Vol. 11, No. 1, 1984

Lens NEWSLETTER

Lentil Documentation at ICARDA

ICARDA

The International Center for Agricultural Research in the Dry Areas is a non-profit research center established in 1977 by the Consultative Group on International Agricultural Research (CGIAR). ICARDA's aim is to improve food production in the developing countries in North Africa and West Asia. The center focuses mainly on winter rainfall areas with 200-600 mm annual rainfall. When appropriate, research also covers environments with monsoon rainfall or irrigation.

ICARDA is a world center for the improvement of barley, lentils, and faba beans, and a regional center for improving wheat, chickpeas, farming systems, and pasture and forage crops. Training agricultural researchers from developing countries is an important part of ICARDA's activities.

CGIAR, an association of governments, organizations, and private foundations, supports agricultural research worldwide to improve food production in developing countries, through a network of 13 international research institutions, including ICARDA.

LENS

LENS Newsletter is produced twice a year at ICARDA in cooperation with the University of Saskatchewan, Canada, with the financial support of the International Development Research Centre (IDRC), Ottawa, Canada.

LENS, the newsletter of the Lentil Experimental News Service, is a forum for communicating lentil research results. Short research articles provide rapid information exchange, and comprehensive reviews are invited regularly on a specific area of lentil research. The newsletter also includes book reviews, key abstracts on lentils, and recent lentil references.

The Lentil Experimental News Service provides information on lentil research free of charge through a question and answer service, photocopies, and searches of a lentil document collection.

DEADLINE: Contributions must reach LENS for Vol. 11(2) by September 30, 1984; and for Vol. 12(1) by March 31, 1985.

SUBSCRIPTIONS: LENS Newsletter is available free to lentil researchers under an IDRC grant. To subscribe, write: LENS/Communications and Documentation Department/ICARDA/P.O. Box 5466/Aleppo, Syria.

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COVER PHOTO: LENS coordinator Kamal Hindawi (left) introduces ICARDA's information collection on lentils—probably the most comprehensive in the world—to two lentil breeding trainees at ICARDA: Mahmoud Askarian (center), a food legume breeder and agronomist from the Seed and Plant Improvement Institute of Iran; and Ahmed Abdel-Hafez Nafal (right), agronomist from the Food Legume Section of the Agricultural Research Station in Egypt. Trainees from the Middle East and North Africa learn about documentation assistance for researchers provided by ICARDA—services they can draw upon when they return to their countries.

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Vol. 11, No.1, 1984

Lens NEWSLETTER

Pierre Kirkby.

CONTENTS

Page

FEATURE ARTICLE

1 Documentation assistance for lentil scientists worldwide
K.Kh. Hindawi and P.J. Kemp

RESEARCH ARTICLES

GENERAL

4 Whither LENS ?
W. Erskine and K.Kh. Hindawi

5 Lentil consumption in the Khartoum area
Abdallah El-Mubarak Ali, Asma Mohamed Ali, and Thomas L. Nordblom

BREEDING and GENETICS

7 Non-hierarchical cluster analysis in lentil
R.L. Sapra, Basant Kumar, and K.L. Mehra

10 Variation at soluble enzyme loci in four *Lens* species
D.O.F. Skibinski and M.E. Warren

13 Variability in lentil germplasm
R.P. Sinha and S.K. Chowdhary

15 Effect of colchicine on lentil
M.L. Tawar and V.K. Gour

AGRONOMY and MECHANIZATION

18 The effect of sowing dates and rates on lentil yield components
A. Krarup H.

20 Response of lentil varieties to iron application in calcareous soil
B.P. Singh, R. Sakal, and A.P. Singh

Page

PHYSIOLOGY and MICROBIOLOGY

22 Seed viability in lentils (*Lens culinaris*)
I.S. Solanki, B.S. Dahiya, and V.P. Singh

PESTS and DISEASES

24 A method to artificially inoculate lentil rust
V. Kramm M. and J. Tay U.

24 Analysis of some structural and biochemical constituents of rust-resistant and susceptible cultivars of lentil
P.N. Reddy and M.N. Khare

27 Observations on infestation of *Lens culinaris* by *Bruchus lentis* in the Chandigarh area of India
H.R. Pajni and K. Mittal

LENTIL INFORMATION

29 LENS Bookshelf

31 Key Lentil Abstracts

32 Latest Lentil References

37 LENS News Service

39 Need More Information ?

40 Subject Index for LENS Newsletter Volumes 1-10, 1974-1983

43 Author Index for LENS Newsletter Volumes 1-10, 1974-1983

46 Erratum

FEATURE ARTICLE

Documentation assistance for lentil scientists worldwide

K.Kh. Hindawi and P.J. Kemp
ICARDA, P.O.Box 5466, Aleppo, Syria.

Lentil is one of the three crops for which ICARDA has a world mandate for research and improvement. One of the recommendations of an international conference on the communication responsibilities of the international agricultural research centers, held at the International Rice Research Institute (IRRI) in the Philippines in May 1979, was to establish special information services in the centers on selected crops and issues of concern within their mandates, similar to those already established at the Centro Internacional de Agricultura Tropical (CIAT) and the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) (IRRI 1981). As a result, an agreement was reached at the legumes information meeting of the international centers in Washington, USA in November 1981 that ICARDA was to become a Specialist Information Analysis Center for lentils (Balson *et al.* 1982). In 1981, ICARDA asked the International Development Research Centre (IDRC) of Canada for a grant to support the cooperative production of LENS by the Crop Development Centre (CDC), University of Saskatchewan, in Saskatoon, Canada, and ICARDA to upgrade the Lentil Experimental News Service (LENS). LENS Newsletter was first published by the University of Saskatchewan in 1974 and the first eight annual volumes were produced and edited by Dr. A. Slinkard.

LENS Background

Because of the importance of lentils in the Middle East and North African region – the location and principal agro-ecological focus of ICARDA – the University of Saskatchewan has been cooperating with ICARDA for some time. In line with the ICARDA mandate for research on lentils, the IDRC project for lentil documentation (1982-84) seeks to improve information dissemination on this crop. The project provided for the co-editorship of LENS, with publishing responsibilities transferred to ICARDA, which is better placed both to serve the needs of developing countries and to publish LENS more economically at ICARDA printing facilities.

LENS Newsletter contains short research articles for quick publication and invited review papers. The newsletter's Lentil Information Section includes book reviews, key lentil abstracts, and the latest lentil references.

A- LENS information collection

The LENS data base contains a card bibliography and a collection of original documents.

1- Card bibliography

ICARDA maintains a comprehensive bibliography of lentil references and abstracts, which is probably the most comprehensive collection in the world. The bibliography comprises a collection of approximately 2200 reference cards on lentils, compiled at ICARDA with the help of the University of Saskatchewan. Some 700 of these references have abstracts, and original copies of documents are being obtained. All references are catalogued and classified by author, and arranged by international information system for the agricultural sciences and technology (AGRIS) subject categories (FAO 1981).

LENS coordinator Kamal Hindawi (left) and ICARDA lentil breeder Dr. Willie Erskine scan references in ICARDA's card bibliography on lentils, probably the world's most comprehensive collection. LENS does reference searches on request for specific topics related to lentils.

The card bibliography is updated by scanning abstract journals, computer printouts, regular literature searches conducted by data banks, document acquisitions lists produced by several documentation centers in the world, the Bibliography of Agriculture, and *Agrindex*, an AGRIS publication arranged by subject category and, within subject, by first commodity. Each issue of *Agrindex* contains a commodities index in addition to a personal author index, corporate entry index, geographical index, and a report and patent number index. Each index entry is categorized by English title, language code, original language, title, and *Agrindex* reference number.

2- Document collection

One objective of ICARDA's lentil documentation project is to build a complete collection of documents on lentils classified by the *Agrindex* system. Items in this collection are retrievable by author, subject, and serial numbers. The nucleus of the collection was 223 original documents supplied by lentil researchers.

If a document is not in the ICARDA library holdings, a reprint is requested from the author. If no reply is received, a photocopy request is sent either to Dr. Slinkard or to IDRC. A questionnaire issued with LENS Newsletter requesting reprints has provided other original papers.

ICARDA research assistant Lina Khoury, from the Food Legume Improvement Program, searches data bases by computer for lentil information – a LENS service for lentil researchers worldwide.

B- Information dissemination

LENS Newsletter disseminates information through the list of latest lentil references, key lentil abstracts, and LENS bookshelf (book reviews). There were 118 classified references in LENS volume 10, 1983, provided in part by Dr. Slinkard from a computer printout in Saskatchewan and in part from literature in ICARDA's library, and also from computer printouts from the Food and Agriculture Organization (FAO), IDRC, and the National Agricultural Library (NAL).

1- Specific requests - Question and answer service

Lentil researchers at ICARDA and the University of Saskatchewan respond to questions from other researchers, lentil producers and the general public.

2- Literature searches on request

ICARDA's lentil card bibliography can be searched for particular topics on request. For example, we recently compiled a bibliography listing references on lentil rust requested by Indian researchers. Enquirers wishing to use this service can write to LENS giving a full narrative description of the search required and related keywords or descriptors. The search will be undertaken either manually at ICARDA on our card bibliography, or on the IDRC computer data base, or at CDC in Canada.

3- Photocopy service

LENS provides free photocopies of lentil documents held in the ICARDA library, if full bibliographic details are supplied, in accordance with copyright rules.

4- Lentil abstracts

Lentil Abstracts journal, published by the Commonwealth Agricultural Bureaux (CAB) for ICARDA, is an annual compilation of CAB abstracts on lentils, which is provided as part of the LENS service and distributed to LENS Newsletter recipients. Each volume contains an average of 130 abstracts from world literature covering all aspects of lentil research. Abstracts are entered into the ICARDA card bibliography.

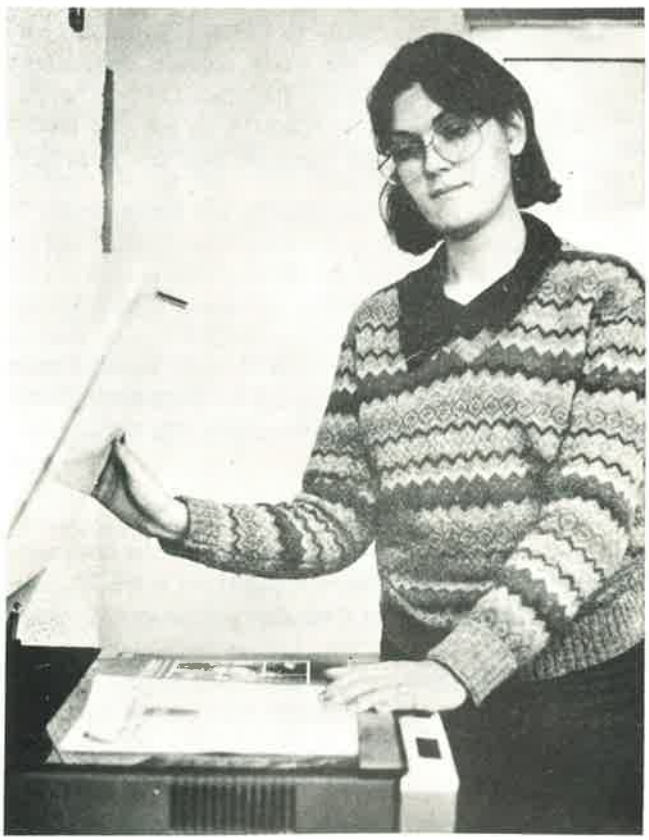
The Institute of Scientific Information of the USSR, Academy of Sciences also reviews LENS articles in relevant Soviet scientific journals, as part of cooperation recently begun with ICARDA.

5- Inclusion of LENS articles in the AGRIS data base

ICARDA was made an AGRIS input center in 1983 for ICARDA publications. The titles and abstracts of LENS articles are now put into the AGRIS data base of FAO for worldwide access and retrieval. The articles in turn will be microfiched by IDRC for wide distribution after the assignment of the *Agrindex* serial numbers.

New Directions

Further plans include the computerization of ICARDA's lentil information collection to facilitate data entry, storage, and retrieval, and the printing of bibliographies. In addition, more abstracts will be published. It is also intended to produce a Directory of World Lentil Research based on questionnaires already sent to LENS Newsletter recipients. Another aim is to increase the scope of the lentil document collection. Thus, we invite all lentil researchers to send reprints and copies of theses on lentils.



As a free service for lentil researchers, ICARDA library assistant Clara Khayat photocopies lentil documents held by the ICARDA library.

Abstracts and titles of LENS Newsletter articles are now entered into the Food and Agriculture Organization's international information system, AGRIS. Articles are also microfiched for wide distribution.

Acknowledgement

We should like to thank IDRC for its generous support of the LENS service which enables LENS Newsletter to be distributed free of charge to more than 800 lentil researchers worldwide.

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RESEARCH ARTICLES

General

Whither LENS ?

W.Erskine and K. Kh. Hindawi
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We analyzed the mailing list of LENS Newsletter to compare the number of LENS recipients with the area of lentils cultivated in different countries. The mailing list has grown from 150 subscribers who received LENS volume 8 (1981), produced at the University of Saskatchewan, to 818 recipients of LENS volume 10, number 2, December 1983, produced at ICARDA. A newsletter subscription originally cost U.S. $2.00/annum, but subscriptions are now free under a grant to LENS from the International Development Research Centre (IDRC), Ottawa, Canada, in 1982.

In 1981, the area of lentil cultivation worldwide was estimated at 1,953,000 ha (FAO 1982) (Table 1). With 818 LENS subscribers, this gives an overall mean of 0.4 newsletter copies/1000 ha of lentils.

Geographical region	Country	No. LENS recipients	Cultivated area (1000 ha)	No. recipients/ 1000 ha
AFRICA		75	119	0.6
	Algeria	8	16	0.5
	Egypt	47	6	7.8
	Ethiopia	11	59	0.2
	Morocco	5	34	0.1
	Tunisia	4	4	1.0
N. & C. AMERICA		52	79	0.7
	Mexico	1	10	0.1
	USA	51	69	0.7
S. AMERICA		38	89	0.4
	Argentina	15	22	0.7
	Chile	13	48	0.3
	Colombia	2	17	0.1
	Ecuador	2	1	2.0
	Peru	6	2	3.0
ASIA		319	1562	0.2
	Bangladesh	15	84	0.2
	Burma	0	3	0
	India	143	1000	0.1
	Iran	9	38	0.2
	Iraq	4	10	0.4
	Jordan	3	9	0.3
	Lebanon	6	4	1.5
	Pakistan	27	87	0.3
	Syria	81	127	0.6
	Turkey	31	200	0.2
EUROPE		65	96	0.7
	Bulgaria	8	1	8.0
	Czechoslovakia	8	2	4.0
	France	33	12	2.8
	Greece	3	4	0.8
	Hungary	6	1	6.0
	Italy	4	2	2.0
	Spain	3	73	0.04
	Yugoslavia	0	1	0
USSR		8	9	0.8
UNLISTED COUNTRIES		261	—	—
WORLD TOTALS		818	1954	0.4

Table 1. *Number of LENS newsletter recipients in different countries, with the lentil cultivation area in 1981 (FAO 1982) and the number of LENS recipients/1000 ha cultivation.*

Looking at the "top twenty" lentil-producing countries in 1981, LENS is well distributed in Argentina, Egypt, France, Syria, the USA, and the USSR, given that the number of LENS copies/1000 ha of lentils exceeded 0.5. The newsletter distribution suggests that the crop receives considerable research attention. In contrast, we find that in Colombia, India, Mexico, Morocco, and Spain, only 0.1 or fewer copies of the newsletter are distributed/1000 ha of lentils. Among these countries, Spain has the lowest research interest (0.04 newsletter/1000 ha), illustrating local researchers' neglect of the crop.

Canada is not listed in the FAO statistics, but is both a major lentil producer (Table 2) and a major recipient of LENS Minor producers of lentils that show considerable interest in LENS include Bulgaria, Brazil, Czechoslovakia, Hungary, Italy, Nepal, New Zealand, Poland, and Sudan. Other countries producing few or no lentils but with an academic or development interest in the crop are Australia, Austria, Belgium, Denmark, Germany (DFR), and the U.K.

Table 2. *Number of LENS recipients in countries not listed in FAO lentil area statistics.*

Country	Number of recipients
Canada	53
Australia	35
Belgium	22
Brazil	18
Sudan	18
UK	17
Denmark	12
Austria	8
New Zealand	7
Germany (DFR)	6
Nepal	6
Total others (5 or less/country)	59
Total	261

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Lentil consumption in the Khartoum area

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Abstract

Consumption surveys made in the urban areas around Khartoum in 1982 and 1983 indicated that lentils are the main substitute for faba beans in human diets. In the 1983 survey of 209 households, per capita consumption of lentils was estimated at 0.41 kg/month. Responses to hypothetical price changes suggest a low price elasticity of demand (−0.1) for lentils. Thus, a small change in per capita lentil consumption could be associated with a doubling or halving of this commodity's price.

Introduction

In Sudan, lentils are consumed in curry, soups, and ta'amya, and as stuffing. Domestic production of lentils is insufficient to meet the country's demand, however. The government imports lentils and sells them on the domestic market at a fixed price. Average annual imports of lentils from 1970 to 1980 were estimated at 4017 tons (metric) with a standard deviation of 2272 tons (Sarrag and Nourai, 1983). Imported quantities depend on the availability of foreign currency and on policy decisions. Lentils can be grown successfully in northern Sudan, and it is now government policy to increase lentil production to satisfy demand.

Most lentil research in Sudan has concentrated on agronomic practices, with very little attention paid to quality and consumption. This article summarizes information on lentil consumption from surveys made in 1982 and 1983.

Methods

In 1982, Ali *et al.* (1983b) surveyed consumption of faba bean and its substitutes in selected urban and rural areas of Sudan. They interviewed members of 212 households in Khartoum and Atbara (urban areas), and Zeidab and Aliab (rural areas).

In the 1983 survey, a random sample of 209 households in the three-town urban area of Khartoum, Khartoum North, and Omdurman was surveyed by personal interview. The survey defined lentil and faba bean consumption in response to price changes, and identified substitutes for these two foods. Details of the sampling method are given in Ali *et al.* (1984).

Results and Discussion

In the 1982 survey, urban consumers identified lentils as the most important substitute for faba beans when faba beans are in short supply. Similarly, the 1983 survey indicated that lentils, and lentils with other foods such as meat, salad, eggs, and cheese, are the main substitutes for faba beans when faba beans are not available.

In the 1983 survey, per capita consumption of lentils in the Khartoum area was estimated at 0.41 kg/month, with a standard deviation of 0.39 kg (Ali *et al.* 1983a). This is only a fraction of the estimated figure for faba beans (1.16-1.54 kg/month). In contrast to fixed prices for lentils, faba bean prices and consumption have been subject to seasonal variations (Ali *et al.* 1984).

The ratio of estimated lentil and faba bean consumption levels in Khartoum (0.41:1.54 kg) can be compared to the estimated availabilities of these commodities in Sudan (4 thousand and 20 thousand tons, respectively). This comparison suggests that slightly more lentils are consumed in the Khartoum area than in the country as a whole. This could be attributed to the relatively greater availability of lentils in the main urban distribution area.

Hypothetical changes in lentil prices were posed in the interviews, with the condition that all other food prices remain constant. In response to a doubling of lentil prices, 28% of the households indicated that their consumption would decrease by an average of 23%. Thus, the weighted average decrease in consumption by all sampled households is estimated at 8.7%.

On the other hand, 38% of the households indicated that consumption would increase if the lentil price was halved. Among these households, the average increase was only 23%. This results in a weighted average increase of 6.4% for all households in the sample. Figure 1 summarizes the hypothetical prices and consumption changes for lentils.

We conclude from these results that demand for lentils is quite inelastic. Price elasticity of demand is defined as the proportional change in quantity consumed given a proportional change in price; i.e., (dQ/Q)/(dP/P). In this case, the estimated elasticity is approximately–0.1 for lentils in Khartoum. Similarly, faba bean demand was estimated to be inelastic (Ali *et al.* 1984).

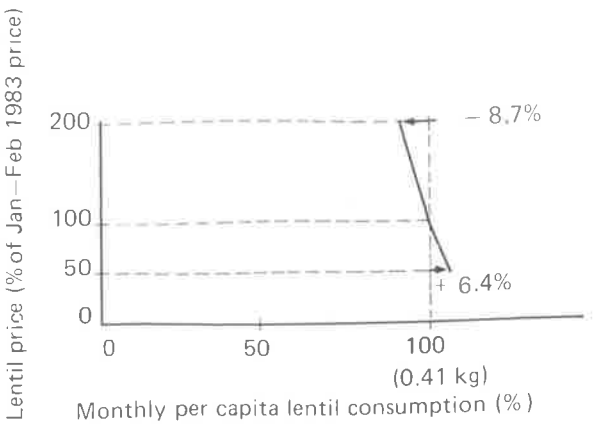

Fig. 1. *Shifts in lentil consumption due to price changes.*

The estimates of per capita lentil consumption reported here may reflect the limited availability of this commodity, which is provided chiefly through foreign imports. The question remains as to whether lentil consumption would increase with increasing domestic production. Domestic production, however, clearly could substitute for some or all lentil imports, resulting in foreign exchange savings for the country. Domestic production would be encouraged by an increase in lentil prices. Further research is needed to determine the best way to accomplish this increase in harmony with other policies.

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Breeding and Genetics

Non-hierarchical cluster analysis in lentil

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Abstract

The variation in eleven characters amongst a collection of Indian lentil germplasm accessions was studied by non-hierarchical cluster analysis to group the accessions. The analysis revealed that clusters contained accessions from more than one state, and that geographical provenance was unrelated to genetic similarity.

Introduction

Crop improvement programs emphasize the importance of genetic diversity in crop germplasm collections. Several workers have used Mahalanobibs D^2 statistics and principal component analysis to quantify the degree of divergence based on phenotypic observations. Sometimes, however, Principal Component Analysis is not appropriate to form clusters in a graphic approach in two dimensional space, particularly when the variation is low when explained with the help of the first two eigen roots.

In this study (see Kumar *et al.* 1983 for a description of materials, methods and primary statistics), the percentage of variation explained by the first two eigen roots—33.30% — was not sufficiently high to justify following a graphic approach. Therefore, we used *non*-hierarchical cluster analysis to arrange the lentil germplasm under study into various groups—a method described by Beale (1969) that takes into consideration the variation explained by all the eigen roots. This paper reports the results of the investigation.

Results and Discussion

The lentil germplasm under study showed a wide range of variation, from 3.26% for days to maturity to 57.5% for yield/plant (Kumar *et al.* 1983). Variation in primary branches, secondary branches and pods/plant ranged from 40 to 50%. Plant height and 100-grain weight showed 20% variation (Table 1).

Table 1. *Cluster means of characters.*

	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}
I	69.76	122.82	31.42	2.94	7.38	33.75	0.98	0.58	2.00	1.92	2.10
II	70.82	123.94	25.96	2.07	4.70	22.64	0.91	0.55	2.00	1.11	2.02
III	64.78	126.33	27.39	4.34	10.79	31.22	0.52	0.48	2.00	2.15	1.84
IV	75.93	124.93	27.39	2.44	6.75	53.55	0.91	0.52	2.00	2.30	1.77
V	70.11	126.05	24.96	3.41	6.09	17.97	0.84	0.41	2.00	2.17	1.84
VI	64.25	125.63	19.25	2.15	4.56	8.31	0.80	0.39	1.38	1.52	1.61
VII	66.48	123.05	22.42	2.47	5.44	17.09	0.86	0.48	2.00	1.83	1.99
VIII	71.25	123.53	22.73	1.85	4.50	14.07	0.89	0.52	1.95	1.85	1.80
IX	67.92	125.00	28.04	4.70	10.40	40.92	0.93	0.51	2.00	2.05	1.79
X	73.04	124.17	20.55	1.50	3.91	15.40	0.91	0.48	1.96	1.63	1.74
XI	77.10	125.50	23.49	1.89	4.32	21.59	0.92	0.51	2.00	1.29	1.76
XII	69.60	123.60	28.86	2.60	5.36	29.50	0.92	0.53	2.00	1.29	2.44
XIII	71.48	124.35	27.31	2.10	5.36	27.13	0.94	0.55	2.00	1.67	1.97
XIV	74.67	127.22	24.26	1.76	5.11	17.96	0.94	0.52	2.00	0.76	1.87
XV	70.56	121.56	29.60	2.43	5.42	30.36	0.91	0.56	2.00	1.62	2.13
XVI	74.00	126.17	21.02	1.73	4.10	20.15	0.99	0.55	1.83	1.37	1.73

X_1 = Days to flower, X_2 = Days to maturity, X_3 = Plant height (cm), X_4 = Primary branches, X_5 = Secondary branches, X_6 = Pods/plant, X_7 = Pod length (cm), X_8 = Pod breadth (cm), X_9 = Grain/pod, X_{10} = Yield/plant, X_{11} = 100-grain weight.

Table 2. *Distances between cluster centroids.*

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV	XV	XVI	*	**
I	0.00																1.38	32.25
II	2.54	0.00															1.25	41.74
III	4.06	5.04	0.00														1.54	21.26
IV	2.49	2.68	4.63	0.00													0.93	12.95
V	3.06	2.90	3.08	3.71	0.00												1.10	22.82
VI	5.48	4.10	5.38	5.15	2.89	0.00											1.40	75.76
VII	2.90	2.03	3.96	2.54	1.62	2.76	0.00										1.08	23.36
VIII	3.99	2.80	5.58	2.10	3.84	3.83	2.24	0.00									1.04	21.73
IX	2.13	3.99	2.27	3.49	3.08	5.86	3.59	5.04	0.00								1.38	23.03
X	3.63	2.08	5.42	3.36	2.61	2.58	1.56	2.41	4.86	0.00							1.21	35.44
XI	3.70	3.63	5.74	3.51	3.55	4.19	2.78	3.21	4.89	2.52	0.00						1.50	22.51
XII	2.34	3.03	4.62	2.70	3.15	4.80	2.75	3.48	3.37	3.17	3.67	0.00					1.08	5.84
XIII	1.74	1.70	4.66	2.15	2.67	4.34	1.85	2.76	3.36	2.18	2.31	2.56	0.00				1.01	23.30
XIV	3.20	2.17	5.46	3.03	3.08	3.70	2.22	2.70	4.55	1.79	3.38	1.88	2.43	0.00			1.05	9.91
XV	2.21	3.41	4.69	2.62	3.22	4.96	2.78	3.49	3.34	3.20	2.44	1.70	2.06	2.73	0.00		1.30	15.27
XVI	4.02	2.25	6.18	3.89	3.87	4.24	2.96	3.43	5.39	2.52	3.42	4.84	2.59	3.75	4.53	0.00	1.66	16.45

Residual sum of squares = 31.24 * Average distances of cluster numbers from cluster centroids ** Sum of squared deviations for each cluster.

Bearing in mind the sum of squared deviations for each cluster, a total of 16 clusters were formed. Cluster III had the maximum number of entries (33), and the maximum value (41.74), for the sum of squared deviations (see Table 2). In contrast, cluster XII, with the minimum number of entries (5), had the minimum value (5.84) for the sum of squared deviations. Clusters III, IV, V, VI, VIII, IX and XI had accessions prefixed with PLMA, whereas the remaining clusters had mixed entries including PLMA, LC, JLS, IC, and PL.

Table 2 shows the distances between various cluster centroids. Cluster II, the largest, showed an appreciable distance only from clusters III (5.04), VI (4.10), IX (3.99) and XI (3.63).

Cluster XIII was very close to cluster II, at a distance of 1.70. Both had more or less comparable mean values for most of the characters. The smallest cluster, XII, diverged appreciably from clusters III (4.62), VI (4.80) and XVI (4.84), but diverged little from XV (1.70) because of small differences in the mean values of 100-grain weight and seed yield.

Cluster III, with only nine entries from U.P., Bihar and Punjab, was quite distant from all other clusters, except that its distance from IX was only 2.7. The distance between clusters III and XVI was the highest (6.18), followed by cluster XI (5.74). This great divergence of cluster III from the other clusters can be attributed to the high values for primary branches (4.34) and secondary branches (10.79), and also to the low value for pod length (0.52).

There was a small divergence between cluster XIII and clusters I (1.74), II (1.70), and VII (1.85). The divergence was the lowest for clusters VII and X, followed by that between cluster VII and V (1.62). Cluster XIV was also close to clusters X (1.79) and XII (1.88). Cluster XII was very close to XV, owing to very small deviations in the mean values for the characters of seed yield and 100-grain weight.

Characteristics incorporated into cluster I were tall growth (31.42) and longer pods (0.58). Accessions in cluster III were early flowering (64.78 days), with a high value for secondary branches (10.79) bearing shorter pods (0.52).

Cluster IV included high seed yielding entries (2.30), whereas cluster XII had bolder grains (2.44). Cluster VI included dwarf entries (19.25) bearing fewer thinner pods (9.31), most of which contained one small grain. Cluster IX had the highest value for primary branches (4.70), whereas cluster X had the fewest primary (1.50) and secondary branches (3.91). Cluster XI included late flowering accessions (77.10) bearing a maximum number of pods (40.92). Cluster XIV—the late maturing cluster (127.22)—included low seed yielding types (0.76). Cluster XVI, with only six entries, was characterized by larger pods (0.99).

Table 3. *Number of entries, accession number and sources.*

Cluster	Number of entries	Accession Number	Source (State)
I	(17)	PLMA-4, 24, 70, 71, 72, 74, 132, 261, 262, 268, IC 32649, LC-47, LC-81, LC-42, LC-51	Maharashtra, Bihar, U.P., Punjab H.P., M.P.
II	(33)	PLMA-253, 274, AC-850, Bombay-18, PLP 203 (8-2), IC 22638, IC 22652, IC 22659.1, 22659.2, 22660-22663, IC 22665-66, 22679, 22685-87, 22689, IC 22641.3, 22645, 22648, 22641.2, 26515, IC 27779, 32634, 32635, 32638, LC-5, LC-12, LC-18, LC-4.	H.P., M.P., Goa
III	(9)	PLMA-9(3-8), 17, 21, 22, 62, 64, 82, 84, 90	U.P., Bihar, Punjab
IV	(15)	PLMA-77, 131, 133, 135, 137, 150-152, 157, 159, 172, 173, 175, 177, 194.	U.P., Punjab, Bihar, W.B., H.P.
V	(19)	PLMA-2, 8, 16, 20-45, 48, 56, 65, 78, 83, 85, 88 93, 103-105, 116, 119, 121	U.P., Bihar, M.P., Punjab, Rajasthan
VI	(8)	PLMA-42, 46, 51, 52, 54, 57, 98, 212	Bihar, Assam, U.P., Punjab, H.P.
VII	(21)	PLMA-18, 23, 44, 47, 67, 79, 108, 114, 123, 124, 149, 256, IC 22688, LWS-56, LC-6, LC-11, LC-24, LC-27, LC-35, LC-56.	Bihar, U.P., Rajasthan, Orissa, H.P., M.P.
VIII	(20)	PLMA-118, 126, 134, 139, 144, 160, 162-63, 166, 168-169, 171, 174, 180, 181, 189, 191-93.	Punjab, U.P., H.P., Orissa, M.P.
IX	(12)	PLMA-13, 19, 25, 59, 60, 63, 66, 68, 69, 86, 89, 161.	Bihar, U.P., M.P. H.P.
X	(24)	PLMA-10, 34, 55, 76, 107, 110-12, 115, 120, 122, 123-(5-23), 125, 127, 143, 211, 248, 255, IC 1843, 15756, 22651-53, 22656.	U.P., Bihar, Rajasthan, Punjab, H.P., M.P.
XI	(10)	PLMA-195, 201-04, 209, 210, 214, 218, 229	H.P.
XII	(5)	PLMA-197, 269, JLS-1, JLS-3, LC-40	H.P., M.P.
XIII	(23)	PLMA-128-30, 196, 200, 231, 243, 249, 245, 259, 267, 270-72, IC 1655, IC 27659, 32636, LC-34, LC 14, IC 77, LC 28, 29, LC 23	Punjab, H.P., Bihar, M.P.
XIV	(9)	PLMA-213, 273, PL-5, PL-6, IC 22654, 22664, 22686-2, 22639, 22641.	H.P., M.P.
XV	(9)	PLMA-206, 251-52, 264-65, LC 46, LC 20, LC 26, LC 30.	H.P.
XVI	(6)	PLMA 215, 234, 236, 239, IC 22655, LC-63.	

From this study, we observed that a number of entries from various Indian states occur in the same cluster (Table 3), which shows that the geographical diversity of seeds is not related to genetic diversity. This observation concurs with the findings of Murty and Arunachalam (1966), who used D^2 Statistics for the formation of clusters, and found that accessions from the same state frequently fell into more than one cluster. We conclude, then, that accessions from the same state or geographical region may differ genetically as well as morphoiogically, and also in adaptability. Our results also confirm the conclusions of Bhatt (1970) and Singh (1979), who found that the processes of genetic drift and selection can produce greater genetic diversity than can the factor of geographical distance.

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Variation at soluble enzyme loci in four *Lens* species

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Abstract

Variation at 20 soluble enzyme loci was studied in *Lens culinaris, L. ervoides, L. nigricans* and *L. orientalis*. Little genetic variation was observed within species compared with that observed between species. The greatest genetic similarity was observed between *L. culinaris* and *L. orientalis*. Other species compared had little genetic similarity.

Introduction

Knowledge of the phenetic or phylogenetic relationship between a crop and its wild relatives aids the use of wild germplasm to improve a domesticated crop. As a step to such improvement in *Lens*, Cubero (1981) gave a detailed account of the morphological variation and geographical distribution of *Lens*. Other studies on the genus have been made or are in progress. Variation in agronomic characters, karyotype and pollen grain size, and morphology, for example, have been reported by Sindhu *et al.* (1983).

Crosses involving the four species have also been made (Ladizinsky 1979). The general consensus seems to be that, out of the four species, *L. culinaris* and *L. orientalis* are the most closely related. No other systematic relationships are clear.

Variation at enzyme loci is useful in systematic studies, since environmental influences can not alter the enzyme genotype of an individual plant the way they can alter many agronomic characters. We report here the results of a study of variation at 20 enzyme loci in *L. culinaris, L. nigricans, L. ervoides* and *L. orientalis*. Our study supports the view that *L. culinaris* and *L. orientalis* are the most closely related species, and identifies a number of genetic markers which might be useful in distinguishing between the four species.

Materials and Methods

Ten accessions of *L. culinaris* obtained from ICARDA, including both *macrosperma* and *microsperma* types, were used in the study. Two accessions each of other species, from material provided by A.E. Slinkard, were used: *L. ervoides* (Nos. 28 and 30), *L. orientalis* (NEWL No. 7 from ICARDA, and No. 23 from Ladizinsky) and *L. nigricans* (Nos. 27 and 28, accessions collected in France). For each enzyme locus, five different plants/species were assayed

Table 1. *Allele frequencies at 20 enzyme loci in four lentil species.*

Locus	Allele	*L. culinaris*	*L. nigricans*	*L. ervoides*	*L. orientalis*
Aspartate aminotransferase-1	a	0.6	–	–	–
	b	0.4	–	1.0	1.0
	c	–	1.0	–	–
Aspartate aminotransferase-2	a	1.0	1.0	–	0.6
	b	–	–	1.0	–
Alcohol dehydrogenase	a	–	–	–	1.0
	b	1.0	1.0	1.0	–
Acid phosphatase	a	–	–	1.0	–
	b	1.0	–	–	1.0
	c	–	1.0	–	–
Aldolase	a	–	1.0	–	–
		1.0	–	1.0	1.0
Amylase	a	–	1.0	–	–
	b	–	–	1.0	–
	c	1.0	–	–	1.0
Esterase (anodal)	a	–	–	–	1.0
	b	1.0	1.0	–	–
	c	–	–	1.0	–
Esterase (cathodal)	a	–	1.0	1.0	–
	b	1.0	–	–	1.0
Esterase-D (methyl umbelliferyl acetate substrate)	a	–	–	1.0	–
	b	1.0	1.0	–	1.0
β-galactosidase	a	–	–	–	0.6
	b	1.0	1.0	1.0	0.4
Leucine amino peptidase	a	–	1.0	–	–
	b	0.6	–	1.0	1.0
	c	0.4	–	–	–
Malate dehydrogenase	a	1.0	1.0	1.0	1.0
6-Phosphogluconate dehydrogenase	a	1.0	1.0	1.0	1.0
Phosphoglucose isomerase-1	a	1.0	1.0	1.0	1.0
Phosphoglucose isomerase-2	a	1.0	1.0	1.0	1.0
Phosphoglucomutase	a	–	1.0	1.0	–
	b	0.2	–	–	0.6
	c	0.8	–	–	0.4
Protein (general)	a	1.0	1.0	1.0	1.0
Shikimic acid dehydrogenase	a	–	1.0	–	–
	b	1.0	–	–	1.0
	c	1.0	1.0	1.0	–
Superoxide dismutase (anodal)	a	1.0	1.0	1.0	1.0
Superoxide dismutase (cathodal)	a	–	–	1.0	–
	b	1.0	1.0	–	1.0

Table 2. *Genetic identity (I) above diagonal, and genetic distance (D) below diagonal. The standard error of D is given in parentheses.*

	L. culinaris	*L. nigricans*	*L. ervoides*	*L. orientalis*
L. culinaris	x	0.62	0.52	0.83
L. nigricans	(0.18) 0.48	x	0.50	0.47
L. ervoides	(0.22) 0.66	(0.22) 0.69	x	0.49
L. orientalis	(0.10) 0.19	(0.24) 0.76	(0.23) 0.72	x

electrophoretically. One plant was tested from a selection of five of the *L. culinaris* accessions, and either two or three plants from the other accessions.

For the electrophoresis process, a few leaflets from each plant were homogenized in a 100 $\mu\ell$ 2% phenoxyethanol solution. The extract, absorbed in filter paper squares, was applied immediately to a horizontal starch gel[1]. For alcohol dehydrogenase alone, crushed seeds were used instead of leaflets.

Results and Discussion

Table 1 shows allele frequencies for the twenty enzyme loci. The alleles are ranked a, b, c, etc. in order of decreasing anodal mobility. For Phosphoglucosisomerase and Aspartate aminotransferase, two loci were scored. Locus 1 was the most anodal.

Only five loci were observed to be polymorphic within species. These were Aspartate aminotransferase-1 and Leucine aminopeptidase in *L. culinaris,* Aspartate aminotransferase-2 and β -galactasidase in *L. orientalis,* and phosphoglucomutase in both *L. culinaris* and *L. orientalis.* The Aspartate aminotransferase-1 locus is known to vary substantially between and within *L. culinaris* accessions (Skibinski and Savage 1981; and Skibinski, Rasoul, and Erskine, unpublished work). Little is known as yet of the pattern of variation at other polymorphic loci. The variation exists as different homozygous types, although rare heterozygotes have been identified at the Aspartate aminotransferase-1 locus in *L. culinaris.*

There is substantial variation between species. No single locus is different in each species, though many combinations of two or more loci do give perfect discrimination, such as the two esterase loci, or alcohol dehydrogenase with acid phosphatase. Five or more loci provide a very powerful diagnostic tool for studying geographic or ecological variation in the four species, and would be particularly useful for determining the affinitives of accessions with intermediate characteristics.

The extent of genetic differentiation between species was measured by the normalized genetic identity (I), (Nei 1972). I is analogous to a correlation, in which the higher the value, the greater the similarity. Genetic distance, defined as $D = -\log_e I$, measures the accumulated number of electrophoretic substitutions since two species diverged.

Table 2 gives I and D values for comparisons between the four lentil species, together with the standard error of D. Although interspecific I values can show considerable variation, the value of 0.83 between *L. culinaris* and *L. orientalis* would normally be thought of as characterizing taxa at the subspecific to specific level. The lower I values for the other comparisons are more characteristic of comparisons at the specific level.

[1]. Details of the buffer system used for each enzyme and the staining recipes can be obtained on request from the authors.

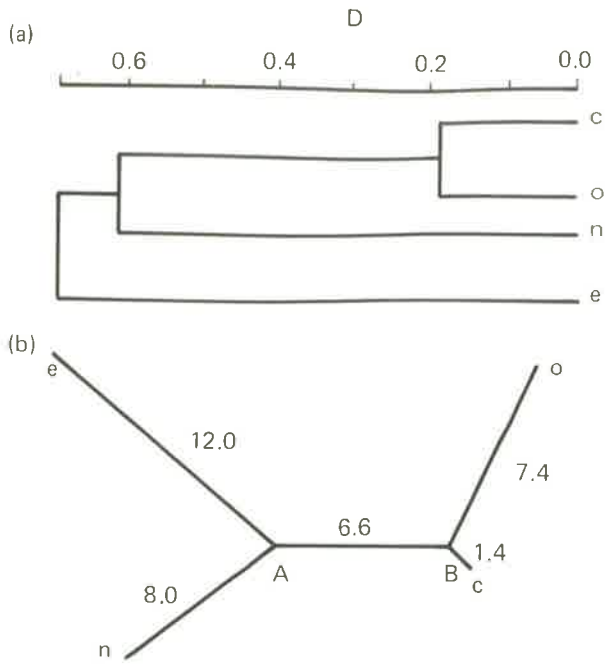

Fig. 1. *Phenetic relationship (a) and phylogenetic relationship (b) between four lentil species: c-Lens culinaris, o-L. orientalis, n-L. nigricans, and e-L. ervoides. A and B are hypothetical ancestors. D is genetic distance.*

Two dendrograms represent the relationships between species (Figure 1). Figure 1 (a) shows the phenetic relationships calculated from the matrix of D values according to the unweighted pair-group method of cluster analysis of Sneath and Sokal (1973). The relationships, based on the overall similarity between the species, may be considered a genealogy only if all lineages evolved at a uniform rate – an unlikely assumption.

Figure 1 (b) shows a phylogenetic sp. tree calculated directly from the data in Table 1 using the Farris algorithm (1972). This represents the genealogical relationships between species and also shows hypothetical ancestors A and B. The number beside a branch represents the amount of differentiation or evolution along the branch. The position of the group's common ancestor cannot be ascertained.

The dendrograms suggest that, as expected, *L. orientalis* and *L. culinaris* are most closely related. There are also indications that *L. nigricans* is more closely related to *L. culinaris* and *L. orientalis* than is *L. ervoides,* and that evolution from a common ancestor has been faster in the lineage leading to *L. orientalis* than to *L. culinaris*. However, some caution is required in this interpretation, in view of the rather large standard errors of D.

In conclusion, we note that this study is based on a small number of accessions, and that a study of accessions drawn from throughout the species' range would lead to more definite conclusions.

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Variability in lentil germplasm

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Abstract

Two hundred and seventy lentil lines were evaluated at Dholi Farm, Rajendra Agricultural University, Bihar for different morphological and quantitative characteristics. Lines varied little from each other in growth habit, flower color, and seed color. Enough variability to provide scope for selection, however, was found in quantitative characters such as plant height, time to flowering, 100-seed weight, and seed yield.

Table 1. *Variation for time to flowering (days), plant height (cm), 100-seed weight (g) and seed yield (g/linear meter).*

Time to flowering		Plant height		100-seed weight		Seed yield	
Range	Frequency	Range	Frequency	Range	Frequency	Range	Frequency
51 - 55	19	15.1 - 20.0	5	1.01 - 1.20	11	< 10.1 - 20.0	90
56 - 60	21	20.1 - 25.0	39	1.21 - 1.40	30	20.1 - 30.0	118
61 - 65	83	25.1 - 30.0	122	1.41 - 1.60	48	30.1 - 40.0	43
66 - 70	60	30.1 - 35.0	83	1.61 - 1.80	66	40.1 - 50.0	14
71 - 75	50	35.1 - 40.0	13	1.81 - 2.00	59	50.1 - 60.0	3
76 - 80	37	40.1 - 45.0	8	2.01 - 2.20	41	60.1 - 70.0<	2
				2.21 - 2.40 <	15		

Introduction

Collecting and maintaining germplasm, and evaluating germplasm for economic traits, are important in a plant breeding program. In this study, lentil (*Lens culinaris* Medic.) cultivars were collected from different parts of Bihar and from different research stations. All cultivars were ssp. of *microsperma*, the only lentil type adapted to this region.

Materials and Methods

Two hundred and seventy lentil lines were evaluated. Most were collected from different lentil areas in Bihar State, but some lines came from Punjab Agricultural University, Ludhiana. Lines were given accession numbers in the DLGS (Dholi lentil genetic stock). These lines were grown in a randomized complete block design with two replications during the winter season 1982/1983 (November-April) at the Tirhut College of Agriculture Farm at Dholi, Rajendra Agricultural University campus in Bihar. Each line was grown in a single 4 m long row with 25 cm between rows. The soil was calcareous sand loam with 8.5 pH. The lines were evaluated at ZIP (Zero input) level because lentils are grown in this tract without fertilizer and irrigation. The lines were evaluated for seven characters: growth habit, flower color, seed color, time to flowering, plant height, 100-seed weight, and seed yield from a one meter row.

Results and Discussion

Table 1 shows the variability observed in different characters.

Growth habit: Different growth habits were designated as E (Erect), SE (Semi-erect), P (Prostrate) and SP (Semi-prostrate). Eighty lines out of 270, or 30%, were erect, and only five lines were prostrate. Other lines were semi-erect and semi-prostrate with no clear distinction between them.

Flower color: Lentil flowers were violet, pink, or white. The frequency of violet flowers was compared to the frequency of other colors. Two hundred and eighteen lines out of 270 (about 80%) had violet flowers, 27 lines had pink flowers, and 25 lines had white flowers. Since violet flower color is a dominant character over other flower colors (Lal and Srivastava 1975), the frequency of pink and white flowers was lower. White and pink flowers do not seem to be linked with any other competitive characteristics.

Seed color: Seeds were mottled grey, light pink, chocolate, and black. Seeds of two lines out of 270 were chocolate colored, two were black, and four were pink. Other seeds were mottled grey with slightly varied mottling patterns and shades. There was no linkage between flower color and seed color.

Time to flowering: This characteristic was defined as the number of days from seeding to the opening of buds in more than 50% of plants in a line. Table 1 gives the frequency distribution of this character, which ranged from 51 to 80 days. Sixty-one to sixty-five days was modal with 30% of the lines in this class. Only 19 lines (7%) fell into the early flowering group (51-55 days). Two high-yielding lines, DLGS 22 and DLGS 23, fell into the middle groups (65-70 and 71-75 days, respectively).

Plant height: The range of this character was 16-45 cm. One hundred and twenty-two lines (45%) fell into the 25-30 cm height class. In *microsperma*, Papp (1980) reported an average plant height of 20-25 cm. The highest-yielding lines—DLGS 22 and DLGS 23—were the tallest (40-45 cm). Five dwarf lines were prostrate in growth habit. Although no quantitative correlation was attempted, most high-yielding lines were also tall. Since taller plants give higher yields, tall genotypes should be selected for unirrigated conditions. Singh and Singh (1969) also reported weak positive correlation between plant height and seed yield.

100-seed weight: Line DLGS 113 had the lowest 100-seed weight (1.02 g), while DLGS 198 had the highest (2.66 g). These results can be compared to other studies of *microsperma*, such as those of Nandan and Pandya (1980), who found a range of 1.52-3.62 g; and Solh and Erskine (1978), who reported the lowest 100-seed weight of 1.07 g. The mid-maturing lines fell into the higher seed weight group. Late maturing lines may have been affected by hot westerly winds at the time of maturity, which probably accelerated ripening and resulted in smaller seeds. The highest-yielding lines had a 100-seed weight of less than 2.00 g. Singh and Singh (1969), Muehlbauer (1974), and Nandan and Pandya (1980) also found negative correlations between seed weight and yield, indicating that genotypes with a medium seed size (2.00 g/100-seed) should be selected.

Seed yield: Seed yield of each line for a one meter row was recorded. The range was 7.2-71.5 g. Line DLGS 22 gave the highest yield (71.5 g). The greatest number of lines (118, or 43%) yielded 20-30 g. Only five lines yielded more than 50 g, and only 14 yielded between 40 and 50 g. Two hundred and fifty-one lines (93%) yielded lower than 40 g.

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Effect of colchicine on lentil

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Abstract

The effect of different concentrations and durations of application of colchicine was measured on lentils. Polyploid lentils were found with 4n=28 in mitotic cells after treatment with 0.25% colchicine Polyploids had larger and more sparsely distributed stomata and bigger pollen grains, but high pollen sterility.

Introduction

The low chromosome number (2n=14) in lentil favors cytological studies, offers opportunities for chromosomal manipulation, and allows the introduction of colchiploidy. This study investigates polyploids in lentil.

Materials and Methods

In this study, seedlings of variety T36 that were soaked for eight hours, dried, and germinated were treated with five different colchicine concentrations (0.01%, 0.025%, 0.05%, 0.1%, and 0.25%). Treatments included four different durations (1/2 hr, 3 hrs, 6 hrs and 12 hrs). Fifty healthy, uniform seeds were selected for each treatment. The seeds were germinated on moist filter paper in petri dishes according to different germination treatments. After treatment, seedlings were washed in running water and planted in different 3 m rows in the field, separated by control rows.

Results and Discussion

The 0.25% germinated seed treatment yielded morphological abnormalities that led to the production of polyploids.

Preliminary screening identified autotetraploids based on poor and delayed germination, coupled with lower survival of plants (Table 1). The polyploids were also delayed in flowering and maturity (Fig 2). Morphological abnormalities including swelling and thickening of stem, and curling, twisting, and wrinkling of leaflets with irregular shapes were also observed. The length and breadth of tetraploids' stomata increased significantly by 39.8% and 49.6%, respectively, over the control. These polyploids had stomata and pollen grains significantly increased in size,

Table 1. *Germination percentage and survival of adult plants.*

Duration	Colchicine concentrations					Control
	0.01%	0.25%	0.05%	0.1%	0.25%	
1/2 hr	54 (44)	52 (40)	50 (36)	48 (34)	46 (34)	60 (50)
3 hrs	32 (32)	30 (24)	26 (22)	24 (22)	22 (20)	64 (60)
6 hrs	32 (30)	30 (22)	23 (20)	26 (20)	20 (18)	64 (40)
12 hrs	30 (26)	26 (18)	24 (6)	18 (6)	12 (2)	92 (60)

Note : Parentheses denote the survival of seedlings expressed as percentage of adult plants.

along with fewer stomata/unit area than the control (Figures 1 and 3). Percentage of pollen fertility was judged by the degree of staining. Polyploids also showed increased seed and pod size with poor seed setting, which could be attributed to high pollen sterility (Table 2).

Cytological studies confirmed the existence of tetraploids with chromosome 4n=28 in the mitotic cells. Meiotic abnormalities such as fragments, laggards, and stickiness of chromosomes further confirmed the production of autotetraploids. Tawar (1976), Solh and Alahaydoian (1980), Tawar and Tiwari (1981), and Gupta and Singh (1982) reported similar results in lentil.

Table 2. *Mean values of morphological traits in diploid and tetraploid lentil plants.*

Serial No.	Characters		Diploid (2n)	Tetraploid (4n)
1.	Pollen size (μ):	Length	30.4	36.0
		Breadth	25.6	29.1
2.	Stomatal size (μ):	Length	28.8	40.0
		Breadth	20.2	30.1
3.	Pollen sterility (%)		1.8	3.9
4.	Pod length (cm)		1.1	1.5

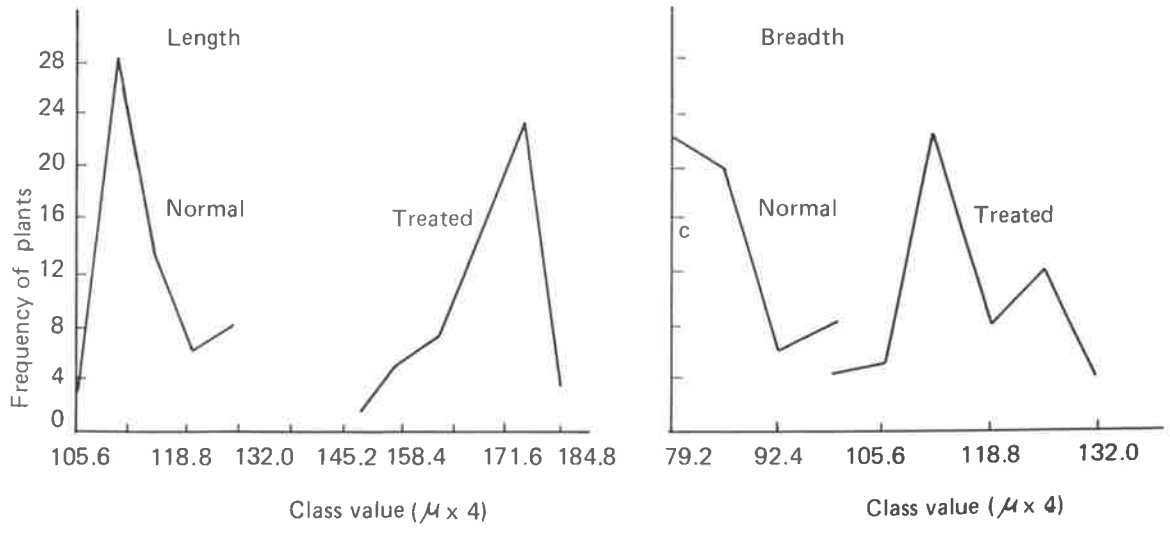

Fig. 1. *Frequency polygon of stomata.*

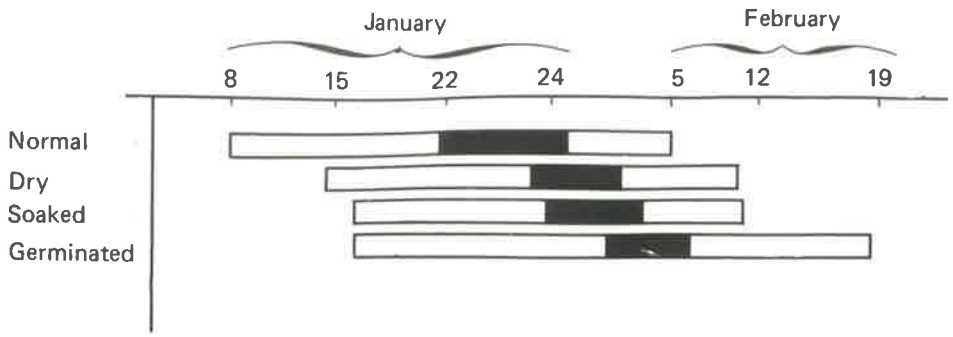

Fig. 2. *Time and duration of flowering.*

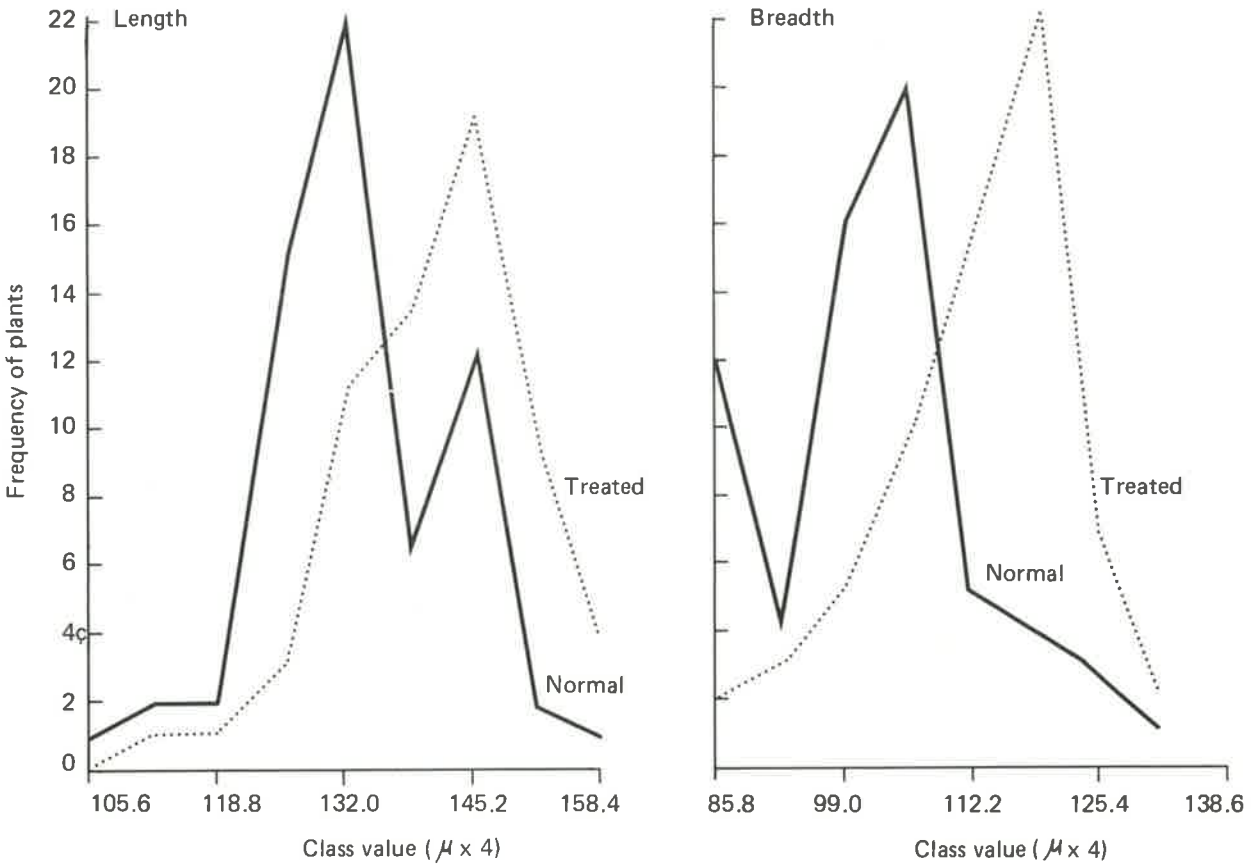

Fig. 3. *Frequency polygon of pollen grains.*

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Agronomy and Mechanization

The effect of sowing dates and rates on lentil yield components

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Abstract

The effect of 60-100 kg/ha seed rates and five different spring sowing dates on lentil yield components were studied in Chile. Lentils sown from mid-August to mid-September gave the highest yields. The mean yield was 1717 kg/ha, but the yield/ha was not affected by the seed rate. High yield/plant was associated with a high number of branches and pods/plant. These three characters – pods, branches, and yield/plant – varied greatly, in marked contrast to the stable traits: average seed weight and seed number/pod.

Introduction

The adaptability of selected lines or cultivars can be tested by sowing on different dates and at different densities. Such trials give valuable breeding information on variation in yield and its components.

In lentils, yield/plant is positively and significantly associated with pods and branches/plant, and negatively with average seed weight (Muehlbauer 1974; Singh 1976; Dixit 1976; Tikka *et al.* 1977; and Chauhuan and Sinha 1982). Thus, yield/plant depends mainly on the number of branches/plant, as shown by the highly significant positive correlations given for these two parameters by the same authors. Accordingly, if yield varies with dates and densities of sowing, branches and pods/plant shift significantly. It is of interest to know how different environments affect these and other more stable characters.

Materials and Methods

In this study, a factorial experiment using the *macrosperma* line INIA (CHILE)-3074 at Valdivia, Chile tested five dates of spring sowing: August 13 and 27, September 10 and 24, and October 8, 1981, combined with three rates of sowing: 60, 80, and 100 kg/ha. The plots, separated by two guard rows, consisted of two rows, each four m long and 35 cm apart. Fertilizers were applied at 150 kg P_2O_5/ha and 100 kg K_2O/ha. Five competitive plants were selected from the central 3 m of rows from each plot for recording observations.

Data were submitted to analysis of variance. Phenotypic coefficients of variation were calculated as described by Singh and Choudhary (1979), assuming that the line had no genotypic variation. Turkey's Honestly Significant Difference (HSD) was used to calculate the differences between the averages. Simple correlations among the parameters were also calculated.

Results and Discussion

The mean seed yield was 17.2 q/ha, but yield/ha was unaffected by seed rate. Increasing seed rate linearly decreased average yield/plant through reducing the number of branches and pods/plant. The average seed weight was greatest at the highest plant density, illustrating compensation among yield components as suggested by Adams (1967). Seed rate did not affect the number of seeds/pod (Table 1). The mean square for seeds/pod was significant, but the HSD value exceeded any difference between sowing densities. The most favourable sowing dates were 27 Aug and 10 Sept, and the least favourable was the latest sowing date (8 Oct), showing the benefit of timely sowing. The highest yields/plant were accompanied by a high number of pods and branches/plant (Table 2).

Table 1. *Average values of parameters for three sowing densities.*

	Sowing densities (kg/ha)		
Parameters	60	80	100
Pods/plant	37.6	31.9	24.4
HSD 5% = 8.63	a	ab	b
Seeds/pod	1.07	1.10	1.08
HSD 5%= 0.033	a	a	a
Av. seed weight[1]	0.089	0.088	0.095
HSD 5%= 0.0049	b	b	a
Yield/plant[1]	3.69	3.17	2.45
HSD 5%= 0.846	a	ab	b
Branches/plant	7.41	6.26	5.13
HSD 5% = 1.66	a	ab	b

[1] grams

Parameters	Sowing dates				
	1 (8/13)[1]	2 (8/27)	3 (9/10)	4 (9/24)	5 (10/8)
Pods/plant	27.35	36.37	44.62	32.53	15.46
HSD 5% = 13,12	bc	ab	a	ab	c
Seeds/pod	1.08	1.08	1.14	1.08	1.03
HSD 5% = 0,085	b	b	a	b	b
Av. seed weight[2]	0.096	0.090	0.090	0.080	0.090
HSD 5% = 0.007	a	a	a	b	a
Yield/plant[2]	2.84	3.70	4.63	2.91	1.43
HSD 5% = 1,31	b	ab	a	b	c
Yield kg/ha	1788	1964	2199	1989	644
HSD 5% = 291	b	ab	a	ab	c
Branches/plant	6.08	8.42	8.06	5.86	2.91
HSD 5% = 2,53	ab	a	ab	b	c

[1] month/day
[2] grams

Table 2. *Average values of different parameters for five sowing dates.*

Pods, branches and yield/plant showed high coefficients of variability (Table 3), and highly significant positive correlations (Table 4), indicating a high degree of interdependence. On the other hand, average seed weight and number of seeds/pod were much more stable characters with lower coefficients of variation. Whereas seeds/pod correlated with yield and branch numbers/plant, average seed weight was not associated with any other characters.

Table 3. *Averages and phenotypic coefficient of variation (%) for different parameters.*

Parameters	Average	Phenotypic coefficient of variation (%)
Pods/plant	31.32	34.39
Seeds/pod	1.08	2.30
Average seed weight[1]	0.09	6.67
Yield/plant[1]	3.10	35.27
Branches/plant	6.27	33.17

[1] grams

Table 4. *Phenotypic correlations among the different parameters.*

Parameters	Seeds/ pod	Av. seed weight	Yield/ plant	Branches/ plant
Pods/plant	0.48[a]	–0.25	0.98[a]	0.92[a]
Seeds/pod		–0.10	0.54[a]	0.38[a]
Av. seed weight (g)			–0.13	–0.08
Yield/plant				0.93[a]

[a] 1% level of significance.

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Response of lentil varieties to iron application in calcareous soil

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Abstract

The response of four lentil cultivars to different levels of Fe application was measured for three years in alkaline soil in India. The cultivars responded differently to Fe application, which increased grain yield significantly in three out of the four cultivars.

Introduction

Iron deficiency or chlorosis is often a severe problem for plant growth on calcareous and saline alkali soils. About 15-25% of calcareous soils of north Bihar have been reported deficient in available Fe. Lentil is an important legume crop of this region that suffers from Fe chlorosis. The magnitude of deficiency differs from variety to variety, however, making selection of proper crop genotypes for such soils immensely important.

Materials and Methods

Field studies of lentils grown on Fe deficient calcareous soils were carried out at the Experiment Research Station at Dholi, Muzaffarpur (Bihar) for three consecutive years during the winter seasons of 1979-81. Table 1 shows some important physico-chemical properties of the experimental fields.

The experiments were carried out in a split plot design, keeping Fe levels (0, 5, 10, 20, and 40 kg Fe/ha as $FeSO_4$) in main plots, and varieties (Pant 639, BR 25, No. 26, and Pant 406) as sub-plot treatment in triplicates. A basal application of 20 kg N, 50 kg P_2O_5 and 40 kg K_2O/ha was given through urea, diammonium phosphate and muriate of potash, respectively. Only one irrigation was given before the crop flowered. The crop was harvested at full maturity and grain yield recorded.

Visual observations

All varieties except Pant 406 exhibited iron chlorosis to a varying degree up to 5 kg Fe/ha application. Fe chlorosis was identified by interveinal chlorosis on emerging leaves, whose interveinal tissues turned yellowish-white and later

Table 1. *Physico - chemical characteristics of the initial soil samples.*

Selection No.	Particulars	Years		
		1979/80	1980/81	1981/82
1.	pH	8.7	8.8	8.7
2.	Free $CaCo_3$ (%)	20.8	30.1	22.7
3.	Organic Carbon (%)	0.55	0.40	0.52
4.	DTPA extractable Fe (ppm)	3.40	4.00	5.56
5.	" " Mn (")	9.00	5.90	7.90
6.	" " Cu (")	1.00	1.00	0.80
7.	" " Zn (")	0.78	0.58	0.79

Table 2. *Influence of Fe application on grain yield of lentil varieties.*

Varieties	Iron level (kg Fe/ha)						C.D. at 5% level	
	0	5	10	20	40	Mean		
			1979/80					
Pant 639	23.14	31.76	20.83	19.86	19.90	23.10	Fe levels mean	= 0.95
No. 26	20.50	24.13	30.61	31.15	26.37	26.37	Varieties mean	= 1.32
B R 25	27.86	29.66	29.80	29.66	27.88	29.77	Fe x varieties	= 2.96
Pant 406	29.71	24.99	19.72	15.73	14.70	20.97		
Mean	25.30	27.63	26.24	24.13	22.21	–		
			1980/81					
Pant 639	9.08	12.60	16.38	14.81	11.59	12.90	Fe levels mean	= 1.31
No. 26	7.18	8.96	13.60	11.14	10.62	10.30	Varieties mean	= 1.36
B R 25	9.59	12.90	13.86	11.29	8.87	11.29	Fe x varieties	= 1.04
Pant 406	14.38	12.73	10.13	10.01	9.54	11.36		
Mean	10.06	11.80	13.48	11.85	10.1	–		
			1981/82					
Pant 639	16.36	20.37	25.00	18.54	18.57	21.27	Fe levels mean	= 1.35
No. 26	18.46	24.99	30.53	19.18	19.83	22.60	Varieties mean	= 4.07
B R 25	25.53	25.92	28.33	29.45	18.91	24.43	Fe x varieties	= 4.13
Pant 406	31.01	30.61	29.96	30.75	30.48	30.56		
Mean	22.53	25.47	28.46	23.23	21.95	–		

lost their original green color. Such symptoms subsequently spread to lower leaves. Leaflets finally dried up, curled, and dropped off. Based on the magnitude of Fe deficiency symptoms, varieties ranked:

No. 26 > Pant 639 > BR 25.

Grain yield

Iron application increased grain yield significantly in all varieties except Pant 406, which responded rather negatively to applied Fe (Table 2). The magnitude of grain yield response to iron varied greatly from variety to variety in all three years with the same trend, revealing clearly that Fe use efficiency is affected not only by plant genotype but also by climate and soil/plant interaction. The optimum Fe dose also differed from variety to variety. Variety Pant 639 yielded highest at 5 kg Fe/ha, whereas BR 25 and No. 26 produced the most grain at 10 kg Fe/ha. The variety that gave maximum grain yield response to Fe application was rated as most susceptible to Fe stress, and the one which responded least is ranked as least susceptible. Based on overall percent grain yield response (figures shown within brackets below), the relative susceptibility of varieties to Fe stress was rated as follows:

No. 26 >	Pant 639 >	BR 25 >	Pant 406
(68)	(50)	(27)	(–24)

The varying responses to iron may be caused by differences in the varieties' genetic make-up, root volume, and nature of root exudates. Further detailed study is needed to identify the mechanism of lentil cultivars' tolerance to Fe deficiency.

Physiology and Microbiology

Seed viability in lentils (*Lens culinaris*)

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Abstract

The seed viability of 28 lentil cultivars was assessed by a standard germination test and by the tetrazolium test. Significant genetic variation between the cultivars was revealed by both tests. Although the tetrazolium test does not assess the % of hard seeds, it is quicker than the germination test. The tests are considered complementary.

Introduction

Lentils, a valuable protein source, can be grown on relatively poor soils under adverse conditions. In India, the largest lentil-producing country in the world, lentils rank fifth among food legumes in area and production. Lentils are now receiving attention because of their production potential under marginal management conditions.

Improved lentil seeds are an important component of higher productivity. Seed viability bears significantly on final yield. This study, therefore, investigated seed viability in lentil genotypes using germination and tetrazolium (TZ) tests.

Table 1. *Germination percentage in lentil.*

Genotype	Tetrazolium test		Germination test			
	Viable seeds	Non-viable seeds	Normal seeds	Abnormal seeds	Dead seeds	Hard seeds
LH1	80	20	68.3	9.0	16.0	6.7
No. 2	77	23	76.0	9.0	15.0	–
LH15	72	28	68.3	15.0	16.7	–
LH30	65	35	57.3	11.3	31.3	–
LH37	55	45	43.0	15.7	41.0	0.3
LH56	78	22	76.0	9.3	14.7	–
LH57	70	30	64.7	14.0	21.3	–
LH73	61	39	53.3	16.0	30.7	–
LH93	76	24	71.0	15.3	13.7	–
LH97	64	36	57.3	28.0	14.3	0.3
LH101	86	14	79.7	9.3	11.0	–
LH143	76	24	81.0	6.7	12.3	–
LH145	80	20	77.0	12.7	10.3	–
LH157	76	24	72.0	9.3	18.7	–
LH159	73	27	68.3	14.0	17.7	–
LH162	64	36	58.0	20.3	21.7	–
LH164	78	22	74.7	9.3	16.0	–
LH238	78	22	71.0	11.7	17.0	0.3
LH243	80	20	81.3	7.0	11.7	–
LH259	81	19	64.3	23.7	11.7	0.3
LH261	40	60	35.7	10.3	54.0	0.3
LH294	67	33	58.7	16.0	25.3	–
LH299	84	16	77.3	7.3	15.3	–
LH311	68	32	73.0	4.7	22.0	0.3
LH319	72	28	72.7	5.3	22.0	–
LH348	76	24	71.3	13.3	15.3	–
Pant 639	63	37	58.3	15.3	26.3	–
L9-12	77	23	73.3	10.0	16.7	–

Although the germination test gives reliable results, it is time-consuming. Seed viability can be assessed more quickly with the TZ test.

Materials and Methods

We tested samples for germination of 28 genotypes harvested from the field and not subjected to chemical treatment. For the TZ test, we prepared a 1% solution of 2, 3, 5-triphenyl tetrazolium chloride (stain) in distilled water.

Seeds were pre-conditioned by soaking in water for two and a half hours at 30°C. Seed coats were removed by pressing the seeds between the index finger and thumb, holding the segment opposite the radicle and plumule. For staining, seeds were placed in 1% TZ solution for two and a half hours at 40°C. After staining, the TZ solution was drained off and the seeds washed several times with water. Water was retained, however, after the final washing to completely cover the seed. The seeds were then categorized into two groups: viable and non-viable (ISTA 1976).

For the germination test, we placed 100 seeds of each genotype on wet germination paper, rolled the paper and placed it upright in a room-type germinator at 30°C for seven days. The procedure was repeated three times for each entry. After seven days, the seedlings were categorized as normal, abnormal, dead, or hard.

Results and Discussion

In the TZ test, the non-viable seeds included the following: (1) seeds with more than the extreme tip (about 1 mm) of the radicle unstained; (2) seeds with more than half of the cotyledonary tissue unstained; and (3) seeds with an unstained area at the juncture of cotyledons and radicle. Most non-viable seeds were either completely unstained, with flabby tissue, or white to cream in color. Regarding weevil-damaged seeds, if damage was slight and did not affect the plumule, seeds were classified as viable. The range among viable and non-viable seeds was 40-86%. Out of 28 entries, the maximum percentage of viable seeds was found in LH101 (86%) and the minimum in LH261 (40%) (Table 1).

In the germination test, the range among normal germinated seed was 35.7-81.3% . The genotype LH243 had the maximum percentage of normal seeds (81.3%), whereas the genotype LH261 had the lowest percentage of normal seeds (35.7%). LH97 had the highest percentage of abnormal seeds (28.0%), whereas LH311 had the lowest (4.7%). Dead seeds in field samples were common, ranging from 10.3 (LH145)-54.0 (LH261)% . In six other genotypes, hard seeds were found, but at a negligible level, (0.3%) . To conclude, then, entry LH243 showed the best germination and LH261 the poorest. More generally, we observe that although the TZ test does not assess the presence of hard seeds, it can be conducted quickly, and so is fairly comparable and complementary to the germination test for seed viability in lentils.

Acknowledgement

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Pests and Diseases

A method to artificially inoculate lentil rust

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Abstract

A method to artificially transmit lentil rust (*Uromyces fabae*) is described. The uredospores from the field must be stored at less than 7°C. A concentration of 3 x 10^4 spores/ml, inoculated at the seedling stage, produced the best results. The plants must be kept at 100% relative humidity for 1-4 days following inoculation.

Introduction

For the systematic study of important plant diseases such as lentil rust (*Uromyces fabae* (Pers.) de Bary), it is important that the disease can be artificially transmitted to avoid depending on unreliable natural infestation. Artificial transmission and multiplication of the fungus *Uromyces fabae* is difficult. Laboratory and greenhouse studies were conducted to establish an inoculation method for this parasite, to be used for lentil improvement under controlled conditions.

Materials and Methods

Uredospores were harvested from infected lentils in the Chanco area (lat. S. 35°45'). The plants were tapped over a 2 mm Ø sieve with a collector beneath. Uredospores were sifted again through a 0.18 mm Ø sieve, and temporarily stored in a portable cooler at 7°C. In the laboratory, they were stored in petri dishes sealed with adhesive and left refrigerated at 3-5°C until required.

Environmental conditions in the greenhouse were recorded: the mean daily temperature was 18°C, and the relative humidity ranged from 60-100%.

The spores were sprayed manually, incorporated into a solution including an adherent-dispersant, Teepol 1% , at a dose of 2 ml/l.

Inoculations included different spore concentrations, which were subjected to different periods of humidity saturation. Lentils were inoculated both as seedlings and at the onset of flowering.

Results

1. A concentration of 3 x 10^4 spores/ml was best to produce a good infection.
2. Seedling stage (15 cm high) was best for inoculation, since many plants can be handled in a small area.
3. The inoculated plants must be subjected to 100% relative humidity for at least one to four days after inoculation. Three days of humidity saturation produced the greatest number of pustules/seedling.
4. Storage and transport of uredospores from the field must be done with care to maintain more than 70% viability.

Analysis of some structural and biochemical constituents of rust-resistant and susceptible cultivars of lentil

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Abstract

The reaction of 93 Indian lines of lentil to rust is given. The variation in structural characters and both chemical and biochemical constituents of three resistant and four susceptible cultivars was examined. There was no difference between the groups of cultivars in structural characters. There were higher levels of reducing and non-reducing sugars, nitrogen,and zinc in susceptible cultivars, whereas resistant ones had more P, Ca, Mg, Fe, Mn, and K.

Several factors contribute to the susceptibility or resistance of a host to disease. In this study, the factors of cultivar, plant structure, and chemical and biochemical constituents of the host were examined for their influence on the reaction of lentil (*Lens culinaris* M.) to rust (*Uromyces fabae* (Pers.) de Bary).

Table 1. *Disease index and disease reaction of lentil cultivars and lines to rust.*

Disease index group	Varieties/lines	Reaction
0	LG-60, Pant-639, PLMA-183, and K-80	Immune
0.1-5	LL-78, JL-279, LC-34, K-75, and SKL-259	Resistant
5.1-20	JL-776, LG-168, and Pant L-184	Tolerant
20.1-50	JL-78, LL-56, LG-112, LG-120, LG-7, JL-129, JL-500, JL-61, JPL-955, JPL-958, LC-264, PLMA-231, HPL-5, PL-77-12, B-235, and Bombay-18.	Susceptible
50.1 and above	LL-30, LL-1, LL-116, LL-34, JL-1, JL-192, JL-955, JL-473, JL-964, JL-559, JL-129, JL-930, JL-460, JL-191, JL-169-2, JL-48, JL-183, JL-470, JL-188, JL-145, JL-480, JL-493, JL-237, JL-29, Pant L-406, Pant L-370, Pant L-234, JPL-970, JPL-971, JPL-954, JPL-972, JPL-959, JPL-953, Lens-312, Lens-1278, Lens-830, Lens-312, LC-34, LC-216, LC-295, LC-266, LC-360, LC-365, LC-319, LC-272, LC-117, LC-103, PLMA-243, PLMA-6, PLMA-269, PLMA-19, PLMA-100, LS-74-3, LS-74-7, RAU-101, PL-77-2, PKVL-1, IC-22286, IC-22687, L-9-12, PL-74-7, B-77, BR-25, and Local JBP.	Highly susceptible

Table 2. *Variation in the structural differences between lentil cultivars that are susceptible and resistant to rust.*

Parameter	Susceptible lines		Resistant lines	
	Range	Mean	Range	Mean
Stomatal length	20.58-22.38 μ	21.77 μ	20.84-22.44 μ	21.47 μ
Stomatal width	5.11- 6.18 μ	5.64 μ	5.35- 6.54 μ	6.02 μ
Guard cell thickness	16.53-17.49 μ	17.13 μ	16.18-17.96 μ	16.97 μ
Stomatal number/microscopic field (600x)				
Lower surface	14.66-16.33	15.83	15.33-16.66	15.99
Upper surface	15.66-17.00	16.24	15.66-16.66	16.21
Cuticle thickness				
Leaf	1.56-1.62 μ	1.59 μ	1.57-1.61 μ	1.59 μ
Stem	2.58-2.65 μ	2.60 μ	2.49-2.67 μ	2.59 μ
Thickness of epidermal cells				
Leaf	23.16-23.96 μ	23.54 μ	23.19-23.92 μ	23.63 μ
Stem	28.95-29.56 μ	29.16 μ	29.12-29.72 μ	29.51 μ
Palisade cell size				
Length	64.88-65.80 μ	65.24 μ	65.24-66.21 μ	65.60 μ
Width	24.87-25.42 μ	25.11 μ	24.86-25.21 μ	25.06 μ

Table 3. *Biochemical and mineral differences in lentil cultivars with susceptible and resistant reaction to rust.*

Parameters	Susceptible lines		Resistant lines	
	Range	Mean	Range	Mean
Reducing sugars				
mg/10g in leaf	5.15-5.15	5.15	5.02-5.15	5.10
stem	4.32-5.15	4.91	3.96-4.92	4.41
seed	1.26-1.44	1.36	1.28-1.37	1.31
Nonreducing sugars				
mg/10g in leaf	5.23-7.60	6.13	4.30-5.53	5.12
stem	1.76-3.03	2.20	2.23-2.29	2.55
seed	1.60-3.50	2.74	1.33-2.46	2.00
Phosphorus (%)				
leaf	0.41-0.44	0.42	0.46-0.49	0.47
stem	0.34-0.37	0.35	0.37-0.41	0.40
seed	0.38-0.43	0.42	0.40-0.44	0.43
Potassium (%)				
leaf	3.60-4.35	4.05	4.36-4.88	4.65
stem	2.30-4.51	3.65	2.00-2.10	2.06
seed	2.08-2.31	2.20	2.31-2.38	2.35
Calcium (%)				
leaf	2.00-2.15	2.09	2.12-2.15	2.13
stem	0.87-0.90	0.89	1.22-1.44	1.33
seed	0.43-0.45	0.44	0.44-0.46	0.45
Magnesium (%)				
leaf	0.22-0.24	0.22	0.26-0.28–	0.27
stem	0.07-0.09	0.08	0.08-0.09	0.88(085)
seed	0.13-0.14	0.13	0.12-0.14	0.13
Iron (ppm)				
leaf	72.96-119.10	92.67	107.00-147.00	126.02
stem	59.66-66.10	60.28	69.06-96.26	80.26
seed	78.66-97.00	84.58	96.16-97.86	96.78
Zinc (ppm)				
leaf	96.96-132.81	118.29	93.22-125.74	109.68
stem	62.11-81.30	70.53	59.49-79.79	69.82
seed	35.35-64.13	48.96	63.12-68.17	65.12
Manganese (ppm)				
leaf	44.16-53.33	48.91	50.00-70.83	62.22
stem	20.16-25.16	21.33	26.00-35.33	32.16
seed	16.83-20.33	19.33	20.00-25.14	22.58
Nitrogen (%)				
leaf	4.35-4.58	4.47	4.24-4.30	4.27
stem	2.14-2.68	2.41	2.71-2.80	2.75
seed	4.01-4.16	4.09	3.81-3.90	3.85
Leaf surface wax mg/sq cm	2.71-3.44	2.98	4.07-4.67	4.27

Cultivar: Four out of 93 cultivars and lines of lentil tested for their reaction to rust were completely free from the disease (LG-60, Pant-639, PLMA-183, and K-80), with 0 disease index. Five cultivars were resistant with 0.1-5 disease index (LL-78, JL-279, LC-34, K-75, and SKL-259). Three cultivars were tolerant with 5.1-20 disease index (JL-776, LG-168, and Pant L-184), and 16 lines were susceptible with 20.1-50 disease index. The remaining lines were highly susceptible with a disease index above 50 (Table 1).

To examine the influence of variation in several factors—structural characters, biochemical constituents, and chemical constituents—upon the mechanism of rust resistance in lentil, we selected four susceptible cultivars: *Lens* 830, JL-1, L-1282, and Jabalpur local; and three resistant cultivars: LG-60, LL-116, and Pant-639.

Structural characters: Table 2 presents data on the parameters of stomatal length and width, thickness of guard cells, number of stomata on both leaf surfaces, thickness of cuticle in leaf and stem, thickness of epidermal cells of leaf and stem, and length and width of palisade cells. These parameters did not differ significantly between resistant and susceptible cultivars.

Biochemical constituents: Lentil leaves, stems, and seeds were tested for the presence of 11 amino acids; however, no qualitative differences were found between resistant and susceptible cultivars. Quantities of reducing sugars, on the other hand, were greater in susceptible cultivars than in resistant ones (Table 3). Amounts of non-reducing sugars were higher in leaves and seeds of susceptible cultivars, although stems of resistant cultivars had more non-reducing sugars.

Quantities of phosphorus, calcium, magnesium, iron, and manganese were significantly higher in leaves, stems, and seeds of resistant cultivars. Potassium quantity was significantly higher in leaves and seeds of resistant cultivars. Significantly higher amounts of nitrogen and zinc were observed in leaves and seeds of susceptible cultivars.

Wax was found in higher quantities on the leaf surface of resistant cultivars, where it acts as a barrier to fungus penetration.

The results of this study suggest that chemical constituents of a cultivar may cause the reaction to the rust pathogen. Similar findings were reported in other host-pathogen systems such as the wheat-rust pathogen (Gassner and Franke 1934), wheat-*Alternaria triticina* (Kumar 1974), and tomato-*Cladosporium fulvum* (Baily and Lowther 1962).

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Observations on infestation of *Lens culinaris* by *Bruchus lentis* in the Chandigarh area of India

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Abstract

Bruchus lentis, a monovoltine pest of *Lens culinaris,* is common in the area around Chandigarh. The pest attacks green pods of the host plant in February, completes its development by June-July, overwinters in protected places, and returns to restart its cycle on the new crop. The feeding of adults on host plant flowers is essential for the pests' ovaries to mature and for copulation to begin.

Introduction

B. lentis Frohl. is a field bruchid associated with *L. culinaris* Med. in different areas. De Luca (1956) briefly outlined the species' biology in Algeria. Arora (1977) and Southgate (1979) listed the species as a pest of *L. culinaris*. In this paper, we report results of a three year study of the biology of *B. lentis*, including surveys of local *L. culinaris* fields for *B. lentis* infestation.

Observations and discussion

A survey of nearly 30 fields of *L. culinaris* was made in the Chandigarh area. The results revealed that *B. lentis* adults appear in the fields toward the end of February when the plants start blooming. All fields were infested at levels ranging from medium to high. Field observations and laboratory experiments showed that adult bruchids feed actively on the host plant pollen and nectar. Several bruchids were seen inserting their heads into staminal tubes to lick nectar at the tube base.

The males and females copulate 10-12 days after starting to feed. Copulation occurs with male above female and lasts for three to five minutes. The female starts laying eggs on the pods one to three days after copulation. The crop is harvested in May when the dry seeds contain the pest's developing larvae and pupae. Adults begin to emerge from the seeds in July and finish by the end of January. Whereas most emerging adults fly to the fields, some continue to occupy the seed cavities for a long time. We noticed a few adults hiding under the bark of Eucalyptus trees about 500 meters away from the lentil fields. All adults visit the lentil fields to repeat the cycle. Since bruchids emerge with significantly higher frequency on rainy days, emergence can be accelerated in the laboratory by dipping the seeds in water for a minute or so.

The laboratory experiments showed that adult bruchids emerging from July-September have poorly-developed ovaries and testes. These adults can be maintained in the laboratory during the winter months (November - January) if sheltered with dry leaves or grass. Flowers of leguminous plants such as *Cajanus cajan*, provided as food, did not prolong adult longevity, but did exert some influence on the growth of ovaries. The testes became fully mature by the end of December in both fed and unfed males. However, the ova formation in the ovaries starts only after females feed on lentil pollen and nectar. The feeding of both males and females on host plant flowers is essential for copulation to start. Copulation does not take place when one or both sexes are prevented from feeding on flowers. *B. lentis* reproduction, then, clearly requires feeding on the host plant. Such a requirement may determine host specificity in this species and allied species from genera *Bruchus* (Pajni 1981) and *Bruchidius* (Singal 1982).

Acknowledgement

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LENTIL INFORMATION

Lens Bookshelf

CEC (Commission of the European Communities). 1977. **protein quantity from leguminous crops.** Brussels-Luxemburg, Belgium, Commission of the European Communities. 395 pp.

This volume contains the proceedings of a seminar held 3-5 Nov, 1976, in Dijon, France, under the auspices of the Commission of the European Communities as part of the EEC Common Program on Plant Protein Improvement. The proceedings, containing 30 papers, are divided into sections on analytical and chemical aspects of legume quality, on the response of animals in feeding experiments involving leguminous crops, and on breeding work to improve legume quality.

Each section ends with a brief commentary. The objectives of the seminar were to summarize and update the information available on the selected subjects and to discuss future research.

Lentils are not covered in this publication, which concentrates on *Pisum sativum* and *Vicia faba*, but the principles are applicable to *Lens culinaris.*

Cubero, J.I. and Moreno, M.T. (eds.). 1983. **Leguminosas de grano.** Madrid-1, Spain, Ediciones Mundi–Prensa. 359 pp. [Sp] ISBN 84-7114-127-2.

Grain legumes have been important to human beings from the earliest times because of their high protein seed and nitrogen–fixing capacity. In Spain, these legumes are now less popular than in the past. The reasons for this and the potential of grain legumes in Spain are the subjects of this multi-author book.

The book discusses the origin, evolution, and improved genetics of grain legumes; the symbiosis of leguminous *Rhizobium*; and the cultivation of legumes in Spain. It also provides preliminary information about legume diseases in Spain, and covers legume seed production and genetic resources in the country. It discusses collections of legumes in the world, and also addresses the role of grain legumes as premium material for the national industry of animal consumption.

Giles, K.L. and Athery, A.G. (eds.). 1981. **International review of cytology: Supplement 13, Biology of *Rhizobiaceae*.** New York, USA, Academic Press. 350 pp. ISBN 0-12-364374-0.

This book discusses the taxonomy and identification of the *Rhizobiaceae*, and suggests some new concepts that may have far–reaching implications.

The book reviews *Agrobacterium*, stressing the concentration of research on the molecular biology of this important group of bacteria. Later chapters present the genetic, molecular, biological, agricultural, and morphological aspects of *Rhizobium*, enabling the reader to compare and contrast the recent findings in diverse areas of *Rhizobia* research, as well as to compare *Agrobacterium* with the *Rhizobia*. This book is of special interest to investigators in agronomy, genetics, molecular biology, botany, and microbiology. Specialists as well as students entering this field of research can benefit from this volume.

Hopkins, S.T. Jones, D.E. (eds.). 1983. **Research guide to the arid lands of the world.** The Pryx Press, 2214 North Central at Encantno, Phoenix, Arizona 85004, USA, 400 pp. ISBN 0-89774-066-1, $74.50.

This volume, compiled under a grant provided in 1980 by the U.S. Department of Education, provides access to reference materials on arid lands, desert, grassland, steppe, and dry forest.

The book is the first comprehensive annotated bibliography to compile and evaluate journals, bibliographies, directories, statistical sources, on–line data bases, atlases, gazetteers, and other useful sources for research on the physical and human geography of the world's dry lands. Sources of current information are emphasized, and major retrospective bibliographies are also included.

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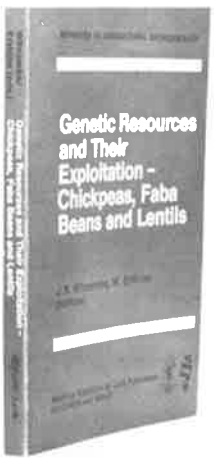

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The Netherlands

Key Lentil Abstracts

Sharma, S.N., Ray, S.B., Pandey, S.L. and Prasad, R. 1983. **Effect of irrigation, pyrites, and phosphobacteria on the efficiency of rock phosphate applied to lentils.** *Journal of Agricultural Science, Cambridge* 101: 467-472. Water Technology Center, Indian Agricultural Research Institute, New Delhi-110012, India.

A field experiment was made at the Indian Agricultural Research Institute, New Delhi, during the autumn-spring season of crop years 1979/80 and 1980/81 to study the effects of irrigation, pyrites and phosphobacteria on the efficiency of Mussoorie rock phosphate (north-western Himalayan deposits) for lentils (*Lens culinaris* Medic.), and residual effects were studied in maize (*Zea mays* L.). Response to phosphate was observed only when the crop received irrigation. Mussoorie rock phosphate was only 40.5% as effective as ordinary superphosphate; its efficiency was increased to 50.4% when it was mixed with 25% (by weight) pyrites. When the lentil seeds were treated with the culture of *Pseudomonas striata* (phosphate solubilizing bacteria) the efficiency of rock phosphate was increased to 79.7% . Rock phosphate together with seed treatment with phosphobacteria also showed residual effects on the succeeding maize crop which were equal to those obtained with ordinary superphosphate. Our results, thus, show that use of phosphobacteria can considerably increase the efficiency of rock phosphate on neutral soils.

Lopez, M., Carbonero, V., Cabrera, E. and Ruiz-Argueso, T. 1983. **Effects of host on the expression of the H_2-uptake hydrogenase of *Rhizobium* in legume nodules.** *Plant Science Letters* 29: 191-199. Departamento de Microbiologia, E.T.S. de Ingenieros Agronomos, Madrid-3, Spain.

The relative efficiency of nitrogen fixation by nodules and the H_2-uptake hydrogenase activity of bacteroids produced by hydrogenase-positive strains of *Rhizobium leguminosarum* and *R. japonicum* in different legume hosts have been examined. Bacteroids from nodules of *Pisum sativum* and *Vicia faba* from strain 128C53 of *R. leguminosarum* showed a capacity to take up H_2, but no hydrogenase activity was detected in bacteroids from nodules of *Lens culinaris* inoculated with the same strain. Seven *R. japonicum* strains produced nodules in *Glycine max* and *Vigna unguiculata* and three of these were also able to nodulate *Vigna radiata*. In all these cases, the nodules evolved little or no H_2 in air and the bacteroids isolated from strain 3I1b6 had 10-fold less hydrogenase activity when isolated from *V. radiata* than when obtained from nodules of *G. max* or *V. unguiculata*. These results demonstrate a strain-dependent host effect on the expression of H_2-uptake hydrogenase in legume nodules.

Weder, J.K.P., Hegarty, M.P., Holzner, M. and Dirndorfer, M.L.K. 1983. **Trypsin and chymotrypsin inhibitors in *leguminosae* VIII. Isolation in some properties of the principal inhibitor from lentils (*Lens culinaris* Medik.).** *Zeitschrift fur Lebensmittel–Untersuchung und–Forschung* 177: 109-113. Institut fur Lebensmittelchemie der Technischen Universitat Munchen, Lichtenbergstr. 4, D-8046 Garching, Federal Republic of Germany.

The principal trypsin-chymotrypsin inhibitor in the seeds of lentils (*Lens culinaris* Medik.) was isolated from a dilute sulphuric acid extract of seeds by ammonium sulphate precipitation and was purified by chromatography on Bio-Gel P-100 and finally by fractionation on a column of DEAE-Sephadex A-50 and elution with a volatile buffer. A 600-fold purification was achieved, and small amounts of three minor trypsin inhibitors were isolated.

The principal *L. culinaris* inhibitor (LCI-4) had a molecular weight of 18,000 Daltons, calculated from its amino acid analysis, and showed high cysteine/cystine and aspartic acid/asparagine contents and was low in methionine and isoleucine. The molecular weight obtained from sodium dodecylsulphate-polyacrylamide gel electrophoresis was 23,100 whilst the isoelectric point was 7.4. Both trypsin and α-chymotrypsin were inhibited at molar ratios of 1:1. These data indicated that LCI-4 is a representative of a new inhibitor family.

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Lens News Service

RECENT CONFERENCES AND MEETINGS

Third International Symposium on Parasitic Weeds
ICARDA, Aleppo, Syria. 7-10 May

"Parasitic Weeds" was the theme of a four–day symposium held on 7-10 May with the collaboration of ICARDA under the auspices of the International Parasitic Seed Plant Research Group. The symposium provided a forum for the interchange of data, techniques, and research results on all aspects of parasitic vascular plants. The following topics were covered: major parasitic groups (*Striga, Orobanche, Cuscuta,* and mistletoe), and their biology and control, as well as basic research in physiology, biochemistry, structure and ecology.

The symposium participants visited field trials to view *Orobanche* infestations and other parasitic species.

Copies of the proceedings are available at US$ 20 each from C. Parker, Weed Research Organization, Begbroke Hill, Sandy Lane, Yarnton, Oxford OX5 1PF, UK.

Seed Production Training Course No. 2, co–sponsored by the Royal Government of the Netherlands and the German Agency for Technical Cooperation (GTZ)
ICARDA, Aleppo, Syria. 15-30 May.

The objectives of the course were to train suitable personnel in West Asia and North Africa in seed production technology, and to promote the development of national seed industries through the participating trainees.

The course curriculum included laboratory and field techniques, and theoretical background, planning, organizing and managing a seed production program, variety release and regulations, crop certification, seed testing–mainly in self–pollinated crops (barley, wheat, lentils, chickpeas, and forage peas), with awareness of seed testing problems in crosspollinated crops (alfalfa and forage grasses), extension methodology, and programs for the promotion of quality seeds, principles of seed cleaning, evaluation of germination cleaning.

Copies of this publication are available free from ICARDA.

FORTHCOMING CONFERENCES–1984

June

Ninth World Fertilizer Congress of International Center of Fertilizers (CIEC)
Budapest, Hungary, 11-16 June
Contact: Hungarian Society of Agricultural Scientists, Kossuthter 6-8, 1055, Budapest, Hungary.

July

Sixth International Conference and Exhibition on Mechanization of Field Experiments
Dublin, Ireland, 8-13 July

18th International Workshop on Seed Pathology of International Seed Testing Association (ISTA)
Puyallup, Washington, USA, 9-16 July
Contact: Dr. R.L. Gabrielson, Washington State University, W. Washington Research & Extension Center, Puyallup, WA 98371, USA.

TASACONEX 84
The Tropical and Subtropical Agriculture Convention and Exhibition
Ardingly, Sussex, England, 18-20 July
Contact: Fairlight World Seminars, 15 Sussex, Havelock Road, Hastings, Sussex TN34 1DE, UK.

Kew International Conference on Economic Plants for Arid Lands
Kew, UK, 23-27 July
Contact: Dr. G.E. Wickens, KICEPAL, Royal Botanic Gardens, Kew, Richmond, Surrey, TW9 3AB, UK.

August

First International Congress of Nematology
Guelph, Ontario, Canada, 5-10 Aug
Contact: Dr. Teo Olthof, Research Station, Agriculture Canada Vineland, Ontario, Canada 1OR 2EO.

Seventh International Congress of Entomology
Hamburg, Federal Republic of Germany, 18-26 Aug
Contact: Dr. L.A. Mound, British Museum (Natural History), Cromwell Road, London, SW7 5BD, UK.

September

Sixth International Congress on Virology
Sendai, Japan, 1-7 Sept
Contact: Prof. S. Glover, University of Newcastle, Department of Genetics, Newcastle–upon–Tyne NE1 7RU, UK.

International Symposium on Plant Tissue and Cell Culture Application to Crop Improvement
Olomouc, Czechoslovakia, 4-10 Sept
Contact: Dr. F.J. Novak, Institute of Experimental Botany, Sokolovaka 6 CS-77200 Olomouc (CSSR).

October

Sixth Congress of the Mediterranean Phytopathological Union
Cairo, Egypt, 1-6 Oct
Contact: Prof. Moustafa Fahim, P.O.Box 198, Orman, Giza, Egypt.

Third Conference of the Arab Biologists Society
Amman, Jordan, 15-20 Oct
Contact: The Executive Secretary of the Conference, The Arab Biological Society, P.O.Box 13322, Jordan University, Amman, Jordan.

International Symposium on Genetic Manipulation in Crops
Peking, People's Republic of China, 22-26 Oct
Contact: Dr. Hu Han Shao Qiquan, Institute of Genetics, Academia Sinica, Beijing, P.R. of China.

November

FABIS and LENS Users' Seminar
Aleppo, Syria, 28-29 Nov
ICARDA plans to hold a seminar at ICARDA, Aleppo for the users of FABIS and LENS. The theme of the seminar is to assess the effectiveness of the service, and to determine ways for improvement. If you are interested in participating in this seminar, contact LENS.

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In English and Arabic, this full-color, illustrated brochure describes the highlights of ICARDA's research during 1982. The topics highlighted give a partial insight into the continuing work of ICARDA scientists and the progress they have already made. The projects described include the development of dual-purpose barley and food legumes, the use of pasture and forage crops as alternatives to fallow, research on improved farming systems, and the breeding of lentils, chickpeas, and barley, and pure lines of faba beans. The benefits of early planting of lentils are described as well as cooperation with the national programs in the use of ICARDA lentil selections in multi-location and on-farm trials. Special emphasis is also given to the use of the Center's research results in a partnership with the national programs to increase agricultural productivity in the region. For your copy, write Communications and Documentation.

ICARDA's Food Legume Improvement Program
In English and Arabic, the 24-page illustrated information brochure briefly describes research projects on lentil, faba bean and chickpea treated either as single crops or as a group. For your copy, write FLIP.

FABIS (Faba Bean Information Service)
This service was established in June 1979 when FABIS Newsletter No. 1 appeared. Now produced triannually, it publishes up-to-the-minute short scientific papers on the latest research results and news items. FABIS has also produced other publications, including *Genetic Variations within Vicia faba.* For further information, write FABIS.

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ICARDA's historical background and research objectives are outlined in English or Arabic. For your copy, contact Communications and Documentation.

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

RACHIS (Barley, Wheat and Triticale Newsletter)
This ICARDA service is aimed at cereals researchers in the Near East and North Africa region and Mediterranean-type environments. It publishes up-to-the minute short scientific papers on the latest research results and news items. RACHIS seeks to contribute to improved barley, durum wheat, and triticale production in the region; to report results, achievements, and new ideas; and to discuss research problems. For further information, write RACHIS.

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ICARDA, P.O. Box 5466
Aleppo, Syria

SUBJECT INDEX FOR LENS NEWSLETTER
VOLUMES 1-10
1974-1983

	Vol./No./ Page
A	
Aged seed and cooking quality	.7 37
Aged seed and electroconductivity	.6 22
Aging of seed	.8 11
	.9 41
Aging seed artificially	.7 39
Amino acid content	.4 28
Aphid resistance	.7 65
Ascochyta in Canada	.10 (1) 31
Aspartate aminotransferase polymorphism	.8 21
B	
Barban efficacy	.2 39
Barban tolerance	.2 38
	.3 30
Breeding	.2 11
Breeding in Brazil	.4 6
Breeding methods	.6 24
Bulk population	.6 24
C	
Chalky spot	.9 42
Chemical composition	.4 28
	.9 39
Climatic effects in Brazil	.10 (2) 22
Colchicine	.7 14
	.9 15
Cold tolerance	.8 5
Combining ability	.4 10
Controlled environment studies	.8 13
Cooking quality	.4 27
	.10 (1) 35
Cooking quality of aged seed	.7 37
Correlated selection response	.4 20
Correlations among yield components	.9 22
Cotyledon color genetics	.5 24
Cultivar	.8 30
Cultivar Araucana INIA	.8 30
Cultivar Eston	.8 30
Cultivar Laird	.5 24
Cultivar Pant L-406	.7 34
Cultivar Precoz	.2 9
Cultivar Pusa 4	.3 11
Cultivar Pusa 6	.3 11
Cultivar Pusa 8	.3 11
Cultivar Pusa 10	.3 11
Cultivar Redchief	.8 31
Cytogenetics	.6 24
	.10 (1) 16
Cytological techniques	.10 (1) 22
Cytology	.2 11
	.3 15
	.8 23
D	
Density of stand	.6 8
	.6 10
	.10 (1) 28
Diseases in Syria	.10 (1) 30
Dormancy	.7 42
E	
Economics of production	.3 10
Electroconductivity of aged seed	.6 22
Etiella zinckenella pod borer resistance	.7 46
	.8 25
Etiella zinckenella pod borer screening	.5 1
F	
Factor analysis of yield components	.8 19
Fall application of herbicides	.3 34
Fallow vs. stubble culture	.5 25
Fertilization	.7 29
Floral biology	.7 8
Fluorescent seed coats	.4 3
Fusarium oxysporum	.4 29
Fusarium oxysporum host range	.5 11
Fusarium oxysporum strains	.5 8
Fusarium root rot	.2 29
Fusarium wilt	.2 20
G	
Genetic divergence	.5 20
Genetic variability	.7 20
	.7 32
	.7 62
	.9 10
Genetics	.2 4
Genetics of cotyledon color	.5 24
Genetics of flower color	.7 15
Genetics of flower no. per inflorescence	.7 15
Genetics of pea seed-borne mosaic virus resistance	.5 1
Genotype x environment interaction	.3 9
	.8 14
	.8 17
Gibberellic acid and plant height	.5 26
Growth analysis	.10 (2) 17
H	
Harvest index	.4 8
Herbicide resistance	.7 54
Herbicides and inoculation	.7 54
Heritability of yield components	.7 32
Heterosis	.3 1
Hybridization techniques	.5 7
	7 9
	.9 10
I	
Inoculation	.4 32
	.7 50
	.9 23
	.9 31
	.10 (1) 25
Inoculation and herbicides	.7 54
Inoculation and insecticides	.9 24
Insect control	.9 34
Insect damaged seed	.9 42
Insect pests in Brazil	.4 6
Insect pests in Syria	.9 34
Insecticides and inoculation	.9 24
Interchange stocks	.8 24
Interspecific hybrids	.6 24
Irrigation	.6 1
	.7 29
	.9 31

Vol./No./Page

K

Karyotype 8 23
. . . . . .10 (1) 14

L

Lens ervoides collection . . .8 5
Lens ervoides interspecific hybrids. 6 24
Lens ervoides karyotype 10 (1) 13
Lens ervoides pollen grains 10 (1) 14
Lens macrosperma drawings 7 1
Lens microsperma drawings 7 1
Lens nigricans collection. 8 5
Lens nigricans interspecific hybrids. 6 24
Lens nigricans karyotype 10 (1) 13
Lens nigricans pollen grains 10 (1) 14
Lens orientalis collection. 8 5
Lens orientalis interspecific hybrids. 6 24
Lens orientalis karyotype 10 (1) 13
Lens orientalis pollen grains 10 (1) 14
Lygus bug damage 9 42

M

MCPB resistance 7 65
. . . . . .10 (2) 15
Management practices 3 13
. . . . . .3 16
. . . . . .3 17
Maturity - early line 4 5
Microsperma dwarfs. 2 11
Mixed culture 5 27
Mutagen induced chimera. 5 14
Mutagen treatment 2 17
. . . . . .10 (1) 16
Mutant acute pod 5 18
Mutant bushy 5 15
Mutant compact 4 25
Mutant compact instability 5 13
Mutant fasciata. 4 23
Mutant flower forms 5 16
Mutant funnel-leaf. 2 18
Mutant fused flower. 4 22
Mutant glabrous 5 18

Vol./No./Page

Mutant globe 10 (1) 17
Mutant growth traits 4 23
Mutant leaf shapes. 4 27
Mutant leaf types 4 26
Mutant multiflower 4 25
Mutant short rachis 5 18
Mutant terminal fasciation. 5 16
Mutant waxless 5 18
Mutations 10 (2) 7

N

Nitrogen fertilization 7 50

O

Orobanche control with glyphosate. 10 (2) 20

P

Parasitic weeds in Syria. 10 (1) 30
Path analysis of yield components 4 17
. . . . . .9 19
Pea seed-borne mosaic virus resistance 4 31
. . . . . .5 1
Phosphate fertilization 5 24
. . . . . .6 1
. . . . . .9 31
. . . . . .10 (1) 25
Plasticity for yield 7 29
Plot technique 8 9
Polyploidy 7 14
. . . . . .9 15
. . . . . .10 (1) 19
. . . . . .10 (1) 20
Postemergent herbicides 2 36
. . . . . .3 29
Pre-emergent herbicides . . .2 34
. . . . . .3 28
Preplant incorporated herbicides 3 27
Production in Argentina. 7 5
Production in Canada. 8 4
Production in Chile 8 1
Production in Peru. 3 8
Production in Sudan 10 (1) 1
Production of red lentils in New Zealand. 10 (2) 16
Production of yellow lentils in New Zealand . .10 (2) 16
Protein quality 6 25

Vol./No./Page

R

Research at ICARDA. 7 4
Research by ALAD and ICARDA 4 1
Research in Sudan 10 (1) 1
Residue cash value. 9 8
Rhizobium. 8 5
Rhizoctonia solani host range 5 11
Rust resistance 7 20

S

Salt tolerance 6 25
Sclerotium rolfsii host range 5 11
Seed carbohydrates and amino acids 7 37
Seed quality 9 42
Seed size and emergence 9 28
Seed storage 7 39
. . . . . .9 26
Seed weight variability 7 23
Seeding date. 9 30
. . . . . .9 31
. . . . . .10 (1) 28
Seeding rate 3 32
Selection for yield 4 20
Setaria control 2 32
Single seed descent 6 24
Sitona macularius control 10 (1) 32
Spacing 6 8
. . . . . .6 10
Stability of percent protein 8 17
Stability of yield 6 14
. . . . . .7 24
. . . . . .9 17
Starch properties. 6 25
Straw cash value 9 8

T

Tannin content 10 (1) 36
Threshing. 10 (2) 1
Translocation stocks 8 24
Triallate tolerance 3 31

V

Variability in maturity 2 15
Variability in seed traits. 2 12
Variation in pollen grain morphology 10 (1) 14
Vegetative propagation. . .10 (1) 27
Virus resistance. 7 65

	Vol./No./Page
W	
Water requirement 6	1
Water use 10 (1)	28
Weed competition studies 7	55
Weed control 4	34
. 5	28
. 6	19
. 6	28
. 7	58
. 7	61
. 8	28
. 9	33
Weeds in Syria 10 (2)	17
Wheat yields 7	52
Wheat yields after inoculation and nitrogen 7	52
Wilt resistance 7	20
Y	
Yield component correlations 10 (2)	10
Yield component genetic divergence 4	14
. 5	21
Yield component path analysis 3	6
. 4	17
Yield component stability 10 (2)	12
Yield component variability 5	4
. 7	20
. 7	32
. 7	62
Yield components 8	19
. 9	10
. 9	19
. 9	22
Yield components and stand density 6	10
Yield stability 6	14
. 7	24
. . . . . .10 (2)	12
Yield trial 10 (1)	15

AUTHOR INDEX FOR LENS NEWSLETTER
VOLUMES 1-10
1974-1983

	Vol./No./ Page
A	
Abu-Shakra	4 27
Afandi, F.	7 50
.....	.9 24
Agrawal, P.K.	9 26
.....	.9 28
Ahlawat, I.P.S.	6 19
Ahmad, F.	8 17
.....	.10 (2) 12
Alahaydoian, K.	7 14
Arjona-Berral, A.	10 (2) 20
Asawa, B.M.	4 14
.....	.4 17
.....	.4 20
.....	.8 19
Ashford, R.	2 32
B	
Baitha, S.P.	6 1
.....	.9 31
Balyan, S.	5 7
Bashir, M.	10 (1) 15
Basler, F.	7 58
Bellar, M.	10 (1) 30
Bhatty, R.S.	4 28
.....	.6 25
.....	.10 (1) 35
Boerger, A.	4 29
C	
Chandra, N.	3 10
.....	.3 11
.....	.3 13
.....	.4 8
.....	.5 4
.....	.5 20
Chauhan, V.S.	9 19
Chhabra, K.S.	7 46
.....	.8 25
Clarke, J.A.	7 37
Cook, R.J.	2 29
D	
De Bezada, M.	7 39
.....	.8 11
De Villamil, A.B.	4 29
Dixit, P.	10 (1) 16
.....	.10 (2) 7
Drew, B.N.	2 32
.....	.2 34
.....	.2 36
.....	.2 38
.....	.2 39
.....	.3 27
.....	.3 28
.....	.3 29
.....	.3 30
.....	.3 31
.....	.3 34
.....	.4 34
.....	.5 28
.....	.6 28
.....	.7 61
.....	.8 4
.....	.8 28
.....	.9 33
Dubey, D.K.	10 (1) 16
.....	.10 (2) 7
E	
El-Sarrag, G.	10 (1) 1
Erskine, W.	8 5
.....	.8 9
.....	.9 11
Eser, D.	3 15
.....	.6 8
.....	.6 10
.....	.7 42
G	
Garcia-Torres, L.	10 (2) 20
Gecit, H.H	7 42
Gill, A.S.	7 15
Gossen, B.	10 (1) 31
Goyal, S.N.	3 1
.....	.4 10
.....	.4 14
.....	.4 17
.....	.4 20
Gupta, P.K.	5 7
.....	.8 23
.....	.8 24
.....	.9 15
.....	.10 (1) 17
.....	.10 (1) 20
Gusta, L.V.	5 26
H	
Haddad, N.I.	5 1
Halimeh, H.	9 8
Hanson, R.	10 (2) 17
Haqqani, A.M.	10 (1) 15
Hariri, G.	9 34
.....	.9 37
.....	.10 (1) 32
Hawtin, G.C.	4 1
.....	.7 4
Henry, J.L.	5 24
I	
Islam, R.	7 50
.....	.7 54
.....	.9 23
.....	.9 24
Izgin, N.	8 5
Izquierdo, J.A.	2 20
.....	.4 29
J	
Jaimini, S.N.	3 1
.....	.4 10
.....	.4 14
.....	.4 17
.....	.4 20
Jana, M.K.	2 11
.....	.6 25
Jermyn, W.A.	7 65
.....	.10 (2) 16
.....	.10 (2) 17
K	
Kannaiyan, J.	5 8
.....	.5 11
Kant, K.	2 12
.....	.2 15
.....	.2 17
.....	.2 19
Kaul, A.K.	9 22
Kaul, J.N.	10 (1) 25
Kebabeh, S.	10 (1) 30
Kooner, B.S.	5 1
.....	.7 46
.....	.8 25
Kramm, V.	8 30
Kumar, B.	10 (2) 10

	Vol.	/No.	Page
L			
Ladizinsky, G.	6		24
Lal, R.S.	8		14
.....	.9		17
Lal, S.	3		10
.....	.3		11
.....	.3		13
.....	.4		8
.....	.5		4
.....	.7		24
.....	.7		32
Lin, Y.S.	2		29
M			
Malaviya, D.R.	10	(1)	19
Malhotra, R.S.	5		7
.....	.7		15
.....	.9		39
Malik, B.A.	10	(1)	15
Manara, N.T.F.	4		6
.....	.10	(2)	22
Manara, W.	4		6
.....	.10	(2)	22
Mate, P.	4		3
Mehra, K.L.	10	(2)	10
Mehra, R.B.	3		9
.....	.5		20
.....	.6		14
Mera, M.	9		11
Meyveci, K.	8		5
Misra, R.C.	3		16
Misra, H.O.	9		10
Morrall, R.A.A.	10	(1)	31
Morrison, M.J.	10	(1)	27
.....	.10	(2)	15
Morse, R.	2		20
Muehlbauer, F.J.	2		4
.....	.2		29
.....	.4		31
.....	.5		1
.....	.8		5
.....	.8		13
.....	.9		42
Murinda, M.V.	10	(1)	28
N			
Nene, Y.L.	5		8
.....	.5		11
Nielsen, M.A.	10	(1)	35
Nordblom, T.	9		8
Nourai, A.H.	10	(1)	1
Nozzolillo, C.	7		39
.....	.8		11
.....	.9		41
Nygaard, D.	10	(2)	17
O			
Ovenden, G.E.	10	(2)	16
P			
Pahuja, A.N.	6		14
Pandey, B.P.	7		32
.....	.8		14
.....	.9		17
Pandey, M.P.	7		34
.....	.8		17
.....	.10	(2)	12
Pandya, B.P.	7		34
Papazian, J.	10	(2)	1
Papp, E.	4		3
.....	.6		22
.....	.7		1
.....	.7		8
Paredes, O.M.	7		9
.....	.8		1
.....	.8		30
Procopiou, J.	7		37
Q			
Quader, M.	9		22
R			
Rana, G.K.	4		32
Riva, E.A.	2		9
.....	.7		5
S			
Sagar, P.	7		24
.....	.7		62
Sahu, R.C.	4		5
Salkini, A.B.	10	(2)	17
Sandhu, T.S.	10	(1)	25
Sapra, R.L.	10	(2)	10
Saraf, C.S.	6		1
.....	.9		31
Sarwar, D.M.	9		22
Savage, F.D.	8		21
Saxena, A.K.	8		25
.....	.9		39
Saxena, M.C.	3		17
.....	.4		32
.....	.7		4
.....	.7		29
.....	.7		52
.....	.7		55
.....	.9		30
.....	.10	(1)	28
Scoles, G.J.	10	(1)	14
Sekhon, H.S.	10	(1)	25
Sharma, A.K.	8		25
.....	.9		39
Sharma, B.	2		12
.....	.2		15
.....	.2		17
.....	.2		19
.....	.4		22
.....	.4		23
.....	.4		25
.....	.4		26
.....	.4		27
.....	.5		13
.....	.5		14
.....	.5		15
.....	.5		16
.....	.5		18
Sharma, P.C.	10	(1)	17
.....	.10	(1)	20
Sharma, S.K.	4		22
.....	.4		23
.....	.4		25
.....	.4		26
.....	.4		27
.....	.5		13
.....	.5		14
.....	.5		15
.....	.5		16
.....	.5		18
Shukla, R.S.	10	(1)	19
Sindhu, J.S.	9		10
.....	.10	(1)	13
.....	.10	(1)	14
Singh, A.	6		19
Singh, B.R.	7		20
Singh, H.	5		1
Singh, H.P.	9		30
Singh, J.	8		23
.....	.8		24
.....	.9		15
.....	.10	(1)	17

Vol./No./Page

Singh, J.P. 7 34
Singh, K.B. 5 1
Singh, S.P. 3 9
.....5 20
Singh, U. 3 6
Sinha, P.K. 9 19
Skibinski, D.O.F. 8 21
Slinkard, A.E. 3 32
.....4 28
.....5 24
.....5 25
.....5 26
.....5 27
.....6 25
.....7 65
.....8 4
.....8 30
.....10 (1) 13
.....10 (1) 14
.....10 (1) 27
.....10 (1) 31
.....10 (1) 35
.....10 (1) 36
.....10 (2) 15
Solh, M. 7 9
.....7 14
.....7 23
.....8 9
Sosulski, F.W. 4 28
Srivastava, S.K. 7 32
.....8 14
.....9 17
Summerfield, R.J. 8 13
.....9 42

T

Tahhan, O. 9 34
.....9 37
.....10 (1) 32
Tarrago, M.F.S. 4 6
Tay, J.L. 8 1
.....8 30
Tholiya, A. 2 11
Tikka, S.B. 3 1
.....4 10
.....4 14
.....4 17
.....4 20
.....8 19
Tikoo, J.L. 3 10
.....3 11
.....3 13
Tiwari, A.S. 7 9
.....7 20

Vol./No./Page

Tiwari, D.P. 10 (1) 22
Tiwari, S. 10 (1) 22
Tosun, O. 6 8
.....6 10
.....7 42
Trabulsi, N. 10 (1) 28
Tripathy, D. 4 5
Turk, M. 10 (1) 28

V

Vaillancourt, R. 10 (1) 36
Veiga, P. 4 6
Verma, S.S. 10 (1) 17
.....10 (1) 20
Voysest, O. 3 8

W

Wassimi, N. 4 27
.....7 29
.....7 52
.....7 55
Wilson, D.R. 10 (2) 17

Y

Yadav, D.S. 3 17

ERRATUM

LENS, Vol. 10, No. 1, Page 17, Table1. In the paper by Dixit, P. and Dubey, D.K., "Influence of separate and simultaneous applications of gamma rays and nitrosomethyl urea on meiosis in lentil," the authors have informed the editors that Table 1 was both submitted and published in an incomplete form. The correct form is given below.

Table 1. *Summary of the synaptic associations and other meiotic irregularities in lentils induced by gamma rays and/or NMU.*

	Diplotene/Diakinesis (Synaptic associations)													Metaphase I			Anaphase I				
Treatment	7 II	6 II 2 I	5 II 1 IV	3 II 2 IV	4 II 1 VI	1 II 3 IV	5 II 4 I	3 II 1 VI 2 I	2 VI 1 II	1 IV 1 VI 2 II	2 II 1 X (Ring/ Chain)	3 II 1 VIII (Chain)	1 II 1 XII (Ring)	Ring of 14 chr.	Non-* inclusion 1	Non-* inclusion 2	Bridges 1	Bridges 2	Laggards	Total no. of cells	% of abnormal cells
5 Kr[xx]	54	13	22	21	11	9	–	–	–	–	–	–	–	1	12	10	21	6	–	180	70
10 Kr	18	15	8	12	9	–	–	–	–	–	1	–	1	–	6	2	–	–	–	72	75
15 Kr	9	–	13	14	10	9	9	9	6	–	–	–	1	1	–	–	–	–	–	81	88
NMU (0.02%)	18	5	–	–	–	–	–	–	–	–	–	–	–	–	3	1	26	10	–	63	71
5 Kr + NMU	9	–	10	27	9	5	1	–	–	–	–	–	–	1	6	3	–	–	18	90	90
10 Kr + NMU	9	2	36	18	18	5	1	–	–	–	1	–	–	–	–	–	–	–	18	108	83
15 Kr + NMU	18	9	18	36	6	8	2	1	–	2	–	1	–	–	–	–	–	–	–	101	82
Control	90	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	90	00

* 1 - One chromosome unoriented, 2 - Two chromosomes unoriented at equatorial plate.
[xx] as gamma rays.

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The aim of LENS Newsletter is to publish quickly the results of recent research. Articles should normally be confined to a single subject, be of good quality and of primary interest to research, extension and production workers, and administrators and policy makers. Articles for the newsletter should not have been submitted to or published in any other journal.

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Articles will be edited to preserve uniform style but substantial editing will be referred to the author for his approval; occasionally, papers may be returned for revision.

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Articles should be typed double–spaced on one side of the page only. The original and two other legible copies should be submitted. The contributor should include his name and initials, title, program or department, institute, postal address, and telex number if available. Photographs, figures, tables etc. should be either 8.5 cm wide (single column) or 17.5 cm wide (double column including space). Figures and diagrams should be drawn in India ink; send original artwork, not photocopies. Define in footnotes or legends any unusual abbreviations or symbols used in a figure or table.

Units of measurement are to be in the metric system; e.g., t/ha, kg, g, m, km, ml (= mililiter), m^2.

The numbers one to nine should be written as words except in combination with units of measure; all other numbers should be written as numerals; e.g., Nine plants, 10 leaves, 9 g, ninth, 10th, 0700 hr.

Examples of common expressions and abbreviations

3g; 18 mm; 300 m^2; 4 Mar 1983; 27% ; 50 five-day old plants; 1.6 million; 23 u g; 5^oC; 1980/81 season; 1981-82; Fig.; No.; FAO; USA. *Fertilizers:* 1 kg N or P_2O_5 or K_2O/ha.
Mon, Tues, Wed, Thurs, Fri, Sat, Sun; Jan, Feb, Mar, Apr, May, June, July, Aug, Sept, Oct, Nov, Dec.
versus = vs, least significant difference = LSD, standard error = SE±, coefficient(s) of variation = CV(s).
Probability: Use asterisks to denote probability * = $P < 0.05$; ** = $P < 0.01$; *** = $P < 0.001$.

Botanical. Include the authority name at the first mention of scientific names. Cultivar(s) = cv(s), variety = var(s), species = sp./spp., subspecies = subsp., subgenus = subg., forma = f., forma specialis = f.sp.

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5-3

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