentil Abstracts.

This journal is an annual compilation of all abstracts concerning this crop. The first issue appeared in February, 1981, and the second issue in February, 1982. The estimated annual output of abstracts is 150.

Information and samples can be obtained from:
Central Sales
Commonwealth Agricultural Bureaux,
Farnham House, Farnham Royal,
Slough, SL2 3BN,
UK.

Bookshelf

Howard, R.J. (Compiler) 1981. **Diseases of Pulse Crops In Western Canada** Western Committee on Plant Disease Control, Agdex 632-1, 98 pages.

This handbook is directed at growers, contracting companies and others concerned with pulse diseases and their control. It describes the most prevalent diseases on the major pulses grown in Western Canada and particular emphasis is given to lentils and faba beans. It was prepared to promote the development and adoption of sound control measures for plant diseases of regional concern. It is written in descriptive language and illustrated with color photographs. An index, a reference list and chemical control recommendations for pulse crops in 1981 are also included.

Single copies of this publication can be obtained free from:
Print Media Branch
Alberta Agriculture
9718 - 107 Street
Edmonton, Alberta
Canada T5K 368

Hawtin, G. and Webb, C. (Eds) 1982. **Faba Bean Improvement.** (Proceedings of the International Faba Bean Conference, Cairo, March 1981). Martinus Nijhoff Publishers, P.O.Box 566, 2501 CN, The Hague, The Netherlands, 1982. 383 pp.

This book is based on papers of an international conference on faba beans held in Cairo, Egypt in 1981, sponsored by the ICARDA/IFAD Nile Valley Project in Cairo. Publication due in autumn, 1982.

The book focuses on genetic improvement, the development of cultural practices, control of pests, diseases and weeds, nitrogen fixation and the use of faba beans as a human food.

Webb, C. and Hawtin, G. (Eds) 1981, **Lentils.** Commonwealth Agricultural Bureaux, Slough SL2 3BN, England 216 pp. ISBN 0-85198-475-4, $ 25.00.

This book is the outcome of a seminar on lentils held in Aleppo, Syria in 1979. It is, however, not merely the proceedings of the seminar but an independent reference work which will be invaluable to research scientists, students and all others with an interest in the production and processing of lentils. Leading scientists from many countries of the world have contributed to make this first authoritative reference book on lentils in the English language. Subjects covered range from the origin, domestication and taxonomy of lentils, to the quality and processing of the seed, production yields and international trade.

Nile Valley Faba Bean Abstracts

Published for ICARDA by CAB.
The publication is a compilation of 568 abstracts of research papers and theses on research carried out on faba beans in Egypt and in the Sudan up to and including 1980.

POSSIBLE USES OF LENTILS TO PREHISTORIC MAN

As with the other pulses lentils have so far not been found in food residues from prehistoric Europe. A paste of cooked lentils was found in one of the Twelfth Dynasty tombs at Thebes (Brothwell and Brothwell, 1969).

In Roman times they were made into soups: prepared first by roasting the seeds, then pounding them with bran in a mortar (Andre, 1963). They were no doubt valued for their high protein content. Lentils were cooked with chestnuts or with mussels, or were added to barley broth together with peas and chickpeas (Brothwell and Brothwell, 1969).

From ' Palaeoethnobotany ' (1973), by Jane M. Renfrew, publ. by Methuen & Co. Ltd., UK.

Contributors' Style Guide

All contributors are requested to use the following guidelines in order to speed editing and to improve communications.

Language
The Newsletter will be published in English. ICARDA will endeavour to translate articles which have been submitted in Arabic.

Editing
All articles will be edited in order to preserve uniform style. If any contributions have to be shortened, the scientific content and meaning will not be changed. If substantial editing is required, ICARDA will send the author a draft for his approval before printing.

Manuscript
Articles are to be typed and double spaced. The original and 2 legible copies should be submitted. The contributor should include his name, title, program or department, institute and postal address.

The article should normally be confined to a single subject and should be of primary interest to lentil workers in research, extension, production and/or to administrators and policy makers.

Photographs, figures, tables etc.. should be either 8.5 cm wide (single column) or 17.7 cm wide (double column including space). Figures and diagrams should be drawn in India ink; if possible send original artwork.

Define in footnotes or legends any abbreviations or symbols used in a figure or table.

All measurement units are to be in the metric system. Avoid national units e.g. quintals. Report yields as kg or t/ha. State measurements, time, money and percentages in numbers e.g. 480 g/l, 6 hr, U.S. $ 75, 10% . With chemicals, place the name next to the unit of measure e.g. 50 kg P/ha and not 50 kg/ha P. Convert all national currencies to U.S. $.

All numbers should be written as figures (e.g. 6, 34) not words except at the beginning of a sentence.

Arrange your Reference List alphabetically (not numerically). Give the surname first e.g. Smith, A.B., Other, A.N. 1980 .... Abbreviate journal titles. Reference information must agree with that in the text. Citations in the text should use "It was found (Jones 1960) that..." and not " It was found (2) that..."- i.e. do not record references numerically in the text and the list. Provide only directly relevant references.

Examples of references:

Slinkard, A.E. 1981. Eston lentil. Can. J. Plant Sci. 61 : 733 - 734.

Solh, M. and Erskine, W. 1981. Genetic resources. In: Lentils, ed. by C. Webb and G. Hawtin. ICARDA/CAB, 111 - 130.

The editors reserve the right to shorten the text and to alter it should it not conform to the above rules.

Please Note:

While LENS articles are not referred as in other journals, we do reserve the right to refer individual articles back to an author in such cases where there are technical inconsistencies. This may mean that an article submitted to LENS does not appear in the next published edition of the Newsletter. This, however, should not result in a long delay in publication, as the Newsletter will appear twice a year.

The views expressed in LENS articles are those of the individual authors, and do not necessarily represent the views of ICARDA or the University of Saskatchewan. Likewise, the results presented in LENS articles are the responsibility of the author(s).

TOP TWENTY

Top twenty lentil producing countries with their annual area (A x 1000 ha) and production (P x 1000 metric tonnes)

Country	1966 - 70		1971 - 75		1976 - 80		1981	
	A	P	A	P	A	P	A	P
1. India	792.8	364.8	851.1	404.8	908.8	401.1	1000	440
2. Turkey	102.0	100.2	113.4	105.6	193.2	205.6	200	220
3. Syria	97.2	62.4	100.4	66.2	127.0	94.2	127	94
4. U.S.A.	26.2	31.6	33.2	41.2	56.4	65.8	69	86
5. Bangladesh	70.6	50.4	68.0	48.8	78.0	48.8	84	49
6. Pakistan	71.0	24.4	74.6	26.2	87.0	33.4	87	37
7. Iran	61.2	39.8	47.0	32.0	40.4	27.6	38	28
8. Ethiopia	171.6	104.4	157.6	80.8	61.6	36.8	59	27
9. Spain	51.6	36.4	65.6	46.8	72.2	52.0	73	23
10. France	10.0	12.6	8.4	11.0	10.8	14.6	12	22
11. Morocco	25.2	13.6	37.0	21.6	40.4	19.8	34	19
12. Chile	11.0	6.2	18.6	11.6	37.6	23.2	48	18
13. Argentina	20.4	12.0	11.0	8.6	28.6	25.2	22	13
14. Iraq	9.8	6.0	6.6	4.2	8.4	7.4	10	9
15. Mexico	6.8	4.4	8.0	6.4	10.2	8.8	10	8
16. U.S.S.R.	53.6	63.2	59.6	57.0	18.0	5.0	9	7
17. Jordan	21.8	14.6	22.0	16.8	14.4	6.0	9	6
18. Colombia	-	-	22.0	10.0	19.8	7.6	17	6
19. Egypt	24.0	34.0	27.6	51.2	15.4	18.8	6	5
20. Algeria	17.2	6.8	18.8	7.2	16.4	6.0	16	3

Source : FAO Production Yearbooks

Research Contributions:

General

LENTIL CROP RESIDUES MAKE A DIFFERENCE

Thomas NORDBLOM and Haitham HALIMEH
Farming Systems Program ,
ICARDA, P.O. Box 5466, Aleppo, SYRIA

In Syria, farmers take great care in the hand harvest, threshing and winnowing of lentil grain to avoid loss of the other plant parts. Highly valued as livestock feed, the residues of a lentil harvest may account for a substantial proportion of the crop's total value. The results of a small survey of Syrian lentil farmers in 1981 allow quantitative estimates of the economic contribution of residues to total crop value. These are analyzed here and implications are drawn for further research.

Following the 1981 lentil harvest, 22 farmers were asked about the yield and sale value of their grain and residues. Thus, the analysis here is based on farm-gate prices immediately after harvest. It should be mentioned that the price of lentil residues is lowest at harvest, and much higher (perhaps double) in late winter when other feed supplies are scarce. Three of the sampled lentil farmers said they had sold their crops for direct grazing (at 267, 350 and 400 Syrian pounds per hectare, respectively).

Of the 19 farmers who did harvest, two reported a combination of high grain yields and very high grain prices. These observations were rejected and the observations of the remaining 17 were used as the basis of the following analysis in which the ratio (R/G) of crop residue value to lentil grain sales value is used as an index of the importance of residue contributions to total crop value.

In Table 1, grain yields and grain and residue values are displayed for the 17 farmers who reported consistent grain prices (close to the average of S.L. 1.02/kg). These have been ranked in the Table from the lowest to the highest grain yields. Adjusted grain values, at S.L. 1.02/kg, are also listed in Table 1. Thus, a small source of bias is avoided in computing the farmer-by-farmer ratios of residue to grain values (R/G). While there was a positive correlation (r = 0.78) between grain yields and residue values, grain yields were negatively correlated (r = – 0.62) with the ratio of residue to grain values (R/G).

Table 1. *Lentil grain and residue values.*

Observation	Reported			Calculated	
	Grain yield (kg/ha) (Y)	Grain value (SL/ha) (V)	Residue value (SL/ha) (R)	Adjusted grain values (SL 1.02/kg) (G)	Ratio of residue to grain values (R/G)
1	173	173	200	176	1.136
2	260	312	267	265	1.008
3	270	324	480	275	1.745
4	270	176	408	275	1.484
5	450	428	222	459	0.484
6	550	523	538	561	0.959
7	675	810	700	689	1.016
8	713	695	453	727	0.623
9	720	684	500	734	0.681
10	733	689	514	748	0.687
11	768	922	350	783	0.447
12	778	778	444	794	0.559
13	800	760	600	816	0.735
14	833	833	400	850	0.471
15	990	1138	850	1010	0.842
16	1294	1294	600	1320	0.455
17	1650	1650	1021	1683	0.607
Mean	702	718	503	716	0.820
S.D.	380	394	213	387	0.370
C.V.%	54	55	42	54	45

The negative correlation of grain yields and the R/G ratios is apparent in both Table 1 and Figure 1. In Figure 1, both linear and logarithmic regression lines have been plotted with the 17 original data points.

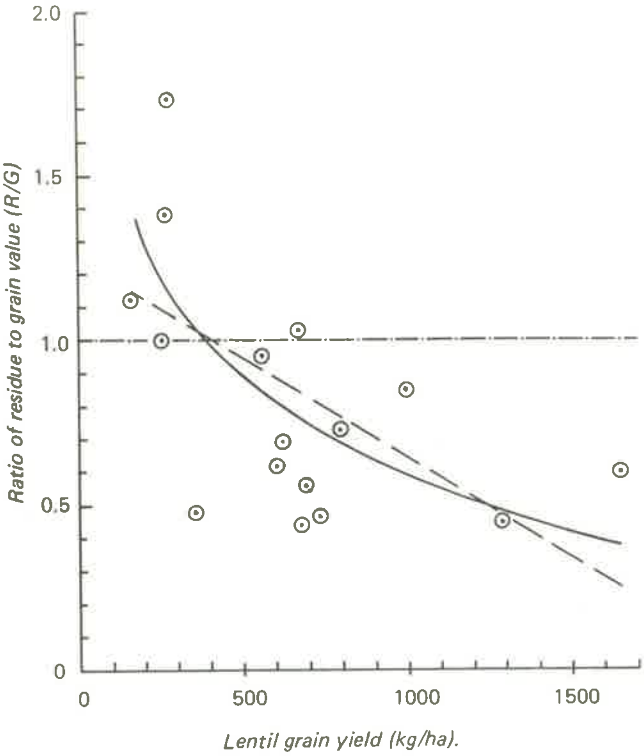

Figure 1: Ratios of lentil crop residue values to grain values, by grain yield levels.

The regression models and their estimated parameters are:

linear, R/G = a – bY, where a = 1.245, b = 0.000606; R^2 = 0.386, and

logarithmic, R/G = a – b ln Y, where a = 3.613, b = 0.4366, R^2 = 0.514, and where Y= grain yield (kg/ha).

For the mean grain yield level of 702 kg/ha, the linear and logarithmic models estimate R/G ratios of 0.82 and 0.75, respectively. Thus, on average for the sample, crop residues at harvest were worth nearly as much as the grain itself.

At the lowest grain yields, the relative contribution of residues was greatest. Conversely, the lower relative contributions of residues to the total crop value were associated with the higher grain yields.

The contribution of the residues to the total crop value per hectare may be expressed as a function of grain yield and price, according to either of the R/G regressions given above:

E (R) = E(R/G)PY where:

E (R) = The estimated total contribution of residues to overall crop value (SL/ha), E (R/G) = estimated ratio of residue to grain value, as a function of grain yield, P = Price per kg of grain (SL/kg), Y = Yield of lentil grain (kg/ha).

Plots of E (R), alone and added to grain sales, are shown in Figure 2. These were calculated with the logarithmic R/G model using a grain price of S.L. 1.02/kg. As shown in the curves of both Figures 1 and 2, residues contribute more than grain to the total crop value where grain yields are under about 400 kg/ha.

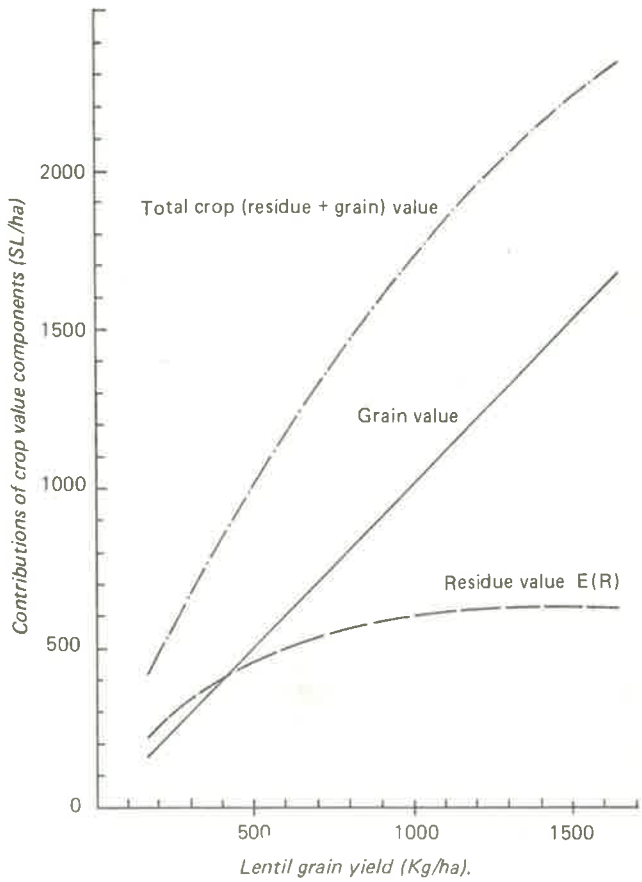

Figure 2: Lentil residue and grain values.

With the R/G models estimated, the total contribution of residues increases with grain yields to a maximum, beyond which the residue contribution decreases. Formulas were derived for estimating the grain yield levels at which residue contributions would be maximized. In the case of the linear R/G function, the grain yield for maximum residue contributions is calculated as:

$$Y = \frac{a}{2b} = \frac{1.245}{2(0.000606)} = 1027 \text{ kg/ha.}$$

In the case of the logarithmic R/G model, maximum residue contributions are implied at grain yields of :

$$Y = e^{\left(\frac{a}{b} - 1\right)} = e^{\left(\frac{3.613}{0.4366} - 1\right)} = 1444 \text{ kg/ha}$$

Visual inspection of the E(R) curve in Figure 2 also shows the maximum in residue contributions at grain yield levels between 1400 and 1500 kg/ha.

Of course, due to variations in weather, grain yield levels in a given year are more a matter of chance than of choice. Thus, calculation of the yield level for maximum residues results in a mathematical artifact, perhaps most useful in evaluating the appropriateness of the functional forms estimated.

The high relative contribution of residues to the total value of a lentil crop at low grain yield levels may provide an important buffering mechanism, limiting the chances of total crop losses. This could provide a partial explanation of why some very poor lentil crops are harvested. The grain yield alone, in many cases, would not cover the costs of crop establishment, weeding, harvest, threshing and winnowing. Thus, the value added by the residues may partly explain why farmers persist in growing lentils year after year in low yield areas. In higher rainfall areas, however, the beneficial effects of including lentils in rotations with wheat and summer crops may be as important as the direct grain and feed production aspects.

The grazing sale values for the crops of the three farmers in the sample who did not harvest must have exceeded the expected total grain and residue value of the crop minus all costs associated with harvest. In this way, and in light of the contribution of residues to total harvest value, high demand for livestock feed provides a force enhancing and stabilizing the income of lentil farmers.

That lentil crop residues make a difference in the total value of the crop has been shown in several perspectives. The residues may make a difference in another important way. Residue yields as well as grain yields may well influence farmers' adoption of new practices and cultivars.

In Italy .... on New Years Day it is traditional to eat lentils to bring wealth in the coming year; the more one eats, the more money he will have.

("The Benevolent Bean" by Margaret and Ancel Keys Forrar, Straus and Giroux, New York)

Breeding and Genetics

GENETIC VARIABILITY IN INDIAN MICROSPERMA TYPES OF LENTIL

J.S. SINDHU* and H.O. MISRA,
C.S.A. University of Agriculture and Technology, Kanpur, INDIA

The importance of genetic variability in any breeding programme is very well known as this works not only as a working bench on which selection operates but also provides valuable information regarding selection of diverse parents to be used in a hybridization programme. Considering that there was a possible dearth of variation in different *microsperma* types grown in India, the present study was undertaken to determine the extent of variability among different lines from the leading lentil breeding research stations in this country. Heritability and genetic advance of different morphological attributes was also computed to supplement this information which is vital for character improvement.

Materials and Methods

The material for this study comprised 30 *microsperma* lines collected from the main centres of the All India Co-ordinated Pulse Improvement Project. The experiment was grown in a randomized block design with three replications at Kanpur during winter 1976-77. The plot consisted of one row three m long spaced 30 cm from other rows, and individual plants were grown 10 cm apart. Observations were recorded on six morphological characteristics *viz.*, plant height (cm), 100 seed weight (g), days to flower, number of secondary branches, pods per plant and grain yield per plant (g).

The data recorded were subjected to the analysis of variance. Heritability in the broad sense was calculated according to Burton and De Vane (1953) and genetic advance was computed according to Johnson *et al.* (1955).

Results and Discussion

The mean, critical difference (C.D.), range, coefficient of variation, heritability and genetic advance (G.A.) for the characters studied are presented in Table 1. It is important to note that there exists sufficient range for most of these traits. However, values of phenotypic variance for all the characters are higher than the genotypic variance values which means that these traits may be easily influenced by the environment. This is further confirmed by their medium heritability values.

Table 1. *Mean, critical difference, range, coefficient of variation, heritability and genetic advance for six characters in microsperma lentils.*

Character	Mean	C.D.[1]	Range	Coefficient of Variation	Heritability (%)	G.A.[2]	G.A. in percentage of mean
Plant height (cm)	28.2 ± 2.4	4.8	17.9 – 33.7	11.0	70.6	4.5	19.2
100 seed weight (g)	2.28 ± 0.36	0.72	1.68 – 3.16	17.4	58.9	0.5	16.5
Days to flower	87.2 ± 6.8	13.6	60.4 –100.5	11.8	78.5	16.9	16.0
Secondary branches	16.3 ± 2.2	4.4	10.6 – 20.8	14.4	55.3	2.7	21.1
Pods per plant	138 ± 36	7.2	72 – 230	25.5	47.9	34.6	25.1
Grain yield of plant (g)	2.93 ± 1.27	2.53	0.99 – 6.32	41.4	45.5	1.1	38.9

[1] **C.D.** = critical difference range
[2] **G.A.** = genetic advance

Grain yield, which is the most important breeding objective in lentils, is affected by the environment but could be improved by visual selection as evidenced by the genetic advance in percentage of the mean. Though there is low heritability for this attribute genetic improvement is quite possible by directional selection. The range of variation for this trait also indicates that ample variation exists for yield and its contributing traits and based on this information diverse lines could be used for improving grain yield through a planned hybridization programme.

References:

Burton, G.W. and De Vane, F.W. (1953). ' Estimating heritability in tall fescue *(Festuca arundinacea)* from replicated clonal material'. Agron. J. 45: 472-481.

Johnson, H.W.; Robinson, H.F. and Comstock, R.E. (1955). ' Estimates of genetic and environmental variability in soybean'. Agron. J. 47: 314-318.

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NOT JUST A LOAD OF OLD LENTILS

Widely praised as one of the very best of vegetarian cookery books, Rose Elliot's 400 varied recipes will stimulate the converted to be more adventuresome, and provide bored meat eaters with a unique source of appetizing ideas.

From ' Not just a load of old Lentils', (1972) by Rose Elliot, publ. by Fontana/Collins, U.K. pp. 216.

CROSSING TECHNIQUES FOR LENTIL UNDER FIELD CONDITIONS

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Introduction

Hybridization is the indispensable basis of breeding programmes. However, crossing in some self-pollinated crops like lentil is difficult, because its flowers are cleistogamous, small and fragile. The success of artificial crossing also depends on the environment. It has been reported that a relative humidity above 50% , night/day temperatures of 15/25° C and a high light intensity are favourable conditions for the success of manual crossing in the greenhouse (Wilson, 1972; Muehlbauer *et al.,* 1980), but these conditions are rarely found in the field.

Although up to 43% of pollinated flowers gave pods in the field in India (Malhotra *et al.,* 1978), the success under field conditions is generally much lower. Protecting the pollinated flower by changing its microclimate has been shown to improve the success in crossing. In Northern Syria, 73% of pollinations produced hybrid seed using a perforated plastic bag to cover the female parent for three days after pollination, while the control produced only 24% (Solh, Paredes and Tiwari, 1980). Also in Northern Syria, a success of 59% was obtained using glassine bags to cover the inflorescence bearing the pollinated flowers for six days after pollination, while the control gave only 34.6 % (unpublished). This experiment was undertaken to investigate further the control of climate around pollinated flowers to improve the efficiency of cross-pollination in the field.

Materials and Methods

The crossing block was planted on January 1980 in the field at Tel Hadya, Northern Syria. Flowering began on April 15. Crosses were done between April 21 and March 12, 1981. Meteorological data during the period of crossing are given in Table 5.

In all flower buds selected, the tip of the petals reached 50-75% along the calyx tube. The lower calyx lobe nearest the base of the keel was removed and the keel slit open with fine forceps. The anthers were taken out without removing any petals. Pollination immediately followed emasculation. Pods from self-pollination were removed regularly from the plants.

A total of 14 treatment combinations were imposed after pollination and these are shown in Table 1. The comparisons tested were bagging material, time of removal of bag, and shading.

Bagging material

1. The plant bearing the pollinated flowers was covered by a plastic bag (45 x 25 cm) perforated with 15 square holes of approximately 2 x 2 cm in size. A wire stake of 50 cm was used as support for the plastic bags against wind.

2. The inflorescence bearing the pollinated flowers was covered with a small glassine/butter-paper bag (8 x 5.5 cm), which was slit prior to use (see Fig.1).

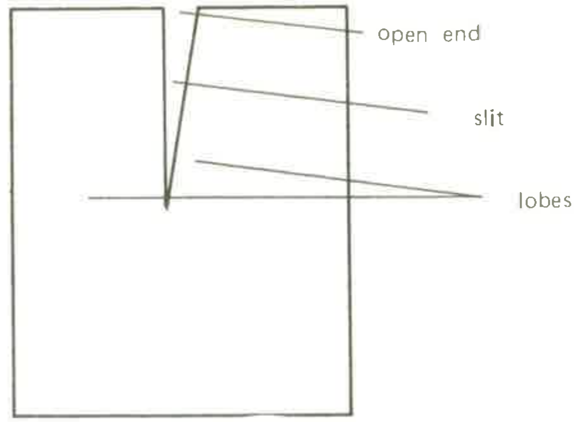

Figure 1: Unperforated glassine bag for covering the inflorescence and its subtending leaf.

The inflorescence and its subtending leaf were covered by the bag, the slit of which was put around the stem. The free lobes of the bag were crossed behind the stem and stapled together. The weight of the bag was borne by the stem.

3. Control: Pollinated flowers left uncovered.

Time of removal of bag

1. Complete removal of the bag 7 days after pollination.

2. The bag was cut open at the top 7 days after pollination.

3. Control-uncovered flowers.

Table 1. *Pods with hybrid seed/pollinations proportion, and percentage of success from crossing obtained in the early and late pollination periods.*

Treatments				Early period Total	Late period Total	% of successful pollinations		
Number	Bag material	Bagging treatment	Shading			Early period	Late period	Total period
T 1	Plastic	Removed	Unshaded	4/9	3/18	44.4	16.7	25.9
T 2	Plastic	Cut open	Unshaded	6/13	0/18	46.1	0.0	19.3
T 3	Plastic	Left	Unshaded	2/10	2/12	20.0	16.7	18.2
T 4	Glassine	Removed	Unshaded	3/9	1/18	33.3	5.5	14.8
T 5	Glassine	Cut open	Unshaded	5/8	1/18	62.5	5.5	23.1
T 6	Glassine	Left	Unshaded	6/7	2/20	85.7	10.0	29.6
T 7	Control	---	Unshaded	1/6	1/20	16.7	5.0	7.7
T 8	Plastic	Removed	Shaded	7/13	1/6	53.8	16.7	42.1
T 9	Plastic	Cut open	Shaded	3/10	8/16	30.0	50.0	42.3
T 10	Plastic	Left	Shaded	5/10	9/13	50.0	69.2	60.9
T 11	Glassine	Removed	Shaded	3/6	2/12	50.0	16.7	27.8
T 12	Glassine	Cut open	Shaded	6/9	3/18	66.7	16.7	33.3
T 13	Glassine	Left	Shaded	3/6	2/18	50.0	11.1	20.8
T 14	Control	---	Shaded	2/9	4/18	22.2	22.2	22.2

Shading

1. Presence of shade made with dark plastic net, which decreased the light intensity by 53 % . Under the shade the light intensity was 950 microeinstein/m^2/sec as measured with a LI-170 quantum radiometer/photometer.

2. Full sun. The light intensity without shade near plants at midday was 1,800 microeinstein/m^2/sec.

Crosses were done by two workers in 8 days of crossing, which covered a total period of 21 days. Workers made crosses in a different randomized order in each day, identifying them by coloured thread looped around the peduncle.

The cultivars Syrian local large (ILL 4400) and Syrian local small (ILL 4401) were used. The former has yellow cotyledons and was used as the female parent; and the latter has red cotyledons and was used as the male parent. Hence, the hybrid seed could be identified by its red cotyledon colour because this character is completely dominant to yellow cotyledon colour (Wilson *et al.*, 1970; Slinkard, 1978).

Results were analyzed after transforming the proportions (pods with hybrid seed/pollinations) to percentages and these, to angular values. Statistical methods used were the Fisher analysis of variance. The residual mean square used is the theoretical value 826.7 divided by the harmonic mean (K_o), where:

$$K_o = \frac{1}{1/n\ (\Sigma\ 1/n)}$$ (Snedecor and Cochran, 1967).

Results and Discussion

The results of the experiment are given in Table 1. To facilitate the analysis of data, and in view of its importance, the first four days of crossing have been considered as early period and the last four days as late period and therefore a new factor, the period of pollination, has been included in the analysis. The calendar date of these days is given in Table 5.

A total of 350 buds were pollinated. The overall percentage success, which was gauged as the percentage of pollinated flowers to produce pods with hybrid seed, was 27.1 % . The success in pod set of the treatments ranged between 60.9 % with plastic bags left on shaded plants until harvest to 7.7 % with the unshaded control. Nevertheless, when treatments were divided into early and late periods of pollination, the best results (85.7 % success) were obtained with glassine bags left on inflorescences until harvest on unshaded plants.

The analysis of variance is shown in Table 2. There was an effect of shading on hybridization. Under shade the percentage of success was 35.4 % and significantly greater than that obtained without shade (19.9 %).

Table 2. *Analysis of variance of transformed data (arcsin) for success from crossing.*

Source of variation	Degrees of freedom	Mean square
Shading (S)	1	534.2 **
Pollination period (P)	1	2431.0 **
S X P	1	406.6 *
Bag material (M)	1	0.40
Bagging treatment (T)	2	78.1
M X T	2	58.0
Control vs. rest	1	415.8 *
S X M	1	264.7
S X T	2	19.1
S X M X T	2	239.3
S X Control vs. rest	1	0.9
P X M	1	637.6 **
P X T	2	36.6
P X M X T	2	210.9
P X Control vs. rest	1	198.3
S X P X M	1	38.8
S X P X T	2	144.4
S X P X M X T	2	125.6
S X P X Control vs. rest	1	
Residual		77.02

* $P < 0.05 > 0.01$.
** $P < 0.01$

There was a highly significant difference between early and late pollination periods. Early buds gave 44.8 % of pods with hybrid seed in contrast to late pollinations which produced a success of only 17.3 % . There was a significant interaction between shading and pollination period. It is clear that the difference between shaded and unshaded treatments only exists during the late period of flowering (Table 3). Related to this, it was observed that plants under shade came to maturity later than unshaded plants. This suggests that shaded plants, which were more vigorous during the late period , would indirectly be able to give higher pod set from their cross pollinated flowers.

Table 3. *Shading vs. pollination period.*

	Early period		Late period	
Unshaded treatments	Success	43.5%	Success	8.1%
Shaded treatments	Success	46.0%	Success	28.7%

By protecting the crosses with either glassine or plastic bags it was possible to obtain a larger proportion of successful pollinations (29.3 %) than when bags were not used (control) (15.1 %).

There was a significant interaction between polination period and bag material. When pollinations were done in the early period, similar proportions were obtained using plastic or glassine bags, but when pollinations were done in the late period, a significantly higher success rate was obtained using plastic bags.

Summary

A study was made of methods of crossing lentils under field conditions in Syria. The period of pollination (or development stage of plants) was the most important factor affecting the success of artificial crosses. The pollination of early flowers gave 44.8 % success against 17.3 % obtained with late pollinations, though the difference between them was only 6 days.

When cross-pollinations were done in the late period, a plastic net shade which decreased the light intensity by 53% increased the success from 8.1% to 28.7% . In general, pollinations under shade were more successful (35.4%) than unshaded ones (19.9%).

Table 4. *Success from crossing with different pollination period and bagging materials.*

	Plastic	Glassine
Early period	Success 41.5%	Success 57.7%
Late period	Success 27.7%	Success 10.6%

Table 5. *Meteorological data during the lentil crossing period at Tel Hadya site, N. Syria in 1981.*

Date		Air temp (^oC) Max	Min	Rel. humidity (%) Max	Min	Evap. class (mm)	Wind speed (km/hr)	Incoming solar radiation (mJm^2)	Sunshine radiation (hr)
April	22 *	25.5	13.3	75	43	3.1	7.3	9.3	0.3
	23 *	30.5	11.7	84	27	7.1	5.8	22.0	11.1
	24	33.0	15.0	77	26	10.6	10.8	23.2	10.0
	25	30.1	10.9	88	31	10.1	14.6	23.3	11.3
	26 *	28.2	8.8	89	24	11.7	18.3	24.1	11.3
	27	28.0	11.3	81	28	10.3	18.7	21.3	8.2
	28	25.2	12.3	89	33	10.0	19.2	24.2	11.3
	29 *	24.3	8.8	92	29	11.0	17.9	25.0	11.3
	30	20.1	8.0	94	27	10.0	17.7	24.5	11.4
May	1	21.2	3.7	80	17	9.3	14.2	25.4	12.0
	2	22.9	2.9	89	19	6.5	6.9	22.8	12.1
	3	20.0	11.4	82	53	3.0	5.6	12.5	3.3
	4	23.2	12.8	89	48	5.2	7.9	17.3	5.3
	5	21.8	14.6	92	41	6.2	12.1	15.0	4.0
	6 *	26.9	7.0	91	25	7.5	11.5	23.7	11.4
	7 *	22.7	11.1	79	29	7.0	8.7	21.1	8.2
	8	22.5	12.7	94	28	7.4	12.9	20.8	9.5
	9	22.6	8.5	90	35	9.0	21.5	23.2	11.1
	10 *	25.0	6.5	88	33	7.8	10.4	23.6	12.0
	11	25.9	6.6	85	23	7.4	9.0	23.9	11.3
	12 *	27.0	8.5	87	28	7.6	8.5	19.5	7.0
	13	32.2	9.6	67	19	9.5	13.5	21.2	11.0
	14	25.2	10.9	84	23	10.4	17.1	23.6	8.3
	15	22.8	8.3	84	26	1.4	16.7	17.3	7.0
	16	20.9	9.9	85	20	8.7	14.2	20.1	9.5
	17	25.0	4.2	85	17	8.9	7.9	25.9	12.0
	18	29.0	10.8	50	22	9.7	11.2	20.7	9.5
	19	30.3	12.5	58	23	11.3	10.2	24.9	12.0

* Days of crossing.

Also in the late pollination period a better percentage of success (27.7 %) was obtained with perforated plastic bags covering all the plant than with small glassine bags covering the inflorescence (10.6 %) (Table 4). However, no such difference was observed in the early pollination period. The use of bags increased success in crossing above the level of the corresponding unbagged control.

Acknowledgements

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Hawtin, G.C. (1978). ' Introduction to breeding food legumes' . Tech. Man. No.2. ICARDA, Aleppo, Syria. pp. 64-72.

Malhotra, R.S.; Balyan, H.S. and Gupta, P.K. (1978). ' Crossing technique in lentil '. LENS 5: 7-8.

Muehlbauer, F.J.; Slinkard, A.E. and Wilson, V.E. (1980). ' Lentil ' . *In:* Fehr, W.R. and Hadley, H.H. eds. Hybridization of Crop Plants. ASA and Crop Sci., Madison, Wis., U.S.A.; 417- 426.

Slinkard, A.E. (1978). ' Inheritance of cotyledon color in lentils' . J. Heredity 69: 139-140.

Snedecor, G.W. and Cochran, W.G. (1967). ' Statistical methods ' . 6th. ed. Iowa State University Press, U.S.A.

Solh, M.B. ; Paredes, O.M. and Tiwari, A.S. (1980). 'Crossing technique in lentil under field conditions' . LENS 7: 9-14.

Wilson, V.E.; Law, A.G. and Warner, R.L. (1970). 'Inheritance of cotyledon color in *Lens culinaris* Medic '. Crop Sci. 10: 205 - 207.

Wilson, V.E. (1972). ' Morphology and technique for crossing *Lens esculenta* Moench'. Crop Sci. 12: 231-232.

IN THE KORAN

'Moses,... we are weary of this monotonous diet. Call on your Lord to give us some of the varied produce of the earth, green herbs and cucumbers, corn and lentils and onions'.

From 'The Koran' translated by N.J. Dawood (1956) Penguin Books Ltd., England. page 338).

INDUCED AUTOTETRAPLOIDS IN LENTILS

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Induced tetraploids are commonly used for the production of trisomics through triploids, and are rarely used for commercial production. However, no report on the induction of tetraploids in lentils is available. The present paper deals with cytomorphological studies of artificially produced C_1 generation autotetraploids in lentils.

Colchicine treatment was given to both seeds and seedlings. The seeds were soaked in water for about 8 hours and after removal of surface water, were placed into colchicine solutions of different concentrations (0.05% , 0.1 % and 0.25 %) for different durations (2 hr and 4 hr). After treatment, seeds were washed in running water and sown in the field. The seedling treatment was given both in the laboratory and in the field. In the laboratory, the seeds were germinated in petri dishes on moist filter paper and seedlings were inverted using wire gauge, so that only shoot tips were immersed in colchicine solutions of different concentrations (0.1% , 0.25% and 0.5%) for 5 hours and 10 hours three times with 12 hr intervals. After treatment, the seedlings were washed with water and planted in the field.

In the field, colchicine solution (0.1% , 0.25% and 0.5 %) was applied using cotton plugs, placed on the apical buds for different durations (5 hr, 10 hr). Cotton plugs were kept wet by regular application of the colchicine solution with the help of a dropper.

Preliminary screening of tetraploids was done on the basis of morphological characters like thickness and size of leaflet and size and frequency of stomata. Young buds from suspected tetraploids were fixed in carnoy' s fluid (6:3:1), to which a little ferric chloride was added to facilitate staining. Anthers were squashed in 2% acetocarmine for meiotic analysis.

Seed treatment was completely unsuccessful, but the seedling treatment (particularly 0.5% , 10 hr) using the cotton plug in the field or laboratory was successful.

Morphological data were recorded on diploids and tetraploids and are presented in Table 1. In tetraploids, there was an increase in stomatal size, pollen size, leaflet size, flower size, pod size and ten-pod weight, and there was a decrease in stomatal frequency.

Diploids exhibited seven bivalents (2n = 14) at metaphase I. Due to stickiness in chromosomes, only two tetraploid plants could be studied in detail at metaphase I, anaphase I and tetrad stage. The chromosome associations and other meiotic abnormalities in tetraploids are presented in Table 2.

Table 1. *Different morphological characters (mean values) in diploid and autotetraploid lentils.*

	Character			Diploid (2 x)	Tetraploid (4 x)
1.	Stomatal frequency/mm^2			4.58	4.22
2.	Stomatal size (μ)	(i)	length	35.77	41.28
		(ii)	width	24.08	26.83
3.	Pollen size (μ)	(i)	P	38.52	43.34
		(ii)	E	32.33	38.52
4.	Leaflet size (cm)	(i)	length	1.07	1.17
		(ii)	width	0.43	0.57
5.	Pod size (cm)	(i)	length	1.00	1.30
		(ii)	width	0.53	0.69
6.	Ten-pod weight (g)			2.30	2.53

Table 2. *Chromosome association at M_I in diploid and autotetraploid lentils.*

Ploidy level	Plant no.	Chromosome associations				Micronuclei/ tetrad
		IV	III	II	I	
2 x (2 n = 14)	–	–	–	7	–	–
4 x (2 n = 28)	1	0–2 (0.39)	0–1 (0.22)	10–14 (12.66)	0–2 (0.44)	3–7 (4.9)
	2	0–2 (0.60)	0–2 (0.20)	8–14 (11.66)	0–4 (1.46)	3–7 (5.4)

Note: Figures in parentheses are mean values.

Earlier Solh and Alahaydoian (1980) treated root tips with 0.1% colchicine solution for 24 hr and observed that there was chromosome doubling in mitotic cells. In the present study, treatment with 0.5% colchicine solution for 10 hr was effective for the production of colchiploids in lentils.

Increased size of stomata, pollen, leaflet, pods, and in ten-pod weight was an expected effect. Stomatal frequency decreased due to increase in size of stomata. Of these traits, long pods and bold seeds of tetraploid were economically important, and can be used for breeding programmes.

As can be seen in Table 2, bivalents ranged from 10 to 14 in tetraploids. An apparent correlation between mean values of micronuclei and univalents suggests that the univalents form laggards at anaphase I, leading to the formation of micronuclei at the tetrad stage.

Reference:

Solh, M. and Alahaydoian, K. (1980). ' Procedure for doubling chromosome number in root tips of lentils'. LENS 7: 14-15.

PHENOTYPIC STABILITY FOR YIELD IN LENTILS

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Environmental conditions differ from state to state and even within a state emphasizing the need for a lentil cultivar which will perform consistently well, irrespective of changes in environmental conditions. Therefore, the present study was undertaken on phenotypic stability of improved cultivars.

Materials and Methods

In the present study 30 lentil cultivars were seeded in a simple randomized block design with two replications at Bahraich on four different dates with an interval of 15 days, commencing from Oct. 15 up to Dec. 1, 1980. On each planting date two environments were also created; one without any fertilizer and the other with 10 kg N and 40 kg P_2O_5 per ha. Thus, eight different environments were created to provide the basis for estimating the stability parameters. The plot size was a single row 3 m long with inter-row spacing of 50 cm and a plant to plant spacing of 10 cm. The yield per plant of a cultivar over replications was used for statistical analysis. Phenotypic stability values were calculated by the method suggested by Eberhart and Russell (1966).

Results and Discussion

Planting on Oct. 31 gave the highest yield per plant (3.28 g), closely followed by planting on Oct. 15 (3.07 g) and on Nov. 15 (2.59 g). The differences among these dates of planting were not significant. Therefore, planting of lentils from the middle of October to the middle of November was better than December sowing under similar conditions. However, the optimum sowing time should invariably be kept around Oct. 31. The present finding confirms the previous finding of Pandey *et al.* (1981).

Fertilizer application significantly increased yield. The poorest response to fertilization occurred with the December seeding, possibly due to inefficient nutrient absorption caused by rapid maturation of the late seeded crop.

Stability of yield of any cultivar is the true evaluation of its inherent performance. However, performance of a cultivar under favourable environments does not indicate its stability of performance or adaptation. Therefore, stability parameters were determined to estimate the true nature of varietal performance.

Differences among genotypes and among environments were highly significant (Table 1). The genotype x environment interaction, heterogeneity among regressions and the remainder were highly significant when tested against pooled error. The partitioning of genotype x environment interaction into linear and non-linear components showed that both were significant. The higher magnitude of the linear component, relative to the non-linear component, suggested the possibility of prediction across environments. Thus, the present study indicated that both linear and non-linear functions are important in the genotype x environment interaction. Similar results were also observed by Jinks and Stevens (1959), Bucio-Alanis (1966), Perkins and Jinks (1968) and Malhotra (1971) in other crops.

Table 1. *Pooled analysis of variance for yield in lentils.*

Source of variation	df	Mean square
Genotypes (G)	29	0.85 **
Environments (E)	7	1.99 **
G x E	203	1.10 **
E + (G x E)	210	0.94 **
E (L)	1	1.08 **
G x E (L)	29	1.17 **
Pooled deviation	180	0.32 **
Pooled error	223	0.24

** Significant at the 1 % level.

Three parameters of stability, viz., a high mean value ($\overline{x}$), the regression coefficient (b) and the deviation mean square (S^2d_i), should be considered in identifying a stable genotype, according to Eberhart and Russell (1966). The highest yield per plant was recorded in Mirzapur Local (3.86 g) (Table 2) . The present study also confirms a previous study regarding the superior performance of the same genotype (Pandey *et al.,* 1981). However, further studies disclosed that Mirzapur Local performed well only under favourable environments and was not suitable for general cultivation as reflected by the above average regression (b =1.46) and significant deviations from linearity. The other high yielding genotypes, viz., P–767, P–629 and P–620, were also sensitive to environmental changes as indicated by above average stability values ($b > 1$). However, these genotypes had non-significant low deviation values (Table 2). Thus, these three strains might be considered to be adapted to favourable environments with little deviation from a linear response to improved environments.

Only three genotypes, viz., T–8, P–587 and P–114, had above average yield, unity regression and non-significant deviation values. Based on these three stability parameters, these three genotypes could be considered stable genotypes, being the least affected by changes in the environment.

Table 2. *Stability parameters for yield per plant (g) of different lentil genotypes.*

Genotypes	Stability parameters		
	$\bar{x}$	b_i	S^2d_i
Mirzapur Local	3.86	1.46 *	2.90 *
P–767	3.23	1.27 *	0.77
P–620	3.06	1.57 **	1.20
P–629	3.02	1.27 *	0.59
P–88	2.98	1.51 **	4.03 *
T–36	2.96	1.83 **	1.93
T–8	2.95	1.04 *	0.88
P–587	2.91	1.08 *	1.92
P–535	2.90	1.18 *	1.77
P–178	2.89	0.80	1.93
Bahraich Local	2.87	1.18 *	2.92 *
Gonda Local	2.81	1.64 **	3.03 **
P–867	2.81	1.10 *	0.76
P–509	2.78	0.60	1.54
P–114	2.76	1.00 *	0.69
P–144	2.70	0.94	0.52
NP–116	2.59	1.49 **	1.22
P–869	2.58	1.11 *	2.36 *
H–58	2.58	1.35 **	3.61 **
H–60	2.56	0.96	5.73 **
P–857	2.51	0.75	2.68 *
P–91	2.43	1.38 *	3.75 **
NP–61	2.42	1.23 *	1.35
P–760	2.42	1.00 *	0.90
P–535	2.40	0.62	2.61 *
P–101	2.32	0.51	0.53
NP–52	2.27	1.08 *	2.26 *
P–112	2.24	0.41	1.22
P–787	2.20	0.50	2.01
P–143	2.11	0.61	0.84

* ** Significantly different from zero at 5 % and 1 % level, respectively.

Summary

An experiment with 30 genotypes of lentils was planted in 1981 on four dates with and without fertilization, creating eight different environments. Phenotypic stability was calculated. The study indicated that Mirzapur Local gave highest yields under favourable environments. However, three genotypes, T–8, P–587 and P–114, could be considered as stable genotypes, having the least sensitivity to changes in the environment.

References:

Bucio-Alanis, L. (1966). ' Environments and genotype-environment components of variability. I. Inbred lines ' . Heredity (London) 21: 387-397.

Eberhart, S.A. and Russell, W.A. (1966). ' Stability parameters for comparing varieties ' . Crop Sci. 6: 36-40.

Jinks, J.L. and Stevens, J.M. (1959). ' The components of variation among family means in diallel crosses ' Genetica 44: 297-308.

Malhotra, R.S.; Singh, K.B.; Bhullar, G.S. and Sethi, S.C. (1971). ' Phenotypic stability in lentil ' . Indian J. Genet. 31: 21-25.

Pandey, B.P.; Srivastava, S.K. and Lal, R.S. (1981). ' Genotype x environment interaction for yield in lentils ' LENS 8: 14-17.

Perkins, J.M. and Jinks, J.L. (1968). ' Environmental and genotype-environment components of variability. IV. Non-linear interactions for multiple inbred lines'. Heredity (Lond.) 23: 525-535.

CORRELATION AND PATH ANALYSIS IN LENTILS

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Abstract

Correlation and path analysis were carried out in 30 genotypes of lentils for seven characters. Grain yield was significantly correlated with pod number, secondary branches and plant height. Path analysis revealed that secondary branches had the highest direct and indirect effect on grain yield followed by days to maturity. Pods per plant had a large direct effect on grain yield, but indirect influences through this trait were low. The direct and indirect effects of 100-grain weight on yield were very high and negative except in pods/plant. Plant height and days to flowering had low and negative direct as well as indirect effects.

Introduction

The inadequate knowledge of inter-relationships among various traits and the practice of unilateral selection for agronomic traits frequently results in retrograde or less than optimum progress in plant breeding (Bhatt 1973). Therefore, knowledge of character associations is very useful in planning a selection program. Path analysis reveals the direct and indirect effects of various yield components on yield and brings out the relative importance of different characters as selection criteria.

Materials and Methods

Thirty genotypes of lentils with diverse geographical background, were grown in a completely randomized block design with three replications during Rabi 1977-78 at the experimental farms of the Institute, situated at 1300 metres above sea level in the hills of U.P.. Each plot consisted of three rows 2.75 metre long, spaced 25 cm apart. Seeds were drilled in rows and seedlings were thinned to maintain interplant distance at 5 cm. Five competitive plants were chosen from the central row of each plot for recording the observations. Data were recorded on days to 75 per cent flowering, days to maturity, plant height, number of secondary branches, number of pods per plant, 100-seed weight and grain yield per plant. Genotypic and phenotypic correlations were calculated for all possible pairs of characters using standard formulae and path analysis was done following the procedure of Dewey and Lu (1959).

Results and Discussion

Analysis of variance revealed that the genotypes differed significantly with respect to all the characters studied (Table 1). Estimates of genotypic and phenotypic correlations among the characters and their association with yield are presented in Table 2.

In general, there was a close agreement between genotypic and phenotypic correlations, but the former was higher for all comparisons, except for height and secondary branches per plant. All references in the text hereafter refer only to genotypic correlations.

Yield per plant was positively and significantly correlated with number of pods per plant, height and number of secondary branches. There was a strong positive association between 100-grain weight and secondary branches. Number of secondary branches was significantly correlated with days to flower, days to mature and height. Days to flower, days to mature and height were positively and significantly correlated among themselves.

The results of partitioning of correlations by the path coefficient technique with grain yield as the resultant variable and days to flower, days to maturity, plant height, secondary branches, pods per plant and 100-seed weight as causal variables are presented diagrammatically in Fig. 1. Estimates of the direct and indirect effects of path coefficients are presented in Table 3.

Yield vs. days to flower

The direct effect of days to flower on grain yield was – 0.1475. The indirect effects via days to maturity and

Table 1. *Analysis of variance for seven characters in lentils.*

Source of variation	df	Mean squares for: Days to flower	Days to mature	Plant height	Secondary branches	Pods/ plant	100 seed weight	Grain yield
Replications	2	0.4500	4.0500	39.2510	14.5325	215.9555	0.2324	0.0617
Cultivars	29	124.9483 **	43.3655 **	31.0038 **	15.0219 **	361.5003 **	1.5224 **	0.3811 **
Error	58	10.8121	2.3328	7.0864	4.1055	122.2295	0.1275	0.0501

** Significant at the 0.01 level

Table 2. *Genotypic and phenotypic (in parentheses) correlation coefficients among different pairs of characters in lentils.*

Character	Days to mature	Plant height	Secondary branches	Pods per plant	100-seed weight	Yield per plant
Days to flower	0.7247 (0.5574) **	0.8143 (0.5331) **	0.7976 (0.4850) **	– 0.1089 (– 0.0744)	0.9110 (0.7328) **	– 0.0174 (– 0.0143)
Days to mature		0.7721 (0.4543) **	0.5184 (0.3460)	– 0.1965 (– 0.1214'	0.7365 (0.5817) **	0.0803 (0.0586)
Plant height			0.7302 (0.3192)	0.2360 (0.3427)	0.7682 (0.5305) **	0.3496 (0.2292)
Secondary branches				0.3218 (0.3707) *	0.9061 (0.5591) **	0.4221 (0.1324)
Pods per plant					– 0.1665 (– 0.0326)	1.1743 (0.5547) **
100-seed weight						– 0.0252 (– 0.0482)

* and ** significant at the 0.05 and 0.01 levels, respectively.

Table 3. *Direct and indirect influences of different characters in yield in lentils* *.

Character	Effects via						Genotypic correlation with grain yield/plant
	Days to flower	Days to mature	Plant height	Secondary branches	Pods/ plant	100-seed weight	
Days to flower	– 0.1475	0.5572	– 0.0782	0.9104	– 0.0816	– 1.1777	– 0.0174
Days to mature	– 0.1069	0.7689	– 0.742	0.5918	– 0.1473	– 0.9521	0.0803
Plant height	– 0.1201	0.5937	– 0.0961	0.8335	0.1768	– 0.9932	0.3496
Secondary branches	– 0.1177	0.3986	– 0.0701	1.1415	0.2411	– 1.1714	0.4221
Pods/plant	– 0.0161	– 0.1511	– 0.0227	0.3637	0.7494	0.2153	1.00
100-seed weight	– 0.1344	0.5663	– 0.0738	1.0343	– 0.1248	– 0.1928	– 0.0252
Residual effect	– 0.4208						

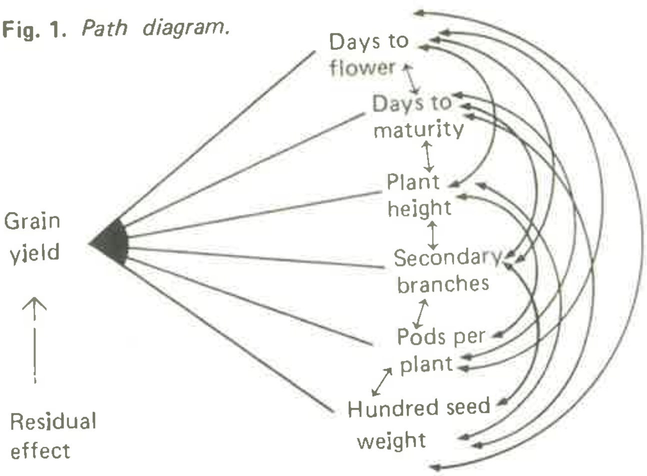
* Direct and indirect effects on diagonal and off-diagonal places, respectively.

secondary branches were positive and high, while those through 100-seed weight were negative and of very high magnitude (– 1.177). The indirect effects via height and pods per plant were negative and negligible. The negative direct effect was, therefore, the reflection of the very high negative influence exerted through 100-grain weight.

Yield vs. days to maturity

The correlation between days to flower and yield was positive and negligible (0.0803). The direct effect of days to maturity on grain yield was positive and high (0.7689). The indirect effect via 100-seed weight was very high and negative and through height and days to flower negative and low. Days to mature, however, registered a high positive effect via secondary branches. In this system of opposing influences the positive direct effect and the indirect effect through secondary branches were counter-balanced by the high negative influence via 100-seed weight resulting in the very low correlation.

Fig. 1. *Path diagram.*



Yield vs. plant height

The direct effect of plant height on grain yield was negative and negligible (– 0.0961). The indirect effects through secondary branches and days to mature were high and positive, but high and negative through 100-seed weight. The indirect effect through pods per plant was positive and through days to flower negative and both values were of moderate magnitude. The correlation value was positive and moderate (0.3496).

Yield vs. secondary branches

There was a very high positive direct effect of number of secondary branches on grain yield (1.1415), but this was counterbalanced by the very high negative indirect effect via 100-seed weight. The indirect effects through days to maturity and pods per plant were positive and moderate, while through days to flower and height they were negative and low. The correlation value was positive and moderate (0.4221). This was largely a reflection of more positive than negative effects.

Yield vs. pods per plant

There was a direct strong positive influence of pods per plant on grain yield (0.7494). The indirect effects through secondary branches and 100-seed weight were positive and moderate, while indirect effects through height, days to flower and maturity were negative and low. The correlation value was very high and positive (1.1743). The greater than unity value of the correlation may be due to the high degree of experimental error. In addition a small sample size may also contribute toward such unexpected results (Van Vleck and Henderson, 1961).

Grain yield vs. 100-seed weight

The correlation value• between grain yield and 100-seed weight was – 0.0242. There was a very strong negative direct effect of seed size on grain yield, but this effect was offset by very high positive indirect effect through secondary branches and days to maturity. The indirect effects through pods per plant, days to flower and height were negative and low.

Discussion

An examination of the components of correlation revealed that the number of secondary branches had the greatest direct and indirect effects on grain yield. Days to maturity exerted the next highest direct influence on grain yield and its indirect effects were also high, except via pods per plant where the effect was negative and low. Number of pods per plant had a high direct effect on yield, but indirect influences through this character were low. The direct and indirect effects of 100-grain weight on yield were very high and negative except via pods per plant. Plant height and days to flowering showed low and negative direct as well as indirect effects.

Comparison of the correlation and path analyses brought out some interesting points. While the correlation study indicated the importance of pods per plant, secondary branches and plant height as yield components, the path analysis also confirmed the significance of the first two components, viz., secondary branches and pods per plant, but suggested that height has neither a direct nor an indirect influence on grain yield. On the other hand path analysis revealed that days to mature and 100-grain weight exerted very high direct and indirect effects on yield, but the correlation values for these traits were negligible. It is therefore, suggested that in addition to correlation analysis, path analysis should also be conducted in order to determine the true genetic relationship among characters.

Number of pods per plant and number of secondary branches were the most important characters contributing to grain yield. The large effect of number of pods per plant on grain yield has been reported previously in green gram (Singh and Singh, 1973) and lentils (Singh, 1977). However, the importance of number of secondary branches as an important yield contributing character is not in agreement with the findings of Singh (1977), who reported that number of secondary branches had a negative direct effect on grain yield.

Acknowledgement

The authors are grateful to Dr. J.P. Tandon, Director, for providing the facilities and offering valuable suggestions.

References:

Al-Jibouri, H.A.; Miller, P.A. and Robinson, H.F. (1958). ' Genotypic and environmental variances and covariances in an upland cotton cross of interspecific origin '. Agron. J. 50: 633-637.

Bhatt, G.M. (1977). ' Significance of path coefficient analysis in determining the nature of character association '. Euphytica 22: 338-343.

Dewey, D.R. and Lu, K.H. (1959). ' A correlation and path coefficient analysis of components of crested wheatgrass seed production'. Agron. J. 51: 515-518.

Singh, T.P. and Singh, K.B. (1973). ' Association of grain yield and its components in segregating populations of green gram '. Indian J. Genet. 33: 112-117.

Singh, T.P. (1977). ' Harvest index in lentil '. Euphytica 26: 833-839.

Van Vleck, L.D. and Henderson, C.R. (1961). ' Empirical sampling estimates of genetic correlations ' . Biometrics 17: 359-371.

CORRELATION STUDIES IN LENTILS

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Lentils are the second most important pulse crop in Bangladesh, next to *Lathyrus.* However, lentils are preferred by the consumers. Lentils are cultivated on 80,000 ha with an average low yield of only 715 kg/ha. In recent years, production, as well as acreage, has been falling (Anon., 1980).

Since grain yield is a function of several yield components, it may be more efficient to select plants on the basis of yield contributing characters rather than yield *per se.* Information on the association of grain yield with its components should, therefore, help breeders in selecting desirable lines. In lentils, little information is available on the correlation between such characters. The present study was undertaken to assess the relationship between grain yield and various yield contributing traits in a set of 78 locally collected cultivars.

Materials and Methods

The experiment was conducted at the Bangladesh Agricultural Research Institute Farm, Joydebpur, Dacca, during the period November, 1979 to April, 1980. Seventy eight cultivars, collected from various parts of Bangladesh, were grown in single rows of 5 m. Ten competitive plants were sampled from each line. Observations on plant height, time to maturity, pods/plant, seeds/pod, 100-seed weight, yield/plant and yield/plant/day were recorded.

Results and Discussion

The range of variability recorded in this material is depicted in Table 1. It is evident that except for pods/plant and yield/plant there is little variability in this material. The least variability was found for time to maturity.

The simple correlation coefficients estimated among various pairs of characters for these 78 cultivars are given in Table 2. Traits like plant height, pods/plant, seeds/pod and yield/plant/day were strongly and positively correlated with yield/plant, while time to maturity was significantly and negatively correlated with plant height, number of seeds/pod, 100-seed weight, yield/plant and yield/plant/day.

Positive association was noted between time to maturity and number of pods/plant. Number of pods/plant was positively correlated with seeds/pod and plant height. It was negatively correlated with 100-seed weight. Plant height was strongly and positively correlated with seeds/pod and yield/plant/day. Jaihini *et al.* (1971) reported that number of pods was the most important yield component in lentils. Tikka *et al.* (1977) also reported that seed yield was positively correlated with height, pods/plant and seeds/pod.

The data obtained suggest that late maturing lines are likely to be low yielding, particularly since these lines seem to have fewer seeds per pod than the early maturing ones.

Table 1. *Range, mean, standard deviation and coefficient of variability in 78 local Bangladesh cultivars of lentils, 1980.*

Character	Range	Mean	S.D.	CV%
Time to maturity (days)	97 – 113	106.0	4.10	4
Plant height (cm)	22.4 -- 40.0	30.2	3.3	11
Pods/plant (no.)	7.7 – 113.3	36.8	22.0	61
Seeds/pod (no.)	1.0 – 1.9	1.49	0.19	13
100-seed weight (g)	0.94 – 1.83	1.49	0.18	12
Yield/plant (g)	0.20 – 2.30	0.92	0.47	51
Yield/plant/day (mg)	1.7 – 23.7	8.71	4.50	52

Table 2. *Correlation among various yield components in lentil, based on 78 cultivars, 1980.*

Character	Time to maturity	Plant height	Pods/plant	Seeds/pod	100-seed weight	Yield/plant
Plant height	– 0.22 *					
Pods/plant	0.29 *	0.31 **				
Seeds/pod	– 0.59 **	0.41 **	0.40 **			
100-seed weight	– 0.23 *	0.11	– 0.22 *	– 0.17		
Yield/plant	– 0.38 **	0.54 **	0.76 **	0.52 **	0.06	
Yield/plant/day	– 0.33 **	0.57 **	0.10	0.46 **	0.11 *	0.97 **

* and ** indicate significance at 5 and 1% levels, respectively.

Tall plants tend to have higher yield potential; all yield contributing factors are positively associated with height.

These findings need to be confirmed through experiments conducted in a large number of lines grown under diverse conditions. Experiments are underway to estimate genotypic covariability.

References:

Anonymous (1980). ' Annual Report of Pulses Improvement Project - 1979-80 ' . Pl. Breed. Div. , Bangladesh Agric. Res. Inst. Joydebpur, Dacca. pp. 191.

Jaihini, S.N., Goyal, S.N., Tikka, S.B.S., Bordia, P.C. and Kumar, S. (1971). 'Genetic variability and correlation studies in lentil (*Lens esculenta* Moench)'. Rajasthan J. Agric. Sci. 2(2): 120-124.

Tikka, S.B.S.; Asawa, B.M. and Gupta, V.K. (1977). ' Interrelationships of quantitative characters with seed yield in lentil *Lens culinaris* Medik ' . Ind. J. Heredity 9(1): 1-6.

LENS CULINARIS Med.

' **Lens** ': Latin name for a disc-shaped ('lens-shaped ') object. In the course of time applied to very different taxa but always indicating a lens-shaped seed.
' **culinaris** ': derived from the Latin 'culina', a kitchen, or what is proper to a kitchen, viz food; 'culinaris ' signifies ' what is edible ', or a food, or what is being eaten.

From ' Pulses in Ethiopia, their taxonomy and agricultural significance' , (1974) by. E. Westphal, publ. by Agricultural University, Wageningen, The Netherlands.

Physiology and Microbiology

A SHORT REPORT ON A NODULATION SURVEY OF LENTILS IN SYRIA AND SOME OTHER WEST ASIAN AND NORTH AFRICAN COUNTRIES

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Lentils are a very important food legume crop grown in many countries of West Asia and North Africa. They serve as an important source of protein, especially for the lower income groups of people. The average yield in this region at present, however, is quite low (e.g. 551 kg/ha, FAO Production Year Book, 1979). Further, yields have either remained static or declined in several countries in the past few years. The poor yields may result from several factors. One of the important factors could be the lack of effective nodulation, as inoculation with efficient strains of *Rhizobium* is rarely practiced.

During the last four years,visits were made to farmers' fields and national programme research fields in Algeria, Egypt, Jordan, Lebanon, Libya, Morocco, Spain, Sudan, Syria and Tunisia and observations were made for the occurrence of nodulation in lentils by naturalized *Rhizobium*. The main objective of these surveys was to locate areas where nodulation failure or inadequate nodulation could limit lentil production and also to identify problems associated with nodulation and nitrogen fixation in lentils.

Table 1 gives the names of those countries, and the number of locations where samplings were done and the nature of nodulation observed in the plants. At all locations, lentils were found to be nodulated by native strains of *Rhizobium,* although there was a considerable difference in the number of nodules produced and the amount of effective nodulation (as assessed by nodule colour). In

Table 1. *Countries, number of locations and nodule status of lentils in the West Asia and North Africa region where surveys were carried out between 1977-78 and 1980-81 growing seasons.*

Country	No. of locations	Nodulation status *		
		Well nodulated	Moderately nodulated	Poorly nodulated
Syria	39	4	21	14
Jordan	10	0	3	7
Spain	8	0	2	6
Egypt	8	1	2	5
Lebanon	6	2	4	0
Morocco	4	0	1	3
Algeria	4	0	2	2
Libya	4	0	1	3
Tunisia	3	0	1	2
Sudan	1	0	0	1

* Well nodulated: More than 30 good sized pink nodules per plant.

Moderately nodulated: Between 15 and 30 medium sized pink nodules per plant.

Poorly nodulated: Less than 15 small white nodules per plant.

some locations (especially in Jordan, Morocco and Spain), lentils formed only a few small white ineffective nodules. The survey revealed several interesting facts. The crops grown in the experimental stations were always better nodulated than those grown by the local farmers outside the stations mainly because of better management practices. Even at the same location, nodulation varied considerably between two fields, mainly reflecting management practices adopted by the individual farmers. Nodulation was better in those fields where the farmers applied farmyard manure or phosphate fertilizer and used irrigation. In general, lentils were very well nodulated in some parts of Syria, mainly in the Hama and Aleppo provinces, and Beqaa valley in Lebanon. In most of the North African countries, particularly Egypt and Morocco, lentils are very poorly nodulated. Nodule damage caused by the larvae of *Sitona* weevil was very widespread in most of the countries and at some locations (e.g., Azaz-Afrine area in Aleppo province, Syria), especially where annual rainfall exceeds 400 mm, damage was very serious. It was frequently observed in these locations that the plants had hardly any intact nodules left on their root system by the time the plant reached the early flowering stage.

In the 1979-80 growing season in an extensive survey in Syria, samples were collected from 120 farmers' fields from different lentil growing areas. The nodulation count showed that some large seeded lentil cultivars had formed 79.3 ± 5.1 nodules/plant at one location (Tal Jibbin near Azaz in Aleppo province) and only 9.2 ± 1.6 nodules/plant in another location (Al Kafar near Idleb in Idleb province). Such variability could result from several factors other than differences in rhizobial population, including age of the crop, genotype, variability in soil fertility, etc. The survey also revealed that many nodules were hollow as a result of attack by insects, mainly larvae of *Sitona* weevils. For example, out of 120 locations surveyed, 72 locations had more than 70 % damaged nodules. This attack on the nodules at such a critical stage of growth (i.e., early flowering stage) could be a major factor limiting nitrogen fixation in lentils (see also Tahhan and Hariri, 1982).

These surveys indicate that in many areas of this region, lentils nodulate poorly and it may be possible to introduce more effective strains of *Rhizobium* through artificial inoculation and increase N_2-fixation and grain production. Also preventive measures may be needed for control of nodule damage.

Reference:

Tahhan, O. and Hariri, G. (1982). 'Survey of lentil insects in Northern and North-eastern Syria'. LENS: 9.

EFFECT OF SOME INSECTICIDES ON NODULATION AND YIELD OF TWO LENTIL CULTIVARS

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Rhizobium within root nodules depends on plant foliage for a regular carbohydrate supply for effective nitrogen fixation. Hence, attack by any insect, pest and disease on the plant tops will affect *Rhizobium* indirectly, thus affecting symbiosis. During studies on nodulation in different cultivars of lentil on the ICARDA farm at Tel Hadya, North Syria, and in the nodulation survey work on farmers' fields in several countries of West Asia and North Africa region, it was observed that many nodules were damaged by the larvae of *Sitona* weevil. At some locations, damage was so serious that there were hardly any intact nodules left on the roots. The attack at such a critical stage of growth could be a major factor limiting nitrogen fixation in lentils. Development of effective control measures to prevent damage is, therefore, of significant importance.

Materials and Methods

An experiment was conducted at ICARDA's site at Tel Hadya during 1979-80 growing season to examine the effects of two soil applied insecticides (Aldicarb, 2 kg product/ha and Carbofuran, 1.5 kg a.i./ha) and one foliar applied insecticide (Folithion, 500 g. a.i./ha applied 14, 28 and 42 days after germination) on nodulation and growth of two lentil genotypes: Syrian Local (large-seeded land race ILL-4400) and ILL- 280 (small-seeded). The primary

Table 1. *Production of nodules, nodule mass, incidence of nodule damage and grain yield of two genotypes of lentils under different insecticide treatments.*

Treatments[1]	Syrian Local				ILL-280			
	Nodules /plant	Nodule dry wt (mg/plant)	Nodule damage (%)	Yield (kg/ha)	Nodules /plant	Nodule dry wt (mg/plant)	Nodule damage (%)	Yield (kg/ha)
Untreated + 120 kg N	25.7	2.5	60.5	1505	11.8	1.0	81.0	1183
Aldicarb	23.7	3.6	64.8	1462	17.4	2.8	50.2	1063
Aldicarb + 120 kg N	19.9	2.3	45.0	1769	10.1	1.5	40.9	1006
Carbofuran	26.0	8.9	2.5	1818	19.9	4.6	5.3	1395
Carbofuran + 120 kg N	27.6	5.5	1.8	1961	14.7	4.4	1.3	1206
Folithion	22.7	5.5	25.2	1495	13.1	2.6	37.9	1014
Folithion + 120 kg N	18.3	4.0	49.6	1747	16.0	1.9	44.4	1319
Untreated	18.4	1.3	78.9	1501	13.8	1.3	73.2	1146
L.S.D. 5 %	3.6	1.0	6.8	210	3.1	0.6	7.4	167

[1] See text for insecticide concentrations.

objective of this study was to identify an insecticide which could control the larvae of the *Sitona* weevil and thus prevent nodule damage. Treatments were evaluated with and without fertilizer nitrogen so as to ascertain whether or not the advantage from carbofuran was due to the prevention of nodule damage with the consequent improved nitrogen supply to the plant. The experiment was planted in late November 1979 using seeds inoculated with mixed strains of *Rhizobium*. A randomized block design was used. About 426 mm of rainfall was received during the growing season.

Two harvests (early vegetative and early flowering stages) were made for the assessment of nodulation and nodule damage before final harvest was made for grain yield.

Results and Discussion

At the early vegetative stage, little difference was observed in nodule development among the treatments and no nodule damage was recorded. Only the plants treated with carbofuran looked slightly more vigorous.

Nodule numbers, nodule weight and % nodule damage at the early flowering stage are presented in Table 1. Both genotypes responded similarly to different insecticide treatments, although Syrian Local produced more nodules and nodule tissues than ILL-280. Aldicarb slightly increased nodule production and nodule mass and reduced % nodule damage to some extent. Folithion significantly increased production of nodule mass for both the cultivars and reduced the % nodule damage considerably, compared to the untreated controls.

Carbofuran treated plants of both genotypes produced 21-35 % more nodules and 3-6 times more nodule tissues than the untreated plant. Carbofuran also gave more than 90 % control of nodule damage. The addition of nitrogen fertilizer to the insecticide treatments reduced nodule mass production and %nodule damage, except in the case of Folithion where the reverse was true.

Both genotypes gave the heaviest yield under Carbofuran treatments (21-31 % more than the untreated controls) whether nitrogen fertilizer was applied or not. The other insecticides had no influence on grain yield. The addition of nitrogen fertilizer to Syrian Local increased grain production in the presence of different insecticides. The cultivar ILL-280 responded positively to nitrogen fertilizer only in the presence of Folithion. Several other insecticides (Diazinon, Novacron-combi dust, and B.H.C.) were ineffective in controlling nodule damage (unpublished data).

The results suggest that the use of the Carbofuran will improve both nodulation and grain production in lentils.

Table 1. *Countries, number of locations and nodule status of lentils in the West Asia and North Africa region where surveys were carried out between 1977-78 and 1980-81 growing seasons.*

Country	No. of locations	Nodulation status *		
		Well nodulated	Moderately nodulated	Poorly nodulated
Syria	39	4	21	14
Jordan	10	0	3	7
Spain	8	0	2	6
Egypt	8	1	2	5
Lebanon	6	2	4	0
Morocco	4	0	1	3
Algeria	4	0	2	2
Libya	4	0	1	3
Tunisia	3	0	1	2
Sudan	1	0	0	1

* Well nodulated: More than 30 good sized pink nodules per plant.

Moderately nodulated: Between 15 and 30 medium sized pink nodules per plant.

Poorly nodulated: Less than 15 small white nodules per plant.

some locations (especially in Jordan, Morocco and Spain), lentils formed only a few small white ineffective nodules. The survey revealed several interesting facts. The crops grown in the experimental stations were always better nodulated than those grown by the local farmers outside the stations mainly because of better management practices. Even at the same location, nodulation varied considerably between two fields, mainly reflecting management practices adopted by the individual farmers. Nodulation was better in those fields where the farmers applied farmyard manure or phosphate fertilizer and used irrigation. In general, lentils were very well nodulated in some parts of Syria, mainly in the Hama and Aleppo provinces, and Beqaa valley in Lebanon. In most of the North African countries, particularly Egypt and Morocco, lentils are very poorly nodulated. Nodule damage caused by the larvae of *Sitona* weevil was very widespread in most of the countries and at some locations (e.g., Azaz-Afrine area in Aleppo province, Syria), especially where annual rainfall exceeds 400 mm, damage was very serious. It was frequently observed in these locations that the plants had hardly any intact nodules left on their root system by the time the plant reached the early flowering stage.

In the 1979-80 growing season in an extensive survey in Syria, samples were collected from 120 farmers' fields from different lentil growing areas. The nodulation count showed that some large seeded lentil cultivars had formed 79.3 ± 5.1 nodules/plant at one location (Tal Jibbin near Azaz in Aleppo province) and only 9.2 ± 1.6 nodules/plant in another location (Al Kafar near Idleb in Idleb province). Such variability could result from several factors other than differences in rhizobial population, including age of the crop, genotype, variability in soil fertility, etc. The survey also revealed that many nodules were hollow as a result of attack by insects, mainly larvae of *Sitona* weevils. For example, out of 120 locations surveyed, 72 locations had more than 70 % damaged nodules. This attack on the nodules at such a critical stage of growth (i.e., early flowering stage) could be a major factor limiting nitrogen fixation in lentils (see also Tahhan and Hariri, 1982).

These surveys indicate that in many areas of this region, lentils nodulate poorly and it may be possible to introduce more effective strains of *Rhizobium* through artificial inoculation and increase N_2-fixation and grain production. Also preventive measures may be needed for control of nodule damage.

Reference:

Tahhan, O. and Hariri, G. (1982). 'Survey of lentil insects in Northern and North-eastern Syria'. LENS: 9.

EFFECT OF SOME INSECTICIDES ON NODULATION AND YIELD OF TWO LENTIL CULTIVARS

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Rhizobium within root nodules depends on plant foliage for a regular carbohydrate supply for effective nitrogen fixation. Hence, attack by any insect, pest and disease on the plant tops will affect *Rhizobium* indirectly, thus affecting symbiosis. During studies on nodulation in different cultivars of lentil on the ICARDA farm at Tel Hadya, North Syria, and in the nodulation survey work on farmers' fields in several countries of West Asia and North Africa region, it was observed that many nodules were damaged by the larvae of *Sitona* weevil. At some locations, damage was so serious that there were hardly any intact nodules left on the roots. The attack at such a critical stage of growth could be a major factor limiting nitrogen fixation in lentils. Development of effective control measures to prevent damage is, therefore, of significant importance.

Materials and Methods

An experiment was conducted at ICARDA's site at Tel Hadya during 1979-80 growing season to examine the effects of two soil applied insecticides (Aldicarb, 2 kg product/ha and Carbofuran, 1.5 kg a.i./ha) and one foliar applied insecticide (Folithion, 500 g. a.i./ha applied 14, 28 and 42 days after germination) on nodulation and growth of two lentil genotypes: Syrian Local (large-seeded land race ILL-4400) and ILL- 280 (small-seeded). The primary

Table 1. *Production of nodules, nodule mass, incidence of nodule damage and grain yield of two genotypes of lentils under different insecticide treatments.*

Treatments[1]	Syrian Local				ILL-280			
	Nodules /plant	Nodule dry wt (mg/plant)	Nodule damage (%)	Yield (kg/ha)	Nodules /plant	Nodule dry wt (mg/plant)	Nodule damage (%)	Yield (kg/ha)
Untreated + 120 kg N	25.7	2.5	60.5	1505	11.8	1.0	81.0	1183
Aldicarb	23.7	3.6	64.8	1462	17.4	2.8	50.2	1063
Aldicarb + 120 kg N	19.9	2.3	45.0	1769	10.1	1.5	40.9	1006
Carbofuran	26.0	8.9	2.5	1818	19.9	4.6	5.3	1395
Carbofuran + 120 kg N	27.6	5.5	1.8	1961	14.7	4.4	1.3	1206
Folithion	22.7	5.5	25.2	1495	13.1	2.6	37.9	1014
Folithion + 120 kg N	18.3	4.0	49.6	1747	16.0	1.9	44.4	1319
Untreated	18.4	1.3	78.9	1501	13.8	1.3	73.2	1146
L.S.D. 5 %	3.6	1.0	6.8	210	3.1	0.6	7.4	167

[1] See text for insecticide concentrations.

objective of this study was to identify an insecticide which could control the larvae of the *Sitona* weevil and thus prevent nodule damage. Treatments were evaluated with and without fertilizer nitrogen so as to ascertain whether or not the advantage from carbofuran was due to the prevention of nodule damage with the consequent improved nitrogen supply to the plant. The experiment was planted in late November 1979 using seeds inoculated with mixed strains of *Rhizobium*. A randomized block design was used. About 426 mm of rainfall was received during the growing season.

Two harvests (early vegetative and early flowering stages) were made for the assessment of nodulation and nodule damage before final harvest was made for grain yield.

Results and Discussion

At the early vegetative stage, little difference was observed in nodule development among the treatments and no nodule damage was recorded. Only the plants treated with carbofuran looked slightly more vigorous.

Nodule numbers, nodule weight and % nodule damage at the early flowering stage are presented in Table 1. Both genotypes responded similarly to different insecticide treatments, although Syrian Local produced more nodules and nodule tissues than ILL-280. Aldicarb slightly increased nodule production and nodule mass and reduced % nodule damage to some extent. Folithion significantly increased production of nodule mass for both the cultivars and reduced the % nodule damage considerably, compared to the untreated controls.

Carbofuran treated plants of both genotypes produced 21-35 %more nodules and 3-6 times more nodule tissues than the untreated plant. Carbofuran also gave more than 90 % control of nodule damage. The addition of nitrogen fertilizer to the insecticide treatments reduced nodule mass production and %nodule damage, except in the case of Folithion where the reverse was true.

Both genotypes gave the heaviest yield under Carbofuran treatments (21-31 % more than the untreated controls) whether nitrogen fertilizer was applied or not. The other insecticides had no influence on grain yield. The addition of nitrogen fertilizer to Syrian Local increased grain production in the presence of different insecticides. The cultivar ILL-280 responded positively to nitrogen fertilizer only in the presence of Folithion. Several other insecticides (Diazinon, Novacron-combi dust, and B.H.C.) were ineffective in controlling nodule damage (unpublished data).

The results suggest that the use of the Carbofuran will improve both nodulation and grain production in lentils.

STORABILITY OF LENTIL SEEDS UNDER AMBIENT CONDITIONS

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Seed needs to be stored at least from time of harvest to the subsequent planting season. Under certain circumstances it may have to be stored for more than one planting season. During storage, seed loses viability. Relative humidity (RH) and storage temperature are the two most important factors influencing loss of viability during storage. RH is the more important because of its direct relationship with seed moisture. Differences in storability among species (Agrawal, 1981) and cultivars (Agrawal, 1979) have been observed. These differences must be recognized and taken into account for planning seed storage. However, very little information is available on seed storability of lentil, and so the present investigation was undertaken.

Materials and Methods

Lentil seeds were harvested in April, 1975, divided into 4 different grades as described in Agrawal (1982) (one sample was kept ungraded) and all samples were stored in cloth bags. The cloth bags were kept in an airtight tin seed box. Periodical observations were started from May, 1975.

Seed moisture was determined by drying the ground material at 130° C for 1 h in 2 replications. Since the effect of grade was not evident, the moisture contents of all 5 samples have been averaged and (thus) each point in Fig. 1 a is the mean of 10 determinations.

One hundred seeds of each grade were germinated by the BP method (Anonymous, 1976) at 20° C in 3 replications. After 7 days, seeds were assessed as normal, abnormal hard and dead (Anonymous, 1976). Germination percentage was calculated on the basis of normal seedlings only. Germination percentages of all the 4 grades have been averaged, because they were almost the same in all grades. Thus, each point in Fig. 2 represents an average of 15 determinations.

One g of seed was surface sterilized in 0.1% solution of mercuric chloride for 10 min, washed twice with sterile water, and then soaked in 25 ml of sterile water at 20° C for 17 h. The steeping water was analysed for reducing sugars at 490 nm by phenol-sulphuric acid method (Dubois *et al*, 1956). Glucose was used as a standard.

Results and Discussion

The mean temperatures and RH of Delhi for the last 30 years (1931-1960) have been plotted in Fig. 1 b. Seed moisture varied during storage with the change in RH of the atmosphere (Fig. 1 a). Maximum and minimum seed moisture was observed in May and September respectively.

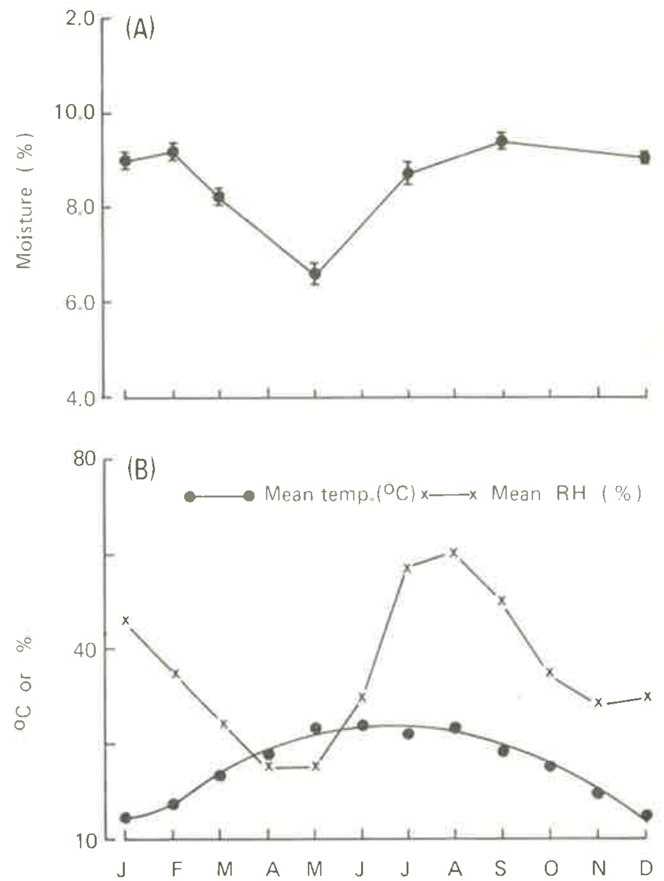

Fig. 1. *Fluctuations in seed moisture during storage (A) and mean temperature and relative humidity (B).*

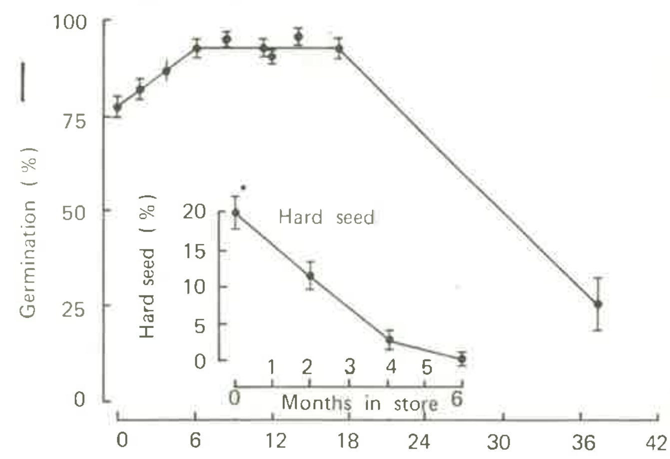

Fig. 2. *Changes in germination and hard seeds of lentil during storage.*

Table 1. *Leaching of sugars from lentil seeds stored under ambient conditions.*

Months in store	Sugar leaching: mg sugar per g of seeds	Sugar leaching: % of water soluble sugars leached
0	4.04 ± 0.22	7.32 ± 0.22
8	5.30 ± 0.09	8.06 ± 0.27
12	5.57 ± 0.13	8.60 ± 0.20

In a changing environment, an equilibrium seed moisture is seldom established.

The initial seed germination percentage was 77% ; germination increased up to 6 months of storage due to a decrease in hard seed percentage (Fig. 2, inset). Soon after harvest the hard seed percentage was 20; this decreased to 6 and almost zero after 4 and 6 months, respectively. Therefore, the period of dormancy was of about 4 months duration in lentil cv. Pusa-4 grown in Delhi. Tosun *et al.* (1980) have reported a dormancy period of 4-5 months in 8 lentil cultivars grown in Turkey. The conclusion was based on percent field emergence. But field emergence is dependent on soil and climatic factors in addition to seed factors. Their laboratory germination data does not indicate any dormancy period in lentil cultivars. The percentage of hard seeds varies according to the species, the degree of maturity and ripening conditions. A low relative humidity during ripening results in a considerable increase in hard seededness (Harrington, 1949).

Seed germination percentage remained high for 17 months and then declined. After 37 months of storage, germination was only 25 %. Therefore, under insect free ambient conditions, lentil could maintain its initial viability for at least 17 months. The ambient conditions in this experiment were characterized by a mean temperature not exceeding 34^{o} C and a mean RH not exceeding 70 % except for 1 month at 71 % (Fig. 1 b).

The leaching of sugars was estimated after 0,8 and 12 months of storage (Table 1), and gives an indication of the degree of deterioration of the plasma membrane during storage. If the leaching of sugars is heavy, it is advisable to use a suitable fungicidal dressing to protect the seeds in the soil. The heavy leaching of sugars from seeds, once they are imbibed, provides a source of food for micro-organisms which cause rotting of seeds. It is evident from Table 1, that leaching of sugars increased during storage.

This would indicate that plasma membranes have deteriorated during storage resulting in increased leaching. Similar results have been observed in paddy (Agrawal, 1977) and wheat seeds (Agrawal, 1979). However, among pulses, lentil registered less leaching than soybean and pea stored under identical conditions for 12 months indicating less deterioration of the plasma membrane.

References:

Agrawal, P.K. (1977). 'Germination, fat acidity and leaching of sugars from five cultivars of paddy (*Oryza sativa*) seeds during storage' . Seed Sci. & Technol. 5: 489-498.

Agrawal, P.K. (1979). 'Genotypic variation in germination and membrane permeability in wheat (*Triticum aestivum*) seeds during storage under ambient conditions.' Seed Res. 7: 120-127.

Agrawal, P.K. (1981). 'Relative storability of seeds of ten species under ambient conditions' . Seed Res. 9. (in press).

Agrawal, P.K. (1982). 'The effect of seed size on germination, vigour, and field emergence of lentil ' . LENS 9.

Anonymous, (1976). ' International rules for seed testing. Annexes 1976' . Seed Sci. & Technol. 4: 51-177.

Dubois, M.; Gilles, K. ; Hamilton, J.K.; Robers, P.A. and Smith, F. (1956). 'Colorimetric method for determination of sugar and related substances' . J. Analyt. Chem. 28: 350-356.

Harrington, J.F. (1949). 'Hard seed in beans and other legumes ' . Seed World. 64: 42-44.

Tosun, O.; Eser, D.; and Gecit, H.H. (1980). ' Dormancy in lentils' LENS 7: 42-46.

Agronomy and Mechanisation

THE EFFECT OF SEED SIZE ON GERMINATION, VIGOUR AND FIELD EMERGENCE OF LENTIL

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Seed size has been considered as an important factor in seedling vigour, subsequent plant growth and yield (Wood, Longdon and Scott, 1977). Large seeds have been reported to produce heavier and more vigorous seedlings as compared to small seeds in many species (Bryssine, 1955; Dhillon and Kler, 1976). Seedling length has been correlated with seed size. However, little information is available on lentil. Therefore the present investigation was undertaken to study the effects of seed size of lentil on germination, seedling vigour and field emergence.

Materials and Methods

a) Grading of seeds and germination:

Seeds of lentil cv. Pusa-4 were graded into 4 sizes using Burrow's oblong hole aluminium screen (Table 1). Seeds were germinated at 20° C using the BP (= between paper) method (Anonymous, 1976) for 7 days and the germination percentage was calculated on the basis for normal seedlings only (Anonymous, 1976).

b) Measurement of seedling length and dry weight:

Seeds were germinated at 20° C for 9 days in a plastic stand for measuring the length of shoot and roots. Ten seedlings were randomly selected, measured and dried at 90° C for 17 hours. Vigour was calculated by multiplying germination percentage with seedling length in cm. (Abdul-Baki and Anderson, 1973).

c) Leaching of sugars from seeds and its analysis:

One g of seed was surface sterilised in 0.1% mercuric chloride solution for 10 min., washed twice with sterile water and soaked in 25 ml of sterile water at 20° C for 17 h. Seeds were then removed from water (steeping water) and water soluble sugars were extracted from seeds.

Table 1. *Seed weight, recovery percentage and germination percentage of different grades of lentil seed.*

Seed grade	Screen size (in)	1000 seed wt. (g)	Percentage recovery in each grade	Germination (%)
1.	Retained on 6/64 x 3/4	24.012	6.02	93
2.	Retained on 5 1/2 x 3/4	20.202	35.30	93
3.	Retained on 5 x 3/4	17.182	43.60	93
4.	Passed through 5 x 3/4	12.882	15.05	90
5.	Ungraded	17.307	–	95
C.D. at 1%		0.488		N.S.

Table 2. *Leaching of sugars, seedling length, dry weight and vigour of different grades of lentil (laboratory experiment).*

Grade	% of water soluble sugars leached in 17 hr.	Seedling length (cm)		Dry wt. per ten (mg.)		Vigour rating
		Root	Shoot	Root	Shoot	
1.	6.8	8.20	10.63	22.3	53.6	1751
2.	7.3	7.97	10.64	21.0	50.1	1730
3.	8.9	8.66	10.08	18.4	45.7	1742
4.	10.6	6.85	9.70	12.9	33.3	1489
Ungraded	6.4	7.43	8.32	21.2	42.3	1496
C.D.		0.91	0.82	3.4	5.3	

The reducing sugars in both these fractions (steeping water and seed extract) were estimated by the phenol sulphuric acid method at 490 mm using glucose as standard (Dubois *et al*, 1956).

d) Field studies:

Two hundred seeds of each grade were dibble planted at uniform distance in five rows of 5 m length in 3 replications. Row to row distance was 30 cm. Emergence counts were taken at 16, 21 and 36 days after sowing. Seedling length and dry weight were also determined as described earlier.

Results and Discussion

Seeds of 4 different grades were obtained ranging in weight from 12.8 to 24.0 g per 1000 seeds. The test weight of ungraded seeds was comparable to that of grade 3. Maximum recovery was obtained in grade 3 and minimum in grade 1. The germination percentage was almost the same in all the grades including the ungraded lot (Table 1). With the decrease in seed size, the leaching of water soluble sugars increased and it was maximum in grade 4 (Table 2). Since the germination percentage was the same in all the grades, the increased leaching indicates the deterioration of plasma membrane. The shoot length of graded seeds was significantly more than that of ungraded seeds but only grade 3 seeds produced roots significantly longer than ungraded seeds. Similarly, only grade 1 and 2 seeds produced significantly more shoot dry wt. than ungraded seeds (Table 2). The vigour of grades 1-3 seeds was almost the same, but more than that of ungraded seeds which was comparable to the vigour of grade 4 seeds. The vigour of ungraded seeds and of grade 4 was comparable.

The numbers of seedlings which emerged from larger seeds were more at all stages (Table 3); 16 days after sowing, grade 1 and 2 produced significantly more seedlings than ungraded seeds, and grade 1, 2, 3 and ungraded seeds produced significantly more seedlings than grade 4 seeds. At 21 days, grades 1 and 2 produced more seedlings than grade 4 and at 36 days, grades 1, 2 and 3 produced significantly more seedlings than ungraded seeds. Grade 4, at all observation times, produced the least number of seedlings. Therefore, in a competitive population, larger seeds have proved their superiority in field emergence. Burris *et al* (1973) have observed significantly lower emergence from the smallest seeds of soybean. Shoot seedling length and dry weight at 40 days after sowing were almost the same in all the grades.

Shoot length and dry weight were more in larger seeds which also produced more seedlings in the field; the leaching of water soluble sugars was less in larger seeds. Thus, it appears that large seed size could be used as an indicator of seed vigour in lentil. A more detailed study would be necessary to establish this relationship.

Table 3. *Emergence of seedlings from different grades of lentil (200 seeds were sown per 5 m row).*

Grades	**No. of seedlings emerged from 200 seeds.**		
	16 days after sowing	**21**	**36**
1.	159	165	184
2.	156	163	175
3.	148	153	173
4.	135	138	148
Ungraded	144	149	163
C.D. 5 %	8.068	18.060	5.868

References:

Anonymous, (1976). ' International Rules for Seed Testing, Annexes 1976 ' . Seed Sci. & Technol. 4: 51-177.

Abdul-Baki, A.A. and Anderson, J.D. (1973). 'Vigour determination in soybean by multiple criteria' . Crop Sci. 13: 630-633.

Bryssine, P. (1955). ' Les variations phenotypiques du genotype chez les Legumineuses on fonction de la dimension des semences' . (Phenotypical variations of the genotype in Legumes in relation to seed size). C.R. Soc. Nat. Phys. No.7: 21-24.

Burris, J.S. (1973). ' Effect of seed maturation and plant population on soybean seed quality ' . Agron. J. 65 (3): 440-441.

Dhillon, G.S. and Kler, D.S. (1976). ' Crop production in relation to seed size'. Seed Res. 4: 143-155.

Dubois, M.; Gilles, K.; Hamilton, J.K.; Robert, P.A. and Smith, F. (1956). ' Colorimetric method of determination of sugars and related substances' . Ann. Chem. 28: 350-356.

Wood, D.W.; Longdon, P.C. and Scott, R.K. (1977). ' Seed size variation; its extent, source and significance in field crops' . Seed Sci. & Technol. 5: 337-352.

IN THE BIBLE

Then Jacob gave Esau bread and pottage of lentils; and he did eat and drink, and rose up, and went his way: thus Esau despised his birthright.

From ' The Genesis ' Chapter 25, Verse 34.

RESPONSE OF LENTIL GENOTYPES TO DATE OF PLANTING

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Lentils are grown in the winter season following the rice crop in the Indian sub-continent. In India this crop is grown mainly in the states of Uttar Pradesh, Madhya Pradesh, Bihar, West Bengal and Orissa; the cropping area represents 50 % of the world' s acreage, but produces only 41 % of the world' s production. The average yield, 526 kg per hectare, is low. An important factor contributing to this is untimely planting. Planting of lentil starts by the middle of October, but is mostly done in December in fields made available after harvest of the rice crop. The present study was undertaken to study the effect of date of planting on lentil yield and also to determine the best cultivar for late planting.

Materials and Methods

Different genotypes of lentil were planted on five different dates to determine the response of these genotypes to planting time (Table 1). The genotypes included in this study were nine new selections made at Pantnagar, and Pusa 4 from the Indian Agricultural Research Institute, New Delhi, along with two standard checks: L 9-12 (a standard check from Punjab State of India) and T 36 (a standard check from Uttar Pradesh, India). A split plot design, with date of planting as the main plots and cultivars as sub plots, was used with three replications.

Seeds were sown in furrows 22.5 cm apart by a Planet Junior planter with seed rate of 40 kg/ha. The data on grain yield (kg/ha) were analysed statistically and are presented in Table 1.

Results and Discussion

Grain yields of lentils were significantly affected by date of planting (Table 1). The highest yield was recorded with planting between Oct. 30 and Nov. 15 in all years, except in 1974-75 when the Nov.30 planting date gave the highest yields. A considerable reduction in grain yield was noticed when planting was delayed beyond 15 Nov. in most years. Plantings later than Nov. 15 , in general, do not get sufficient cool temperatures for optimum vegetative growth; and the flowering and fruiting is affected adversely by the rapid rise in temperature during February and March and, consequently, lower yields result.

Table 1. *Grain yield (kg/ha) of lentil genotypes as affected by planting dates.*

Treatment	1972-73	1973-74	1974-75	1975-76	Mean
Planting date					
15 Oct	1351	2466	–	–	
30 Oct	1596	2695	1719	1525	1883
15 Nov	1458	2789	2062	1562	1975
30 Nov	1196	1817	2261	1475	1687
15 Dec	1231	1544	2204	1225	1551
30 Dec	–	–	1989	875	
C.D. 5 %	178	355	361	522	
Variety					
Pant 184	330	–	–	–	
Pant 209	1643	2234	2217	1550	1911
Pant 220	1272	2120	1756	1150	1504
Pant 234	1296	1948	–	–	
Pant 241	1157	2311	1844	1325	1659
Pant 370	1411	2031	1892	1287	1655
Pant 406	1902	1691	2447	1637	1944
Pant 538	1687	2398	2057	1200	1835
Pant 638	1536	2628	2190	1325	1919
Pusa 4	1570	2361	2055	1437	1855
L 9-12	1617	2209	1964	1262	1763
T 36	1047	1830	–	–	
C.D. 5 %	168	355	76	323	

The yield of all cultivars was reduced with a delay in sowing. Pant 406 outyielded all cultivars, followed by Pant 638 and Pant 209. Pant 220, Pant 241, and Pant 370 were the lowest yielders. Almost all cultivars did best when planted between Oct. 30 and Nov. 15. Pant 406 was found

Summary

Lentil planting should be completed preferably by the end of October. However, planting can be taken up to 15 Nov. without much loss in yield. Any delay beyond mid-November causes drastic yield reductions. Under such a situation Pant 406 should be grown. The cultivar release committee, Govt. of India, therefore, recommended and certified this cultivar for cultivation under normal as well as late sown conditions in the northern plains of India.

Reference:

Pandya, B.P.; Pandey, M.P. and Singh, J.P. (1980). ' Development of Pant L 406 lentil, resistant to rust and wilt ' . LENS 7: 34-37.

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INFLUENCE OF SOIL MOISTURE REGIMES, PHOSPHORUS LEVELS AND DATES OF PLANTING ON NODULATION AND PROTEIN CONTENT OF LENTILS IN NORTHWEST INDIA.

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Lentils are one of the more nutritive winter crops containing about 25 % protein with a yield potential of about 3 tonnes per ha. In most parts of Northwest India, lentils are increasing in importance as a food legume crop. The crop is normally planted in October-November, generally after a rice crop. The plantings are, however, likely to be delayed, depending on the availability of rice fields. Hence, late plantings up to mid-December are of common occurrence. In late plantings, nodulation, growth and development of the plants are likely to be affected by the low temperatures. Consequently, it is expected that the protein content may also be affected. No research data are available on nodulation and protein content of lentils as influenced by water management and phosphorus levels in relation to dates of sowing. Field studies were, therefore, conducted to assess the effect of these important inputs on nodulation and protein content.

Materials and Methods

The field trial was conducted on the Indian Agricultural Research Institute farm, New Delhi, during the winter season of 1973-74. The experimental site had a well drained soil of medium fertility with a pH of about 8.1. The field capacity and wilting point values ranged from 17.08 to 17.79 and 6.54 to 6.79, respectively in the surface 120 cm. and the bulk density was around 1.48 g/cc. The treatments consisted of three dates of planting; Oct. 25 (D_1); Nov. 16 (D_2) and Dec. 7 (D_3); and five soil moisture regimes: 2 atm at 30 cm depth throughout the crop growth (I_1); 2 atm in vegetative phase and 4 atm in reproductive phase (I_2); 4 atm in vegetative phase and 2 atm in reproductive phase (I_3); 4 atm throughout the crop growth (I_4), and an unirrigated control (I_5). There were three phosphate levels of 0, 60 and 120 kg P_2O_5/ha. The experiment was laid out in a split-plot design having three replicates with a combination of dates of sowing and soil moisture regimes as main plots and phosphorus levels as sub-plots. The data obtained were analysed statistically.

Results and Discussion

Number of nodules per plant. Crop growth was quite vigorous and free from any pests and diseases. The effects of different dates of sowing, soil moisture regimes and phosphorus levels on number of nodules per plant are presented in Table 1.

Date of planting significantly affected number of nodules per plant (Table 1). This was due to the varying growth period for the different planting dates. The total growth duration in the first, second and third planting dates

Table 1. *Number of nodules per lentil plant as affected by dates of planting, soil moisture and phosphorus levels.*

Date of planting	Number of nodules	Soil moisture regime	Number of nodules	Phosphorus level	Number of nodules
D_1	25.7	I_1	19.3	P_0	21.6
D_2	27.7	I_2	25.1	P_1	24.3
D_3	18.7	I_3	25.1	P_2	26.4
		I_4	28.0		
		I_5	23.0		
C.D. 5%	2.5		3.3		1.7

was 156, 135 and 120 days from planting to harvest. The number of nodules per plant was not significantly different between the first and second date of planting but was significantly lower for the third date. This is attributable to more or less similar conditions in the first two dates of planting. Similar results were reported by Sharma *et al.* (1967). The optimum temperature for the formation of nodule bacteria lies between 25 - 30^{o} C and this requirement was met in the first two dates which resulted in more nodules per plant. At the third date, low temperatures, at times reaching the freezing point, resulted in significantly fewer nodules per plant.

Wetter regimes produced significantly fewer nodules per plant compared to drier regimes. This confirms the results of Wilsôn (1937). Fewer nodule bacteria may have survived in the wet regimes for lack of adequate aeration. In the control treatment, Albrecht (1925) holds the view that too much compaction reduces nodule number.

The number of effective nodules per plant increased with increasing levels of phosphorus (Table 2). Similar results were noted by Rewari *et al.* (1965) and Fageria *et al.* (1969). This was because nodule bacteria required phosphorus for their own growth and development. The increased number of nodules, however, was not reflected in increased protein percentage. Similar observations were recorded by Petro (1969) and Sinha (1967). This might be attributed to initial medium status of soil phosphorus and some other unknown factors. The initial phosphorus status of the soil was 29.12 kg P_2O_5 per ha which can be considered fairly satisfactory for crop growth .

The interaction between soil moisture regime and date of planting was significant as shown in Table 2. Data presented in Table 2 reveal that treatment I_4 in D_1 was significantly better than treatment I_2, but was on a par with other treatments. Treatments I_2, I_3 and I_4 in D_2 were similar, but were significantly better than I_1 and I_5. Treatment I_4 in D_3 was significantly better than I_1 but was not significantly different from I_2, I_3 and I_5. In general, treatment I_2 in D_2 appeared to be best. This might be due to a much more favorable temperature and soil moisture situation at this particular date.

Percent protein. The quality of lentil seed is affected by agronomic factors besides nutrition and genotypes. The influence of planting date and soil moisture regime on percent protein of lentil is shown in Table 3. Data presented in Table 3 show that the last date of planting (D_3) gave significantly higher percent protein than earlier dates, which were similar to each other. Percent protein increased significantly in I_2 (wetter regime in vegetative phase and drier regime in reproductive phase) over I_5 (control) and I_4 (4.00 atm throughout the crop growth).

It is concluded that in order to get best nodulation, the optimum planting time is about the middle of November in the area around New Delhi. Later plantings result in severely reduced nodulation and yield.

Editors Note: Differences in percent protein less than 1% may be statistically significant, but are meaningless from a practical view point.

Table 2. *Interaction of date of planting with soil moisture regime on number of nodules per lentil plant.*

Date of planting	No. of nodules per plant				
	I_1	I_2	I_3	I_4	I_5
D_1	23.0	22.0	25.9	29.2	28.2
D_2	21.6	33.4	30.5	32.2	20.7
D_3	13.2	20.0	19.0	22.5	20.0
C.D. 5%	5.7				

Table 3. *Interaction effects of planting date with soil moisture regime on percent protein of lentils.*

Date of planting	% protein of lentil seeds					
	I_1	I_2	I_3	I_4	I_5	Mean
D_1	22.96	23.87	23.78	23.56	23.78	23.59
D_2	24.18	24.46	23.85	23.29	22.97	23.75
D_3	24.30	24.06	23.93	24.08	24.13	24.10
Mean	23.82	24.13	23.85	23.64	23.64	
C.D. 5%	D = 0.26;		I = 0.32;		D x I = 0.60	

References:

Albrecht, W.A. (1925). ' Survival of *Rhizobium japonicum*'. Bull. Agric. Expt. Sta. No. 228: 23.

Fageria, N.K. and Bajpai, M.R. (1969). ' Effect of irrigation, phosphorus and spartin B on nodulation in pea'. Rajasthan Agric. 8: 86-88.

Petro, C. (1949). ' Effect of phosphate alone and in combination with N and K on growth, nodulation and yield of pea '. Thesis (unpublished) Assoc. I.A.R.I., New Delhi.

Rewari, R.B.; Sen, A.N. and Sen, A. (1965). ' Nitrogen fixation by cluster bean in relation to phosphate uptake from soil '. Indian J. Agric. Sci. 35(2): 162-166.

Sharma, H.D.; Batra, B. and Vaidya, S.M. (1967). ' Effect of normal and late sowing on the behaviour of some improved type of grain '. J. Post-grad. School, I.A.R.I. 5(1): 56-61.

Sinha, P. (1967). ' Effect of phosphate on bacteria inoculation in green manuring '. Proc. 44th Indian Sci. Cong., Calcutta, 391-392.

Wilson, P.W. (1937). ' The carbohydrate nitrogen relation in symbiotic nitrogen fixation '. Wisc. Agric. Exp. Sta. Bull. 129.

HARIRA **NORTH AFRICA**

2 oz. chickpeas	pinch of saffron powder
2 oz. lentils	1 lb. tomatoes
4 oz. lean lamb	6 pints water
1 medium onion, chopped	2 oz. plain flour
2 tbs. oil	juice of 1 lemon
1 tbsp. paprika	salt and ground black pepper
1 tbsp. chopped parsley	2 oz. long grain rice

Soak chickpeas and lentils overnight. Dice lamb. Heat oil in a large saucepan, add lamb, onion, parsley, paprika and saffron. Fry, gently stirring for about 5 minutes. Skin, deseed and chop tomatoes Drain chickpeas and lentils. Add tomatoes, chickpeas and lentils to the pan, together with the water, seasoning and lemon. Simmer 1½ hours. Stir in rice and continue cooking for further 20 minutes until the rice is tender. Mix flour with a little cold water to form a smooth paste; stir into soup. Bring to the boil; simmer for 2-3 minutes, stirring . Serve immediately.

Serves 8

(from 'Lentil Cook Book' by Lorna Hawtin ICARDA, Aleppo, 1980).

WEED CONTROL RESEARCH IN LENTILS AT SASKATOON, SASKATCHEWAN - 1981 UPDATE

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Experiments conducted during 1981 in Saskatchewan expanded on testing in the previous year with the soil incorporated herbicides, examined several new formulations of postemergence chemicals and evaluated two novel application devices.

Chloramben (Amiben) at 2.2 kg/ha in a tank-mix with trifluralin (Treflan) at 1.4 kg/ha fall soil applied and double incorporated with a vibrashank cultivator added wild mustard, volunteer rapeseed and stinkweed control to those weeds controlled by trifluralin alone (notably wild buckwheat, lamb's quarters, redroot pigweed, wild oats, green foxtail, cow cockle and Russian thistle). Spring application of this combination was less desirable as it not only caused a degree of crop phytotoxicity (thinning and reduced vigour), but also left the soil surface loose and subject to wind erosion and too dry to promote rapid and uniform lentil emergence. Rates of chloramben in excess of 2.2 kg/ha caused excessive crop injury and would be prohibitive from a cost standpoint. Chloramben at rates less than 2.2 kg/ha was ineffective for *Brassica* species control. Plant residues were collected and forwarded to the manufacturer (Allied Chemicals Ltd.) and a decision on possible registration is expected this year. Tank-mixes of chloramben with ethalfluralin (Sonalan) produced a very high level of weed control but created unacceptable crop injury, particularly when spring applied. In other tests with soil applied materials the dinitroanilines (trifluralin and ethalfluralin) provided a superior balance between weed control and crop tolerance relative to other products in these tests (oryzalin and metolachlor). Soil moisture was extremely low during most of the growing season at these Saskatoon test sites. As a result shallow harrow incorporated surface treatments of triallate (Avadex BW) and triallate plus trifluralin mixtures failed to control the weeds which were germinating and emerging from greater depths in the soil.

In tests examining postemergence applications, lentils showed excellent tolerance to a number of experimental grass control herbicides including Hoe 00734, Hoe 00736, TF 1169 (Fusilade), Bas 9052 (Poast), Dowco 453 and RO 13-8895. Adjuvants at rates of 0.1 to 0.5 per cent on a spray volume basis enhanced control of wild oats, green foxtail, Persian darnel and yellow foxtail. Several interesting aspects concerning use of these " grass killers " observed in these field tests included: excellent control of volunteer wheat, barley, tame oats, triticale and canary grass; control of grasses over a wide range of growth stages from emergence to 6-leaf and including control of tillers;

rapid killing action leading to complete necrosis within ten days; a potential for tank-mixing with several herbicides to add broadleaf weed control (particularly metribuzin which appeared to enhance activity in grasses); virtually 100 per cent weed contol; absence of any detrimental effects on broadleaf crops even at rates in excess (2x) of those necessary for adequate control of annual grasses; and control of perennial quackgrass at slightly higher rates of application. Postemergence tests also examined the active isomer formulation of diclofop methyl (Hoe Grass Plus) and found it to have improved crop safety, more rapid activity on wild oats and control at more advanced growth stages for both green foxtail and wild oats when compared to commercial formulations. No new postemergence broadleaf weed control chemicals were available for testing.

Several equipment items were examined for usefulness in applying herbicides in pulses. Rope wicks successfully treated weed growth which extended above the lentil canopy, and was particularly useful for control of thistles. A spinning disc device (Micron) was used to apply wild oat control herbicides at ultra low volumes. Pattern distribution from an electrically charged spray carrier solution applicator (Electrodyne) was examined with reduced drift and accurate placement of extremely small droplets observed.

Examination of grower fields indicated three problem areas of importance during the summer of 1981. First, performance inquiries involving metribuzin (Sencor) injury in lentils showed that crop phytotoxicity could be traced to situations where excessive rainfall immediately after application washed the herbicide into the soil where rapid root uptake resulted in death of the affected lentil plants. Damage was most severe in areas of low organic matter such as sandy eroded knolls and clays in the brown soil zone. A change in labelling in response to this problem now warns of injury in situations where rain falls immediately after application and for soils containing less than three per cent organic matter. It is interesting to note that these conditions which caused injury in producer fields could not be duplicated in experiments which deliberately attempted to apply metribuzin under harsh environments, at late growth stages and excessive rates. Second, failure of weed control in drier areas was found to have been caused by weeds showing retarded growth so that they were either physiologically inactive or beyond the normal stage of growth for adequate control when the herbicide was applieo. Finally inadequate product knowledge led to application of unsuitable herbicides and the planting of lentils on to areas previously treated with picloram (Tordon 202 C).

No new registrations for lentils were granted in 1981. New applications for Poast and Fusilade join the long list of submissions which include Avadex BW, Sonalan, Treflan, Lexone and Reglone. Pre Merge 360 is no longer licensed for use on lentils.

Pests and Diseases

SURVEY OF LENTIL INSECTS IN NORTHERN AND NORTH-EASTERN SYRIA

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Little is known about insects associated with lentils in Syria. Consequently, a survey of insects on lentils of the major producing areas of Syria (Aleppo, Idleb, Hama and Hassakeh governorates) was made.

Materials and Methods

A total of 115 farmers' lentil fields were visited from mid-April to mid-May 1980 (Figure 1). Fifty randomly selected plants were picked diagonally from each field. These were examined for percentage of plants infested and severity of damage. The degree of severity of damage was recorded as light (1), moderate (2) and heavy (3). The presence of other pests in the field, which were not scored from the picked 50 plants, was recorded.

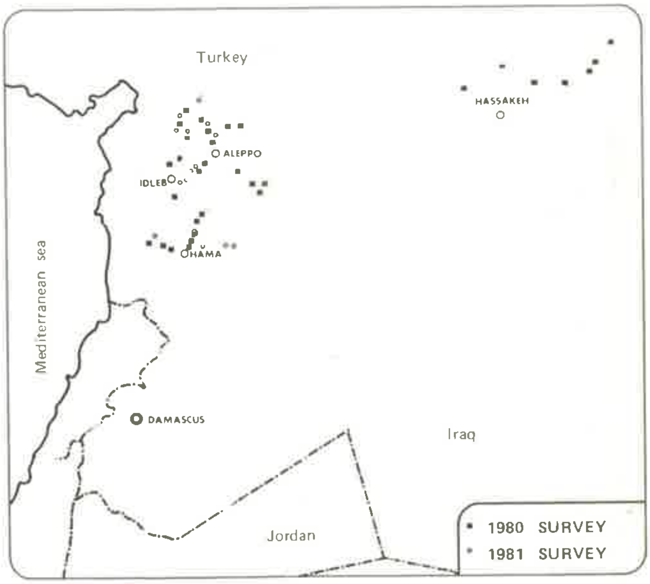

Fig. 1. *Map of Syria, showing locations of villages used in 1980 and 1981 surveys.*

Ten of the picked plants from each field were examined in the laboratory for nodule damage by *Sitona* larvae. Two hundred seeds were obtained from each farm after harvest and scored in September for seed infestation by *Bruchus* spp.

Table 1. *Pests and predatory insects of lentils in 115 fields in northern and north-eastern Syria, 1980.*

Pest		Plant parts attacked	% Fields showing infestation	% Plants infested
A.	**Insect Pests**			
1.	Leaf weevil *Sitona* spp. adult	Leaves	99	71.4
2.	Leaf weevil *Sitona* spp. larvae	nodules & roots	93	68.2 *
3.	Bud weevil *Apion* spp. adult	leaves	99	15.2
4.	Bud weevil *Apion* spp. larvae	buds	34	10.6
5.	Alfalfa weevil *Hypera* spp. adult & larvae	leaves	17	12.8
6.	Seed beetle *Bruchus* spp.	seeds	93	1.9 **
7.	Cut worm *Agrotis* spp.	stems & leaves	37	--
8.	Pod borer *Heliothis* spp.	pods & leaves	26	--
9.	Semi looper *Autographa* spp.	leaves	9	--
10.	Pod borer *Laspeyresia* spp.	pods	10	--
11.	Leaf miners	leaves	50	5.5
12.	Leaf midges	leaves	17	7.5
13.	Ants	-	23	--
14.	Aphids	leaves, stems, pods	100	17.5
15.	Root aphid	roots	14	--
16.	Thrips	flowers, leaves, pods	71	13.5
17.	Grasshoppers	leaves	18	--
B.	**Other Pests**			
18.	Rats	whole plants	63	--
19.	Moles	whole plants	22	--
C.	**Predatory Insects**	**Insect attacked**		**% Field showing presence**
20.	Coccinellids	aphids		62
21.	Syrphids	aphids		4
22.	Chrysophids	aphids		4

* % of nodule infestation

** % of seed infestation.

Fifteen lentil off-station trials in 15 villages of Aleppo and Idleb were visited during the last week of March 1981 for scoring insects. The presence of damaging insects was scored. Additionally, leaflet damage by *Sitona* adults on 10 picked plants from each field was recorded.

Results and Discussion

The most common insect pests attacking lentils were *Sitona macularius* Marsham *(= S.crinitus* Hbst), *S. limosus* Rossi, *Apion arrogans* Wenck., thrips, the aphids *Acyrthosiphon pisum* Harris and *Aphis craccivora* Koch. and *Bruchus ervi* Froel; followed by leaf miners, *Agrotis* spp, *Heliothis armigera* Hb., *H. viriplaca* Hufn., grasshoppers, leaf midges, *Hypera variabilis* Hbst. *(= H. postica* Gyll.) , *H. subvittata* Cap. *(= H. striata* Boh.) . root aphid *Smynthurodes betae* Westw. *(= Trifidaphis phaseoli* Pass.), *Laspeyresia* spp., *Autographa gamma* L., *Sitona lineatus* L. and *Bruchus lentis* Froel. (Tables 1 and 2). The lentil parts attacked by these species are shown in Table 1. The curculionid *Strophomorphus hebraeus* Stierl. was collected only from Kamishly (Hassakeh) feeding on lentil leaflets.

The main findings of the survey in the district of Aleppo were that the average plant infestation levels were: *Sitona* spp. adult, 71.4% ; *Apion* spp. adult, 15.2% ; thrips, 13.5% ; aphids, 17.5% and leaf miners 5.5%.

The main findings of the survey in the district of Aleppo were that the average plant infestation levels were: *Sitona* spp. adult, 71.4% ; *Apion* spp. adult, 15.2% ; thrips,

Table 2. *Lentil insects in 15 localities in Aleppo and Idleb during the last week of March 1981.*

Location	*Sitona* adult	Percent leaflets infested by *Sitona*	*Apion* adult	*Bruchus* adult	*Heliothis* larvae	Semilooper larvae	Aphids	*Hypera*	Leaf midge
Aleppo									
Atareb	SM, SL	7.9	+	–	+	–	–	–	–
Ibbin	SM	29.8	–	–	–	–	–	HP	–
Ishqbar	SM, SL	19.8	–	+	+	–	–	–	+
Zetan Al Masna	SM	26.4	–	–	–	–	–	HP, HS	+
Derqaq	SM	9.9	–	–	–	–	–	–	–
Alqamiah	SM	15.6	–	–	+	–	–	HP, HS	+
Qurbeh	SM	22.3	+	–	–	–	AP	–	–
Hayan	SM	12.7	–	+	+	–	–	–	–
Idleb									
Kafar Yahmol	SM, SL	11.2	–	+	+	–	–	–	–
Tal-Tokan	SL	6.9	+	–	–	+	–	–	–
Ajez	SM	6.3	+	–	–	–	AP, AC	–	–
Bejghas	SM	6.5	–	+	+	+	–	–	–
Ram Hamdan	+	5.6	–	–	–	–	AP	+	–
Khan Sheikhoun	SM	5.2	+	–	+	–	–	–	–
Rass Alein	SM, SL	13.7	–	–	–	–	AP	–	–

\+ Present; – not present; SM = *Sitona macularius* Marsh; SL = *S. limosus* Rossi; AP = *Acyrthosiphon pisum* Harris; AC = *Aphis craccivora* Koch; HP = *Hypera postica* Gyll.; HS = *Hypera subvittata* Cap..

13.5% ; aphids, 17.5% and leaf miners 5.5% . *Sitona macularius* was observed in most of the fields and the highest percentage of infestation was recorded in Kafar Antoon (North of Aleppo), where it attacked 80% of seedling leaflets. *S. limosus* was less prevalent on lentils and the highest infestation percentage was in Atareb (West of Aleppo), where it attacked 70% of the seedling leaflets. *Hypera* spp. were observed attacking lentils in the Azaz area (North of Aleppo) with an average plant infestation of 12.8% . Leaf midge was observed at a high rate of infestation in Hassakeh. Root aphids were observed in Hama and Hassakeh governorates.

The predatory insects included the coccinellids *Coccinella septempunctata* L. (the most common species), *C. undecimpunctata* L., *Hippodamia variegata* Goeze, and *Hyperaspis waisi* Kh. plus syrphids and chrysopids. The predator *C. septempunctata* was observed in all the fields where aphids were found.

Vole holes and mole hills in lentil fields were observed in 63 % and 22% of the fields, respectively. In addition to the lentil insects reviewed by Hariri (1979; 1981), some insects were recorded for the first time on lentils in Syria. These are the curculionids *Hypera subvittata* (Cap.), *Strophomorphus hebraeus* Stierl., *Altonomous reitteri* Stierl., *Cleonus excorratus* Geoze, *Myllocerus* spp., *Pholicodes plebejus* (Boh.); the Meloid, *Meloe chrysocomus* Miller; the chrysomelid, *Phytodecta fornicata* Brug.; the bruchid, *Bruchidius albopictus* Allard, the pod borer, *Laspeyresia* spp.; and the root aphid, *S. betae* Westw. . Most of these insects are of no economic importance and not widely distributed.

Field evaluation of the economic importance of the main insect pests, leaf weevil and aphids, is in progress.

Acknowledgements

We thank the ICARDA Farming Systems Program staff for the support they gave us during the survey. We are indebted to the Commonwealth Institute of Entomology (London), and to Drs. J. Decelle (Belgium), N. Lodos (Turkey) and Z. Kaszab (Hungary) for their help in insect identification. Our thanks are due to the Entomology Laboratory technicians, Mr. B.S. Darweesh, Mr. M.E. Maarawi and Mr. M. Sebahi for their assistance.

References:

Hariri, G. (1979). ' Insect pests of chickpea and lentils in the countries of the Eastern Mediterranean. A review' *In:* Food Legume Improvement and Development. G.C. Hawtin and G.J. Chancellor, eds. ICARDA and IDRC. pp. 120 - 123.

Hariri, G. (1981). ' Insects and other pests' . *In:* Lentils. C. Webb and G.C. Hawtin, eds. CAB and ICARDA. pp. 173 - 189.

CHEMICAL CONTROL OF LENTIL INSECT PESTS IN NORTHERN SYRIA

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Lentil plants are subject to insect attack which may cause economic losses. To evaluate these losses, chemical control trials on lentil insect pests were conducted at Tel Hadya farm (ICARDA) during 1980 and 1981.

Lentil root nodules and leaflets are attacked by *Sitona* sp. larvae and adults, respectively; and the foliage is infested by aphids and other sucking and chewing insects. Buds and pods are infested by *Apion* spp. and pod borers (Tahhan and Hariri, 1982, in press). Several chemicals were used as soil and foliar treatments for controlling damaging insects and to determine infestation and crop loss. Timing of application was also evaluated.

Materials and Methods

1980 Experiment: Four treatments were tested in a randomized complete block design with four replicates of 6 x 6 m plot size and 20 rows/plot. The treatments were as follows:

1. Check

2. Carbofuran (Furadan G 5 %) was applied at 1 kg a.i./ha at planting (22.11.79) in seed furrows, followed by an application of 0.75 kg a.i./ha at the seedling stage (10.2.80) as top dressing between the rows.

3. Carbofuran was applied at 0.75 kg a.i./ha at the seedling stage (10.2.80) as top dressing between the rows, followed by three sprays of dimethoate (Rogor 40%) at 300 g a.i./ha each. These three sprays were applied on 9.4.80 (early flowering), 27.4.80 and 7.5.80, respectively .

4. Application of Carbofuran 0.75 kg a.i./ha at seedling stage (22.1.80) as top dressing between the rows, followed by three sprays of methidathion (Supracide 40%) at 500 g a.i./ha each. The first spray was at early flowering (9.4.80); the second and third were on 27.4.80 and 7.5.80, respectively.

1981 Experiment 1: Three treatments were tested in a randomized complete block design with four replicates of 36 row plots (10.8 m x 11 m). The treatments were:

1. Check.

2. Application of Carbofuran (Furadan G 5%) 1.5 kg a.i./ha at planting (25.11.80) in seed furrows.

3. Five sprays of deltamethrin (Decis 25 g/l) at 38 g a.i./ha each. The date of sprays were: March 8 and 31, April 13 and 27 and May 12, 1981.

1981 Experiment 2: Two treatments in 2 replicates with 80 row plots (24 m x 24 m). The treatments were:

1. Check

2. Carbofuran (Furadan G 5%) was applied at 1.5 kg a.i./ha at planting (22.11.80) followed by five sprays of methidathion (Supracide 4%) at 500 g a.i./ha each. The spraying dates were: March 8 and 31, April 13 and 27 and May 12, 1981.

All experiments were hand-weeded and non-irrigated. Fifty kg P_2O_5/ha were added to all plots before planting as a broadcast application.

To determine *Sitona* larval and adult infestation, 10 lentil plants were picked from each plot for every reading. In experiment 2, 1981, 20 plants were examined. Total and damaged leaflets and nodules were counted in each reading. The number of insect pests per m^2 in all experiments was counted in early May 1980 and 1981 and in mid-April for experiment 2.

Seeds from each experiment were kept indoors for evaluation of *Bruchus* infestation after the insect completed its development to adult stage (September-November).

Weight of 100 seeds and grain yield of each treatment were recorded.

Results and Discussion

Insects that were damaging lentils during the study included leaf weevil, *Sitona macularius* (Marsham); bud weevil, *Apion arrogans* Wenck; lentil black aphid, *Aphis craccivora* Koch; pea aphid, *Acyrthosiphon pisum* (Harris); thrips; pea moth, *Laspeyresia* sp.; pod borer, *Heliothis* spp.; and seed beetle, *Bruchus ervi* (Froel).

Among these insects, *S. macularius*, *Acyrthosiphon pisum*, thrips and *Apion arrogans* were the most abundant and injurious (Tables 1, 2 and 3).

Adult and larval infestations in carbofuran-treated and untreated plots are shown in Tables 1 and 2. Carbofuran, when applied at planting in seed furrows, ensured excellent control of *Sitona* spp. larvae infesting root nodules and good control of adults damaging leaflets (Tables 1, 2 and 3), but did not control *Sitona* adults when applied at the seedling stage (Table 1). Carbofuran, applied at planting time, did not control other insects which attacked lentils later in the season.

Foliar treatments of methidathion, dimethoate and deltamethrin gave good control of aphids and thrips. Methidathion was effective in controlling *Bruchus* and *Apion* infestation and superior to dimethoate and deltamethrin, which were ineffective against these insects.

Deltamethrin and methidathion were effective and gave good control of *Heliothis* and *Laspeyresia* larvae (Tables 1, 2 and 3).

Table 1. *Chemical control of insects on lentils at Tel Hadya, Syria in 1980.*

Treatments	% leaflets infested by *Sitona* adults		No. of insects/m^2 (167 plants)				% seeds infested by *Bruchus*	Yield (kg/ha)
	4.Feb.	3.Mar.	Pea aphids	Black aphids	Thrips	*Apion* adults		
Check	47.7	15.8	956	147	556	6	10.0	1830 a
Carbofuran[1]	16.7	3.8	945	292	267	11	12.8	1870 a
Carbofuran[2] + Dimethoate[3]	50.0	17.9	53	22	70	6	9.3	1970 a
Carbofuran[2] + Methidathion[3]	38.4	14.1	53	36	70	0	1.0	2140 a

Figures followed by the same letter are not significantly different at the 5% level.

[1] Applied at planting.

[2] Applied at the seedling stage.

[3] Three foliar sprays at two week intervals, beginning at early flowering stage.

Table 2. *Infestation by major insect genera, aphid numbers and the crop yield of treated and untreated lentils at Tel Hadya in 1981.*

	Percent infestation of									No. of aphids/m^2		Weight of	
	Nodules by *Sitona* larvae 21.Apr.	Leaflets by *Sitona* adults 12.1 to 6.4.	Plants by *Apion* adults 21.4.	Plants by *Apion* larvae 21.4.	Plants by Thrips 21.4.	Plants by Aphids 21.4.	Pods by Pea moth 27.5.	Pods by Pod borer 27.5.	Seeds by *Bruchus*	Pea aphids 5.5.	Black aphids 5.5.	100 seeds (g)	Grain yield (kg/ha)
Check	97	26	98	8	80	35	4	2	1.6	309	27	6.9	1513 (b)
Carbo-furan[1]	3	7	83	10	90	43	4	4	1.5	481	28	7.3	1758 (ab)
Delta-methrin[2]	92	24	73	13	8	5	0.1	0.2	1.0	15	2	7.6	1946 (a)

Figures followed by the same letters are not significantly different at the 5% level.

[1] Applied at planting.

[2] Five foliar sprays between 8 March and 12 May.

Table 3. *Infestation by major insect genera, aphid numbers and crop yield of treated and untreated lentils at Tel Hadya in 1981.*

Treatments	Percent infestation of					
	Nodules by *Sitona* larvae 6.Apr.	Leaflets by *Sitona* adults 12.1 to 6.4.	Plants by *Heliothis* larvae 27.5.	Pods by *Heliothis* larvae 19.5.	Pods by *Laspeyresia* larvae 27.5.	Seeds by *Bruchus* 30.11.
Check	92	23	31	6	5	2.0
Carbofuran + Methidathion	1	6	5	1	2	0.3

In all treated plots, lentil grain yield increased in a range of 2 to 29% . Only deltamethrin gave a significant increase of 29% in yield. These results show that yield loss in lentil can be attributed to insects attacking foliage later in the season since deltamethrin gave excellent control of aphids and thrips when used from early March to mid-May at two week intervals; and did not control *Sitona*, the main insect attacking lentils early in the season. Although carbofuran reduced *Sitona* adult infestation by about 70%, crop yield increased insignificantly by 2% and 16% in 1980 and 1981, respectively.

Plants infested with *Sitona* larvae and adults, may be able to compensate for this damage, if chemicals are used to control other insects present later in the season.

Reference:

Tahhan, O. and G. Hariri (1982). ' Survey of lentil insects in northern and north-eastern Syria' .

LENTIL RISSOLES

1 lb. lentils
1 lb. mashed potatoes
white of 1 egg
1 chopped fried onion
pepper and salt
parsley, chopped fine

Soak lentils. Cook in a little water until tender. Add other ingredients to lentils and mix well together. Roll in flour and form into rissoles or sausages. Coat with white of egg and fry until a golden brown colour.

(from 'Lentil Cook Book' by Lorna Hawtin. ICARDA, Aleppo, 1980).

Seed Quality and Nutrition

A NOTE ON THE CHEMICAL COMPOSITION OF IMPROVED GENOTYPES OF LENTILS

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Plant breeders are guided in their hybridization programme by the chemical and nutritive value of their genetic material. The present study was undertaken to determine the potential of some improved genotypes for such a programme.

Materials and Methods

Fifteen strains of lentils were grown in a randomized block design at the farms of Punjab Agricultural University, Ludhiana during the winter season of 1980-81. Each strain was grown in a plot of 10 rows, 5 m long and 22.5 cm apart.

Data on yield were recorded on a per plot basis; seeds per pod and 100-seed weight on the basis of five random plants per replication; and for crude fiber, fat, protein, total digestible carbohydrates (TDC) and mineral content, the bulk sample from each replication per entry was used for the analysis. Crude protein was determined by the micro-kjeldahl method of McKenzie and Wallace (1954) and the factor 6.25 was used to convert the nitrogen into protein percentage (Pant and Tulsiani, 1969). Total fat, crude fiber and ash (minerals) were determined using the methods of AOAC (1970). The total digestible carbohydrates were calculated by subtracting the percentage

Table 1. *Chemical composition (%) and agronomic performance of 15 lentil strains.*

Strain	Protein	Fat	Mineral Matter	Total digestible carbohydrates	Crude fiber	100-seed wt. (g)	Seeds/ pod	Seed yield (g/plot)
LL 48	21.67	1.78	2.61	68.90	5.04	2.00	1.75	31.50
LL 56	21.72	1.66	2.36	69.67	5.72	1.38	1.75	28.25
LL 79	22.14	1.70	2.64	68.71	4.22	2.00	1.60	26.50
LL 116	21.58	1.78	2.48	70.28	5.64	1.64	1.60	26.00
LL 75	22.08	1.73	2.60	68.70	5.12	1.60	1.60	25.35
L 9-12	23.15	1.77	2.85	67.26	4.97	1.95	1.75	24.06
LG 120	21.32	1.72	2.50	69.46	5.16	2.14	1.65	24.00
LL 73	23.46	1.60	2.35	66.79	4.89	1.28	1.60	21.50
LL 72	22.17	1.72	2.50	67.88	5.76	1.38	1.65	20.75
LL 78	23.25	1.56	2.51	67.82	4.82	1.90	1.75	18.00
LG 7	21.90	1.68	2.24	69.49	4.38	2.00	1.60	16.90
LL 1	22.14	1.50	2.39	68.64	5.19	1.71	1.65	13.50
LL 30	21.83	1.48	2.45	64.23	5.50	1.47	1.70	13.00
L 1278	22.18	1.82	2.53	67.92	5.41	1.66	1.45	5.68
L 830	22.64	1.76	2.30	67.60	4.84	2.06	1.75	4.82
Mean	22.22	1.69	2.49	68.22	5.11	1.84	1.66	19.98
C.D. 5 %	0.783	0.134	0.122	N.S.	0.221	0.068	0.423	5.050

summation of protein, fat, crude fiber and ash from 100. Simple correlations were calculated by standard procedures.

Results

The ANOVA for different traits revealed that there were significant differences among strains for the different traits except total digestible carbohydrates. LL 48 was the highest yielder (3150 kg/ha) and was followed by LL 56, LL 79, LL 116, LL 75 (Table 1). LG120 had the largest 100-seed weight followed by L 830, LL 79, LL 48 and L 9-12. The range for seeds per pod was only 1.60 to 1.75. The protein content was highest for LL 73 (23.46 %) and was followed by LL 78 (23.25 %), L 9-12 (23.15 %) and L 830 (22.64%). In general, none of the high yielding lines possessed high protein content. The fat content ranged from 1.48 percent to 1.83 percent and the lines possessing high fat percent included L 1278, LL 116, LL 48, L 9-12, and L 830. The percent range for mineral matter was 2.30 to 2.85, for starch from 64.23 to 70.28, and for crude fiber from 4.22 to 5.76 % . Line L 9-12, which is the released cultivar of the State of Punjab, possessed most of the desirable traits including protein, fat, mineral matter, seed size and seeds per pod. In addition to L 9-12, a few more lines including LL 73, LL 78, L 9-12, L 830, L 1278, and LL 48 exhibited their superiority for one or the other trait; such lines may be extensively used in a hybridization programme designed to combine these traits into a single line using conventional breeding procedures. Correlations between these characters were estimated, but all were statistically not significant. Considering the small sample size, no conclusive inferences can be drawn on this aspect.

References:

AOAC (1970). ' Methods of analysis of the Association of Official Analytical Chemists'. W. Horomitz, ed., Washington, D.C., U.S.A.

McKenzie, H.A. and Wallace, H.S. (1954). ' The Kjeldahl's determination of nitrogen' . Aust. J. Chem. 17: 55.

Pant, R. and Tulsiani, D.R. (1969). ' Solubility, amino acid composition and biological value of proteins isolated from leguminous seeds ' . J. Agric. Food Chem. 17: 361.

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EFFECT OF SEED COAT DARKENING ON GERMINATION AND YIELD OF LENTILS

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In the summer of 1980, seeds of Laird lentil were separated into categories on the basis of color and planted at the Central Experimental Farm (CEF),Ottawa. Plants grown from "yellow" seeds were found to produce an average of 20% more dry matter per 100 seeds planted than did "green" seeds (Nozzolillo and Bezada, 1981). The experiment was repeated in 1981 with 3 categories of seed color separated: green , green-yellow , and yellow. Five lots of 100 seeds of each color were planted on May 7, 1981, in a plot at the CEF which had not previously been sown to lentils. Each lot of 100 seeds was surrounded by a border planting of lentils separated by a distance of 15 cm. Germination was counted 2 weeks later and at 8 weeks plants were thinned to 60 per row spaced at about 7 cm intervals. Shoots were harvested at 12 weeks and air-dried to constant weight. Results presented in Table 1 show that a) germination was significantly less for yellow seeds, as observed previously and b) no significant difference in yield was obtained when the 3 color categories were compared, although the mean value was slightly lower with each change in seed color. This is not what was observed in 1980, but there were some important differences between the 2 years:

1) The plants had an earlier start in the season (9 days) in 1981, in soil not carrying a heavy inoculum of *Fusarium* from previous lentil plantings.

2) They were thinned to equal spacing in the row, and each row was surrounded by a border row, and

3) Plants in 1981 suffered less from fungal damage than in 1980, and many survived to produce a crop of seeds.

It is interesting to note that plants growing in the heavier soil on one end of the long narrow plot used in 1981 were more severely affected by fungus than were plants growing in the more sandy soil on the opposite end. Three lots grown from green or green-yellow seeds produced an average of only 129 g dry wt. per 60 plants in the heavier soil, while 3 lots grown from yellow seeds in the same soil produced an average of 161 g per 60 plants. That is, under conditions of severe fungal infection, plants grown from yellow seeds produced about 25% more dry matter than plants grown from green seeds. One would not expect to find any differences in yield results from differences in the color of the seeds at planting time, and the results of 1981 support this expectation. Nevertheless, there was an indication, as in 1980, that lentil plants grown from yellow seeds yield about 20 - 25% more dry matter when under severe fungal attack than do plants grown from green seeds selected from the same harvest. Further testing of this intriguing phenomenon is planned for 1982.

Reference:

Nozzolillo, C. and M. de Bezada (1981). 'Effect of seed coat darkening on germination and yield in lentils' LENS 8: 11-13.

Table 1. *Seed color, germinability, and yield of Laird lentil seeds.*

Seed color	Germination (% ± S.D.)	Yield (g/60 plants at 12 weeks, S.D.) Shoot dry wt.	Seeds
Green	89 ± 5	186 ± 47	25 ± 5
Green-yellow	91 ± 7	182 ± 61	24 ± 14
Yellow	65 ± 8	176 ± 27	23 ± 14

ESAU SAYS

Commuted to lentils.
Drown in a sea of lentils.
On my lentil-stuffed cushion.
Hope springs like lentils.
And what the prophets have always wanted is a miraculous multiplication of lentils.
And when he arose on the third day his hunger for lentils was great.
Beginning at breakfast.
Thickened till the spoon stands erect.
With marjoram-seasoned shoulder of mutton.
Or remembered lentils: once when King Stephen Batory returned to camp from the hunt
Mother Margarete Rusch boiled up a (tough, year-old) pheasant with lentils to make him a polish-style soup.
With a bagful I walked without fear,
Since me, birthrights have been available.
Paid off, I live by lentil law.
My little brother has a tough time of it.

From ' The Flounder ' by Gunther Grass, 1978, p. 190.

LYGUS BUGS AND SEED QUALITY IN LENTILS

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Physical deformations, referred to colloquially as " chalky spot" (Plate 1), are not uncommon on lentil seeds harvested from crops grown in eastern Washington and northern Idaho (USA). Seed lots with chalky spot command prices inferior to undamaged ones, but farmers have not been able to pinpoint how or when the damage occurs. In an attempt to resolve the problem, we have solicited the opinions of local producers, carried out numerous and varied investigations on damaged and undamaged seeds, and investigated the consequences when *Lygus* bugs are caged onto pot-grown plants in a glasshouse (Summerfield *et al.* 1981).

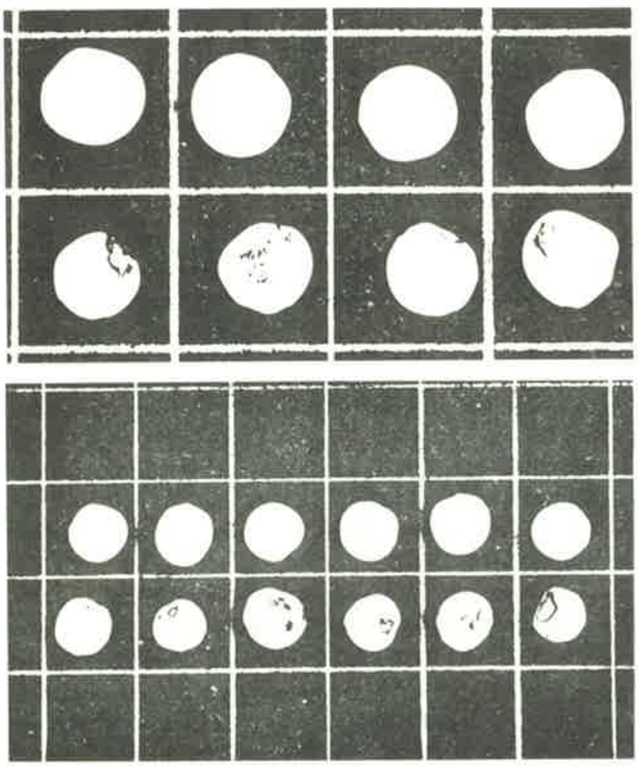

Plate 1. Seeds of lentil cv. Chilean damaged (above in each case) or not (below) by chalky spot syndrome (lines are a 1 cm^2 grid).

Data from each of these diverse types of investigations lend mutually supporting evidence to the hypothesis: ' Chalky spot syndrome of lentil seeds is the result of *Lygus* bugs feeding on immature reproductive structures' . Furthermore, it seems probable that depredations by these pests can not only result in the formation of seeds of poor quality, but may also reduce economic yield *per se.* Caging bugs onto pot-grown plants at the appearance of first flowers increased the subsequent prevalence of more-or-less shrivelled, unfilled pods by 13.0-15.1 % (3 cultivars); promoted the abscission of immature pods by 22.6 % on cv. ' Chilean' (the cultivar which dominates commercial production in the Palouse) but did not significantly affect pod abscission on two exotic accessions; increased seed abortion by 4.3-19.7 % (3 cultivars) and so reduced yields by 18.1-26.2 % compared with *Lygus*-free control plants. Then again, between 16.4 and 40.2 % of the seeds harvested had chalky spot damage, whereas none were damaged on plants kept free from *Lygus* throughout growth.

Scanning and transmission electron micrographs of damaged and healthy cotyledons dramatically exposed the consequences of chalky-spot syndrome for cellular integrity. Damaged cells contained very little rough endoplasmic reticulum but osmiophilic droplets, never seen in healthy cells, were common. These droplets may be "congealed" cellular contents, " coagulated" membranes or may even have been extra-cellular in origin. Damaged cells seldom contained the starch grains common in undamaged ones.

Cooked samples, comprising 10 or 20 % chalky spot seeds (by weight), were evaluated for sensory characteristics, texture and colour. Samples with damaged seeds were slightly, but not significantly, " less sweet , " more bland", and " more prone to become mushy during cooking ". These changes, although undesirable, could not, by themselves, be the basis for down-grading seed lots comprising up to 20% chalky spot seeds by weight.

The consequences of chalky spot may persist into storage and through to subsequent crops. Damaged seeds seem prone to more rapid deterioration in storage, they leaked cellular contents more readily when imbibed and were more susceptible to attack from fungal pathogens; some (about 5 %) did not contain embryos. Germination of damaged seeds was retarded and less successful than in visibly healthy seeds; the seeds which did germinate often produced abnormal seedlings with morphological characteristics similar to those associated with mechanical damage in other grain legumes.

References:

Summerfield, R.J.; Muehlbauer, F.J. and Short, R.W. (1981). ' *Lygus* bugs and seed quality in lentils *(Lens culinaris* Medik).' USDA Production Research Booklet (in press).

Latest Lentil References

A. Genetics, Breeding and Agronomy

Ahlawat, I.P.S.; Singh, A. and Saraf, C.S. (1981). ' Effects of winter legumes on the nitrogen economy and productivity of succeeding cereals'. Exp. Agric. 17: 57-62.

De Bezada, M. and Nozzolillo, C. (1980). ' The effects of storage conditions on lentil *(Lens esculenta)* seeds'. Plant Phys.. 65 (6 suppl.): 104 (Abstr.).

De Bezada, M.V. (1980). ' Effect of environmental conditions on lentil seeds'. Unpublished M. Sc. thesis. University of Ottawa, Ottawa, Ontario. 76 pp.

Bhalla, M.K. and Schneider, E.F. (1981). ' A Fusarium root rot of lentils *(Lens culinaris)'.* Phytopathol. 71: 203. (Abst.).

Bhargava, S.N.; Shukla, D.N.; Pandey, R.S. and Khati, D.V.S. (1981). 'Some new root rot and seedling blight diseases of pulses and oil crops caused by *Fusarium solani'.* Acta Bot. Indica 9: 127-128.

Bhatty, R.S. (1981). ' Laird lentil research project'. Agricultural Development Corporation of Saskatchewan, Regina. 12 pp. (Cooking quality).

Bisen, C.R.; Tomar, S.S.; Shivamurthy, R.B. and Kashyap, M.L. (1980). 'Response of lentil *(Lens esculenta)* to *Rhizobium* inoculation and fertilization under different moisture regimes'. Mysore J. Agric. Sci. 14: 483-486.

Blakey, L.J. and Priest, F.G. (1980). ' The occurrence of *Bacillus cereus* in some dried foods including pulses and cereals'. J. Appl. Bacteriol. 48: 297-302.

Chauhan, R.P.S. and Asthana, A.K. (1981). ' Tolerance of lentil *(Lens esculenta),* barley *(Hordeum vulgare)* and oats *(Avena sativa)* to boron in irrigation water'. J. Agric. Sci. 97: 75-78.

Daghir, N.J.; Sell, J.L. and Mateos, G.G. (1981). ' Effects of gamma irradiation on nutritional value of lentils *(Lens culinaris)* for chicks'. Poult. Sci. 60: 1643 (Abstr.).

Duczek, L. and Buchan, J.A. (1981). ' The effect of captan seed treatment on emergence, nodulation, seed yield and seed protein content of lentils'. Can. J. Plant Sci. 61: 727-730.

El-Nahry, F.I.; Mourad, F.E.; Abdel Khalik, S.M. and Bassily, N.S. (1980).' Chemical composition and protein quality of lentils *(Lens)* consumed in Egypt'. Qual. Plant. Foods Hum. Nutr. 30(2) : 87-96.

Eutaxias, Ch. and Iliadis, K. (1980). ' Assessment and adaptability of 10 small-seeded lentil varieties'. Agric. Res. , Greece 4(2) 211 - 218.

Fatma, M.; Kies, C. and Fox, H.M. (1981). ' Evaluation of methionine supplementation of legume based diets - biological approach'. Nutr. Rep. Int. 23: 485-492.

Fisher, J.R. and O'Keeffe, L.E. (1979). ' Host potential of some cultivated legumes for the pea leaf weevil, *Sitona lineatus*:Coleoptera *(Curculionidae).* Pan-Pac. Entomol. 55: 199-201.

Fisher, J.R. and O'Keeffe, L.E. (1979). ' Food plants of the pea leaf weevil *(Sitona lineatus*: Coleoptera *(Curculionidae)* in northern Idaho and eastern Washington, U.S.A.' Pan-Pac. Entomol. 55: 202-207.

Govind, P.; Agrawal, P.K. and Singh, V.P. (1977). ' Seed germination and seedling growth in response to sulfur dioxide'. Plant Sci. 9: 79-80.

Haddad, N.I.; Bogyo, T.P.; Muehlbauer, F.J. (1982). ' Genetic variance of six agronomic characters in three lentil *(Lens culinaris* Medic.) crosses. Euphytica 31, 113 - 120.

Hamilton, M.J. and Vanderstoep, J. (1979). ' Germination and nutrient composition of alfalfa seeds'. J. Food Sci. 44: 443.

Hawtin, G.C.; Singh, K.B. and Saxena, M.C. (1980). ' Some recent developments in the understanding and improvement of *Cicer* and *Lens'.* In: Advances in legume science. London, HMSO, 613 - 624.

Haytowitz, D.B.; Marsh, A.C. and Matthews, R.H. (1981). ' Content of selected nutrients in raw, cooked and processed legumes'. Food Technol. 35(3): 73-74.

Holt, N.W. and Sosulski, F.W. (1981). ' Non-protein nitrogen contents of some grain legumes'. Can. J. Plant Sci. 61: 515-523.

Kaiser, W.J. (1981). ' Diseases of chickpea, lentil, pigeon pea, and tepary bean in continental United States and Puerto Rico'. Econ. Bot. 35: 300-320.

Kaiser, W.J. and Horner, G.M. (1981). ' Root rot of irrigated lentils in Iran'. Can. J. Bot. 58: 2549-2556.

Kannaiyan, J. and Nene, Y.L. (1974). ' Effect of fungicidal seed treatment on wilt disease of lentil'. Ind. J. Pl. Prot. 2 (½) : 80-85.

Kannaiyan, J. and Nene, Y.L. (1975). ' Note on the effect of sowing dates on the reaction of twelve lentil varieties to wilt disease'. Madras Agric. J. 62: 240-242.

Kannaiyan, J. and Nene, Y.L. (1976). ' Reaction of lentil germplasm and cultivars against three root pathogens '. Ind. J. Agric. Sci. 46(4): 165-167.

Kannaiyan, J.; Tripathi, R.K. and Nene, Y.L. (1976). ' Degradation and persistence of benomyl in lentil'. Ind. Phytopath. 28: 305-306.

Kamel, M.; Shatla, M.N. and Elshanavi, M.Z. (1973). ' Histopathologische untersuchungen an hypokotylen von linsen infiziert mit *Fusarium solani'.* Zt. PflKrank. PflSchutz., 80: 547-550.

Kylen, A.M. and McCready. (1975). ' Nutrients in seeds and sprouts of alfalfa, lentils, mung beans and soybeans'. J. Food Sci. 40: 1008-1009.

Lakhanov, A.P. and Balachkova, N.E. (1980). ' Effect of low positive temperatures on seed productivity of leguminous plants'. Fiziol. Biokhim. Kul't. Rast. 12: 137-142.

Morrall, R.A.A. and Sheppard, J.W. (1981). ' Ascochyta blight of lentils in western Canada: 1978 to 1980'. Can. Pl. Dis. Surv., 61: 7 -13.

Muehlbauer, F.J.; Short, R.W.; Summerfield, R.J.; Morrison, K.J. and Swan, D.G. (1981). ' Description and culture of lentils'. Washington St. Univ. Coop. Ext. Bull. No. 957, 8 pp.

Nandan, R. and Pandya, B.P. (1980). ' Correlation, path coefficient and selection indices in lentil'. Ind. J. Gen. 40: 399-404.

Parveen, G. and Prakash, D. (1981). ' Studies on the seed mycoflora of lentil'. Acta Bot. Indica 9: 158-159.

Sanoria, C.L. and Mallik, M.K. (1981). ' The effect of seed inoculation with *Rhizobium* and *Azotobacter* on yield and quality of lentils *(Lens esculenta)'.* J. Agric. Sci. 97: 237-239.

Sarbhoy, R.K. (1980). ' Effect of p-dichlorobenzene on the somatic chromosomes and mitosis of *Lens esculenta'.* Cytologia (Tokyo) 45: 381-388.

Sharma, S.K. and Sharma, B. (1979). ' Leaf mutations induced with NMU and gamma rays in lentil *(Lens culinaris* Medic.) ' Curr. Sci. 48: 916-917.

Sharma, S.K. and Sharma, B. (1980). ' Induced mutations of physiological nature in lentil'. Ind. J. Gen. 40: 290-294.

Sharma, S.K and Sharma, B. (1981). ' Gamma ray induced crumpled petal mutation in lentil *(Lens culinaris* var. *microsperma)'.* Ind. J. Agric. Sci. 51: 119-120.

Singh, G.P. and Ji, T. (1979). ' Seeds mycoflora from flood affect grain samples of East Uttar Pradesh, India'. Ind. J. Mycol. Pl. Pathol. 9: 255-256.

Singh, N.; Bansal, M.L. and Basra, B.S. (1978). ' Production of pulses in the Punjab, India'. Crop Improv. 5: 155-161.

Singh, S.J. and Sokhi, S.S. (1980). ' Pathogenic variability in *Uromyces viciae fabae'.* Pl. Dis. 64: 671-672.

Slinkard, A.E. (1981). ' Eston lentil'. Can. J. Plant Sci. 61: 733-734.

Soran, H. (1977). ' The fungus disease situation of edible legumes in Turkey'. J. Turkish Phytopathol. 6: 1-7.

Soran, H. (1979). ' Nachweis der wurzelfauleerreger on linsen in der umgebung von Ankara.' (Detection of causal agents of root rot of lentils in the outskirts of Ankara)' J. Turkish Phytopathol. 8(1): 1 - 8.

Summerfield, R.J. and Muehlbauer, F.J. (1982). ' Controlled environments as an adjunct to field research on lentils *(Lens culinaris).* I. Perspectives, tenets and objectives'. Expl. Agric. 17: 363-372.

Summerfield, R.J. and Muehlbauer, F.J. (1982). ' Controlled environments as an adjunct to field research on lentils *(Lens culinaris).* II. Research strategy'. Expl. Agric. 18: 3-15.

Summerfield, R.J.; Muehlbauer, F.J.; Short, R.W. (1982). ' Description and culture of lentils'. US Dep. Agric., ARS, Prod. Res. Rep., Pullman, Washington, No. 181, 22 pp.

Vishunavat, K. and Shukla, P. (1980). ' Combined effect of lentil *(Lens culinaris)* seed mycoflora on amino acid contents of its seed'. Ind. J. Mycol. Pl. Pathol. 10: 76.

B. Biochemistry and Physiology

Bhatty, R.S. (1982). ' Albumin proteins of eight edible grain legume species; electrophoretic patterns and amino acid composition'. J. Agric. Food Chem. 30, 620 - 622.

Chavan, J.K. and Heljaard, J. (1981). ' Detection and partial characterization of subtilisin inhibitors in legume seeds by isoelectric focusing'. J. Sci. Food Agric. 32: 857-862.

Ek, K.; Cianazza, E. and Righetti, P.G. (1980). ' Affinity titration curves, determination of dissociation constants of lectin-sugar complexes and of their pH dependence by isoelectric focusing electrophoresis'. Biochim. Biophys. Acta 626: 356-365.

Engvild, K.C.; Esgaard, H. and Larsen, E. (1981). ' Determination of 4-chloro IAA methyl ester in Vicieae species by gas chromatography mass spectrometry'. Physiol. Pl. 53: 79-81.

Foriers, A.; Lebrun, E.; Van Rapenbusch, R.; De Neve,R. and Strosberg, A.D. (1981). 'Structure of the lentil *(Lens culinaris)* lectin, amino acid sequence determination and prediction of the secondary structure'. J. Biol. Chem. 256: 5550 - 5560.

Gomes, J.; Debnath, J.C.; Winterhalter, M.; Jadric,S. and Brkic, S. (1979). ' Electrophoretic patterns of alcohol dehydrogenase, lactate dehydrogenase and malate dehydrogenase in leguminous seeds'. Acta Biol. Med. Exp. 0 (Suppl. 1): 66 - 67. (Abstr.).

Hankins, C.N.; Kindinger, J.I. and Shannon, L.M. (1980). ' Legume alpha galactosidase forms devoid of hemagglutinin activity'. Plant Physiol. (Bethesda) 66: 375-378.

Hofinger, M.; Thorpe, T. Bouchet, M. and Gaspar, T. (1980). ' Auxin-like activity of benzo-B-selenienyl-3 acetic acid'.. Acta Physiol. Pl. 2: 275-280.

Horejsi, V. and Ticha, M. (1981). ' Affinity isoelectric focusing in polyacrylamide gel, a method to detect ligand binding proteins'. Anal. Biochem. 116: 22-26.

Kaczmarek, U. and Giebel, J. (1980). ' Disturbances of plant cell mitosis caused by *Globodera rostochiensis* and some plant tissue substances'. Bull. Acad. Pol. Sci. Ser. Sci. Biol. 27: 969-974.

Klimenko, U.G. and Ibragimov, T.T. (1981). ' Chromato-electrophoretic properties of proteins from the seeds of legumes cultivated under various ecological conditions'. Izv. Akad. Nauk. Mold. SSR. Ser Biol. Khim Nauk. No. 1: 26-34.

Kornfeld, K.; Reitman, M.L. and Kornfeld, R. (1981). ' The carbohydrate binding specificity of pea and lentil lectins-fucose is an important determinant'. J. Biol. Chem. 256: 6633-6640.

Kuhla, S. and Ebmeier, C. (1981). ' Tannin content of horse beans. I. Methodical investigations for determining condensed tannins in horse beans'.Arch. Tierernaehr. 31: 573-388.

Kuzmanoff, K.M. and Evans, M.L. (1981). ' Kinetics of adaptation to osmotic stress in lentil *(Lens culinaris)* roots'. Pl. Physiol. (Bethesda) 68: 244-247.

Malinow, M.R. and Burns, A.K. (1980). ' In vitro removal of micellar cholesterol by dietary plants rich in fiber'. Amer. J. Clin. Nutr. 33: 940 (Abstr.).

Matsumoto, I.; Jinbo, A.; Kitagaki, H.; Golovchenko-Matsumoto, A.M. and Send, N. (1980). ' Detection of lectin-sugar interaction by UV difference spectroscopy'. J. Biochem. (Tokyo). 88: 1093-1096.

Morad, M.M.; Leung, H.K.; Hsu, D.L. and Finney, P.L. (1980). 'Effect of germination on physicochemical and bread making properties of yellow pea, lentil and faba bean flours and starches'. Cereal Chem. 57: 390-396.

Pandey, R.K. (1979). ' Physiology of yield of lentil and utilization of ^{14}C assimilate'. Legume Res. 2: 73-78.

Pandey, R.K.; Singh, V.B. (1980). ' Distribution and utilization of ^{14}C assimilate in lentil *(Lens esculenta)'.* J. Nucl. Agric. Biol. 9(2): 47-49.

Robeson, D.J. and Harborne, J.B. (1980). ' A chemical dichotomy in phytoalexin induction within the tribe Vicieae of the Leguminosae'. Phytochem. (Oxf.) 19: 2359-2367.

Rouge, P. and Causse, H. (1980). ' In vitro study of interaction between lectins and glycoproteins from legume seeds using fluorescein labelled lectins'. Bull. Soc. Bot. Fr. Let. Bot. 127(4): 311-318.

Rzhanova, E.I.; Shaklin Khasan, N. and Shalabi, T.A. (1979). 'Effect of different light regimes on morphogenesis of legumes'. Biol. Nauki (Moscow). No. 6: 68-72.

Salle, G. (1979). ' Effects of an extract from mistletoe *Viscum album* on the growth of *Lens culinaris* roots'. Biol. Cell. 35(2): 7A (Abstr.).

Siddiki, S. Kh. and Klimenko, V.G. (1980). ' Comparative chromatographic and electrophoretic study of lentil and chickpea seed albumin'. Izv. Akad. Nauk. Mold. SSR Ser. Biol. Khim Nauk. No. 4: 19-23.

Summerfield, R.J.; Meehlbauer, F.J.; Short, R.W. (1982). ' Description and culture of lentils'. US Dep. Agric., ARS, Prod. Res. Rep., Pullman, Washington, No. 181, 22 pp.

Tyler, R.T.; Youngs, C.G. and Sosulski, F.W. (1981). 'Air classification of legumes. 1. Separation efficiency, yield and composition of the starch and protein fractions'. Cereal Chem. 58: 144-148.

Vanderstoep, J. (1981). ' Effect of germination on the nutritive value of legumes'. Food Technol. 3: 83-85.

Varshney, C.K. and Garg, K.K. (1980). ' Significance of leaf surface characteristics in plant response to air pollution'. Water Air Soil Pollut. 14: 429-434.

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SHAWRABAT ADAS (LENTIL SOUP) — **SYRIA & LEBANON**

1½ c. lentils	5 cloves garlic
2½ lbs. swiss chard leaves or spinach	1½ tsp. salt
3/4 c. chopped onions	3/4 c. lemon juice (to taste) or 2 tbsp. tomato puree mixed in 3/4 c. water
3/4 c. olive oil	1 tsp. flour
1 bunch coriander	
1 stalk celery	

In pressure cooker: wash the lentils and drain overnight. Wash again in the morning and pich over. Cook with water to cover under pressure for 10 minutes. Add chopped chard leaves, a few stems and 1 cup water. Cook under pressure for another 8 minutes. Meanwhile, fry onions in olive oil and garlic crushed with salt. Add washed and chopped coriander or celery. Add with the onions to the lentil chard mixture. Stir. Add lemon juice mixed with one teaspoon flour to thicken sauce. Simmer until a thick soup consistency. Add seasonings. Serve hot.

Variation
In saucepan: Boil washed lentils until tender, add hot water as necessary. Combine lentils with chard fried onions and garlic mixture. Continue as above.

Serves 6

(from 'Lentil Cook Book' by Lorna Hawtin. ICARDA, Aleppo, 1980).

The Lentil Experimental News Service (LENS) is provided by the International Center for Agricultural Research in the Dry Areas (ICARDA) and the University of Saskatchewan, Canada. This Newsletter appears in ICARDA's Scientific Newsletter publication series. For details of other ICARDA publications, please write to:

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