Effect of Different Fertilizers and Seed Rates on the Growth, Yield and Quality of Two Varieties of Lentils

ABDELLAH M. NASSIB AND MUHAMMAD S. BAJWA*

The effect of seeding rates and fertilizers on the growth, yield and yield components of lentil was studied at Lyallpur by using two varieties, three seed rates and three fertilizers.

Branching rate and number of branches and pods per plant decreased by increasing seed rates. The same effect was recorded on the seed yield per plant during the first season. Variety × seed rate interaction existed regarding per-acre seed yield, the ratio of straw to seed and seed yield per plant during the second season.

Nitrogen fertilization accelerated the growth of the Local variety during a period from the fifth till the ninth week after sowing. Branching of Giza 9 plant continued at a considerable rate up to harvest with potassium fertilization. Phosphorus increased per acre seed yield during the first season. Variety × fertilizer interaction existed regarding per acre straw yield and number of pods per plant during the first season.

Varietal difference in protein content of the lentil seeds was found during two seasons. The carbohydrate, protein, and ash contents showed no response to either the seeding rates during the first season or to fertilization during both seasons. The colour and flavour of the cooked seeds were distinguished organoleptically in the two varieties.

INTRODUCTION

A number of workers have studied the effect of plant population on yield components and seed yield in the leguminous crops. Vittum *et al.* (1958) working on peas and Sengupta (1962) on lentils showed that a reduction in plant population was not compensated by an increase in individual plant yield. Probst (1945) and Canviness and Smith (1959) reported that larger seed yield variation in soybeans appeared among different varieties than among different seeding rates. Nelson and Roberts (1962) stated that soybean grain yields decreased with decreasing plant density. According to Reiss and Sherwood (1965), plant height and seed yield of soybeans were not influenced by seed rates. Studies in Ontario (Anonymous 1962) concluded that with increase in soybean plant population, the plant height and 100-seed weight increased, but the number of branches, pods, and beans per pod decreased. Hodgson and Blackman (1956) found that the number of pods per plant and the

*Department of Agronomy, Faculty of Agriculture, West Pakistan Agricultural University, Lyallpur.

extent of branching fell progressively in *Vicia faba* as plant density increased. However, there was no change in seed size or number of seeds per pod and the differences in plant height were small.

On the effect of fertilizer application, studies by FAO (1961) and Richardson (1965) showed that lentil responded well to phosphorus and potassium fertilizers. According to the former, nitrogen resulted in excessive vegetative growth and little seed, whereas the effect of this nutrient, according to the latter, was more variable and depended on the local root nodule organism. Muhammad (1964) obtained inconsistent effect for phosphorus fertilizer on per acre lentil seed yield, height and number of pods per plant and non-significant effect on flowering date and number of branches per plant. Addition of potassium to an acid soil increased seed yield in soybeans according to Nelson (1960), whereas no response to this nutrient was reported by Reiss and Sherwood (1965) and Tewari (1965) in the same crop. Addison (1957) found that potassium fertilization reduced the seed yield of Jack bean.

The influence of fertilization on the chemical composition of food plants was inconsistent in the studies of a number of workers. Veenbaas (1948) reported that environmental factors and management had a far greater effect on chemical composition and consumption value of the dry pulse than did varietal differences in which soil and manurial treatments were the most important factors. Studies in Illinois (1947-49), and Haque (1949) reported an increase in protein content of the soybeans with fertilization. However, studies in the same crop published by Cartter (1940) showed that the small differences in the chemical composition could not be attributed to fertilization. Lyons and Earley (1952) recorded inconsistent results in two seasons regarding the effect of fertilization on the chemical composition of soybeans. Harris (1960) attributed the confusion relating to the effects of fertilization on nutrient content of food plants to the complex interrelationships which existed between the elements of the soil.

The present investigation reports the effect of different seed rates and application of different fertilizers on the growth, yield and quality of two indigenous and introduced varieties of lentil.

MATERIALS AND METHODS

A split-plot field design was used in which the factorial combinations of two varieties, Local (v_1) and Giza 9 (v_2), cum three seed rates 8, 12 and 16 seers per acre (s_1, s_2 and s_3, respectively) were the main plots and four fertilizer levels (control where no fertilizer was applied and 50 pounds of either N, P_2O_5 or K_2O) were the sub-plots. The test was planted in four replications

at the Students' Farm, West Pakistan Agricultural University, Lyallpur, in 1963-64 and 1964-65 seasons.

Local, an indigenous variety, has small seed size with different colours and the plants are usually prostrate with green foliage. Giza 9, an introduced variety from U.A.R., has light-brown bold seeds and the plants are sub-erect to erect with lighter green foliage.

The 1/100-acre sub-plot had 13 rows with a row to row distance of 9 inches. The placement of superphosphate and potassium sulphate fertilizers was done in full at a depth of 3 inches between seed rows on the same day of sowing. Ammonium sulphate was side-dressed in a single dose 30 days after sowing. For single plant observations, three plants in the first season and ten in the second were selected at random in each sub-plot. For estimating the number of seeds per pod and the number of immature seeds per 100 pods, counts were made from ten pods picked at random from the total pods of each selected plant. The seed was considered to be immature when its size was about half that of the normal size.

The standard method of analysis of variance for the simple split-plot design given by Cochran and Cox (1957) was followed in the statistical analysis of the data. Means were compared by Duncan's Multiple Range Method at 5 per cent level (LeClerg *et al.*, 1962).

Chemical Analysis

Determinations were made during 1963-64 season on duplicate samples taken at random from the seed mixture of the four replications for all 24 field treatment combinations. During 1964-65 season, both random samples were taken from the seed yield of one replication for the eight variety combinations with fertilizer levels. The following constituents were determined as percentage of fresh weight of the ground whole lentil seeds.

Carbohydrate content: Direct acid hydrolysis method was used and the invert sugars were estimated by Lane-Eynon volumetric method (A.O.A.C., 1960).

Protein content: Total nitrogen was determined by micro-Kjeldahls' method. Percentage crude protein content was calculated by multiplying percentage nitrogen determined by the factor 6.25.

Ash content: It was determined by igniting weighed samples at 525°C. until carbon free.

With only one replication, the significance of the differences was tested by using the second order interaction for the three factors in the first season and the variety fertilizer interaction in the second to provide an estimate of the error (Cochran and Cox, 1957).

Organoleptic Test

The whole and decorticated seed samples of the two varieties during 1964-65 season were cooked in two ways (Table 3). The four dishes were presented in randomized order to a panel of 12 judges who recorded their judgments against arbitrary scale ranging from 0 to 10. The significance of the difference between average scores was determined by working out the Critical Ratio as described by Krum (1955).

RESULTS AND DISCUSSION

Giza 9 flowered 31 days earlier than the Local and neither seeding rates nor fertilizer application affected the number of days to flowering.

The growth rate of Giza 9 plant was higher than that of the Local variety (Fig. 1) and the growth of the latter slackened throughout a four-week period extending from the fifth till the ninth week after sowing. However, nitrogen fertilization accelerated the growth of the Local variety at this stage which was followed by a period of rapid growth beginning nine weeks after sowing for this variety and lasting 10 weeks, whereas with Giza 9 the rapid growth started two weeks earlier and extended for 12 weeks. A pre-harvest two-week period with more or less low growth rate for both varieties followed the period of rapid growth. At maturity, there was non-significant effect for seeding rates and fertilizer levels on plant height.

The branching rate of the Local plant was higher than that of Giza 9 (Fig. 2). At the highest seeding rate, the lentil plant had the lowest branching rate for both varieties and all fertilizer treatments. Moreover, the branching curve for both varieties showed a sharp fall 2 to 4 weeks before harvest. This might be attributed to interruption of the newly grown shoots by the abrupt maturation of plants. At the lowest seeding rate, branching of Giza 9 plant continued at a considerable rate up to harvest with potassium fertilization. At maturity, the average total number of branches per plant decreased by increasing seeding rates during both seasons; the decrease at the highest below the medium seed rate was non-significant during the first season. Fertilizer application had non-significant effect on the number of branches at maturity during both seasons.

The per acre as well as plant seed yield of the Local variety were significantly higher than that of Giza 9 during the first season (Table 1 *a* and *d*). At the lowest seeding rate, the increase in seed yield per plant over both varieties compensated for the reduction in plant population and ultimately the seed yield per acre showed no response to higher seeding rates. During the second season, the compensating effect of the plant-yield increase on per acre

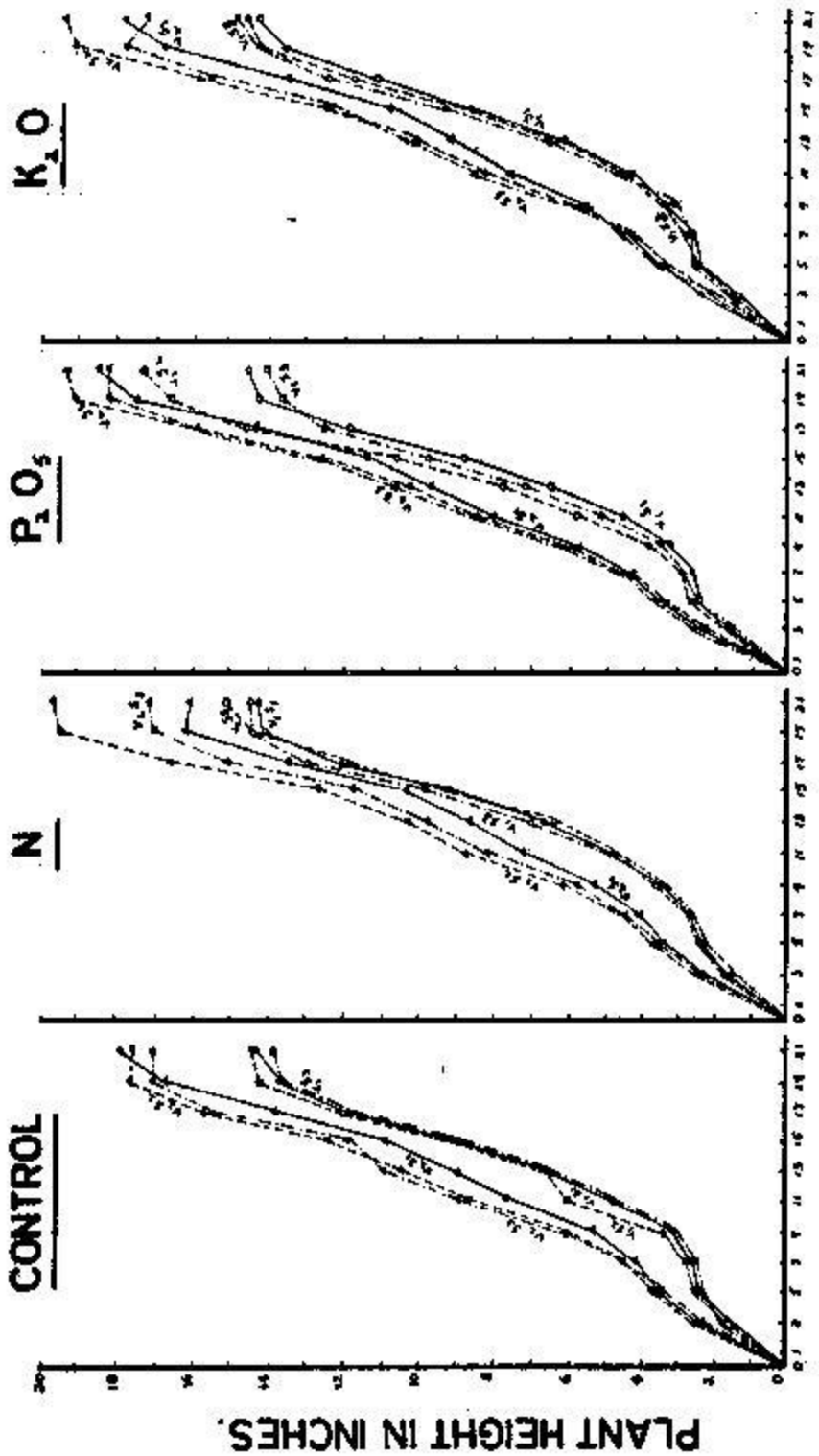

Fig. 1. Fortnightly plant height for the Local and Giza 9 Acala varieties of different levels of seeding and fertilizer during 1964-65 season.

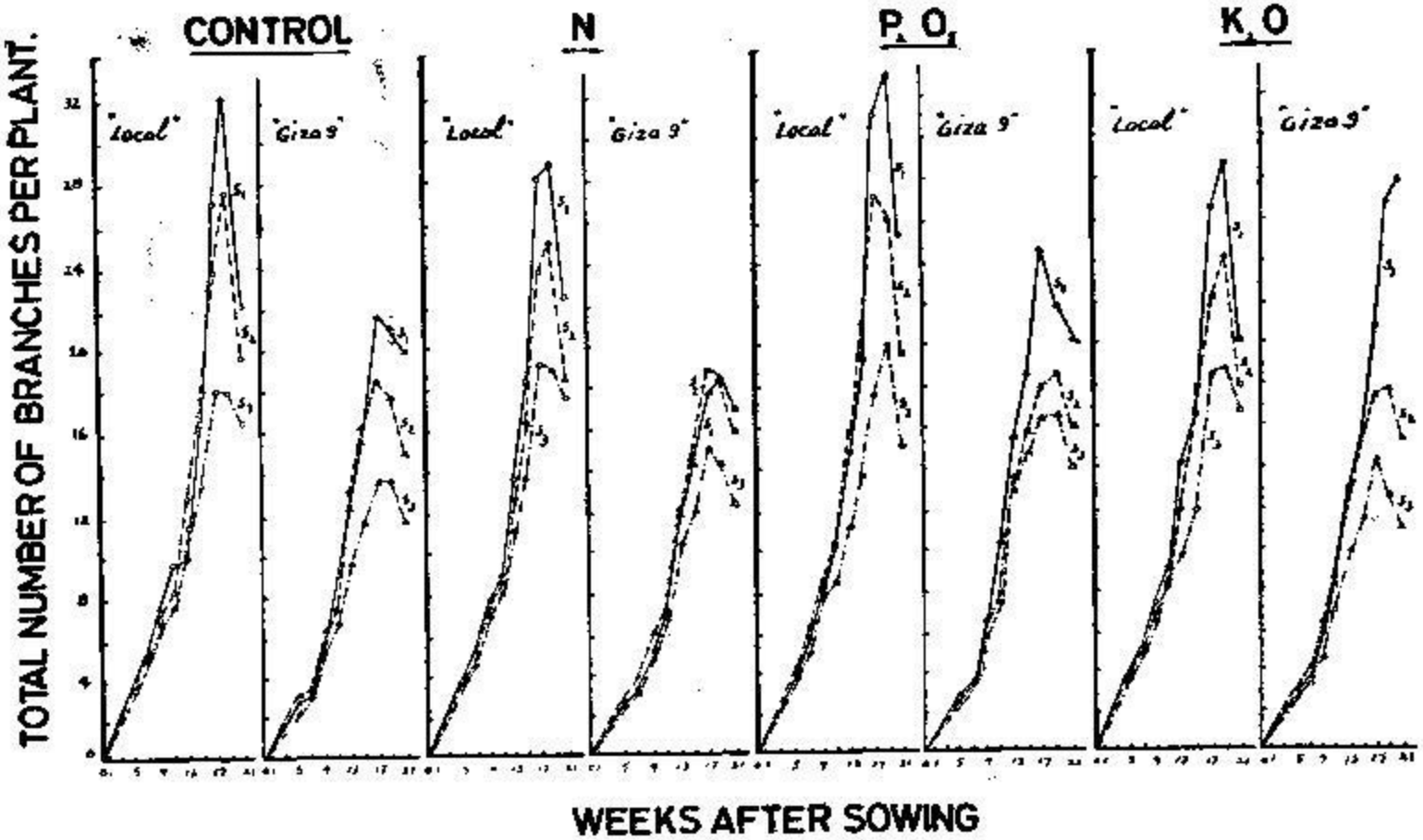

Fig. 2. Fortnightly total number of branches per plant for the Local and Giza 9 lentil varieties at different levels of seeding and fertilizer during 1964-65 season.

production was consistent with Local variety at the lowest seeding rate. However, the reduction in plant population, with Giza 9, did not show significant increase in individual plant yield and a decrease in per acre seed production was recorded at the lowest level of seeding. On the other hand, the two varieties did not differ in individual plant yield at the medium or the highest seeding rate. However, only at the former seed rate per acre seed yield showed non-significant difference between the two varieties. Fertilizer application showed non-significant effect on individual plant yield during both seasons, whereas the phosphorus fertilizer gave an average increase of 1.05 maund of lentil seed per acre over the control during the first season. Neither nitrogen nor potassium fertilizers during the same season nor the three fertilizers during the second showed significant response regarding per acre seed yield.

The production of lentil straw per acre for the Local variety during the first season exceeded that of Giza 9 and the ratio of straw to seed was greater for the latter (Table 1*b* and *c*). Moreover, the seeding rates had non-significant effect on straw yield and the ratio of straw to seed. During the second season, the average lentil straw yield per acre did not differ significantly in two varieties or seeding rates and non-significant difference in the ratio of straw to seed existed between the two varieties at the medium or the highest seeding rate, whereas at the lowest seeding rate, Giza 9 had greater ratio than that of the Local variety. On the other hand, the lowest seeding rate showed greater ratio of straw to seed with Giza 9, whereas the same ratio for the Local variety did not respond to seeding rates. The phosphorus and nitrogen fertilizers increased per acre straw yield for the Local variety over the control during the first season; the increases were inconsistent during the second season. The ratio of straw to seed showed non-significant response to fertilization during both seasons.

The average weight of 1000 lentil-seeds for Giza 9 exceeded that of the Local variety during both seasons (Table 1*e*). There was non-significant effect for seeding rates on the seed weight during the first season, whereas with the Local and Giza 9 varieties the seed weight increased at the medium and the lowest seeding rates, respectively, during the second season. Fertilizer application had non-significant effect on the seed weight during both seasons.

The average number of seeds per pod for the Local variety was higher than that of Giza 9 during both seasons (Table 1*f*). Besides, immature seeds per 100 pods in the latter outnumbered that of the Local variety (Table 1*g*). There was non-significant effect for either the seeding or fertilizer levels on any of the two yield components during both seasons.

The average number of pods in lentil plant decreased by increasing the seeding rate (Table 1*h*). However, the decrease at the highest below the

TABLE 1. *Mean values for seed and straw yields, straw to seed ratios, and the components of seed yield for the main effects and the important interactions in lentils during* 1963-64 *and* 1964-65 *seasons.*

Season	Varieties	Seed rates (seers per acre)				Fertilizers			
		8	12	16	Aver.	O	N	P	K
		a—Mean seed yield in maunds per acre							
I	Local	22.47	22.00	21.91	22.13	21.41	21.09	23.20	22.82
	Giza 9	5.50	5.87	4.92	5.43	5.29	5.14	5.59	5.69
	Aver.	13.99	13.94	13.42	13.78	13.35	13.12	14.40	14.26
II	Local	16.53	14.46	16.39	15.79	14.72	15.33	16.69	16.43
	Giza 9	8.20	13.49	12.15	11.28	11.06	11.18	11.70	11.19
	Aver.	12.37	13.98	14.27	13.54	12.89	13.26	14.20	13.81
		b—Mean straw yield in maunds per acre							
I	Local	44.52	45.14	43.79	44.48	40.98	47.07	47.59	42.30
	Giza 9	26.17	24.67	23.80	24.88	26.11	22.92	25.40	25.10
	Aver.	35.35	34.91	33.80	34.68	33.55	35.00	36.50	33.70
II	Local	32.25	35.36	34.13	33.91	33.46	33.77	36.32	32.10
	Giza 9	29.90	35.35	29.77	31.68	29.75	32.12	30.99	33.85
	Aver.	31.08	35.36	31.95	32.80	31.61	32.95	33.66	32.98
		c—The mean straw to seed ratios							
I	Local	2.04	2.13	2.05	2.07	1.98	2.29	2.11	1.92
	Giza 9	5.40	4.79	5.05	5.08	5.28	5.08	5.17	4.78
	Aver.	3.72	3.46	3.55	3.58	3.63	3.68	3.64	3.35
II	Local	1.92	2.39	2.14	2.15	2.27	2.19	2.18	1.96
	Giza 9	3.53	2.60	2.51	2.88	2.78	2.97	2.75	3.01
	Aver.	2.72	2.49	2.32	2.51	2.53	2.58	2.46	2.49
		d—Mean seed yield in grams per plant							
I	Local	4.47	3.14	2.47	3.36	3.84	3.49	2.84	3.26
	Giza 9	1.26	0.84	0.88	0.99	1.08	0.92	0.86	1.11
	Aver.	2.86	1.99	1.67	2.17	2.46	2.20	1.85	2.18
II	Local	3.59	2.26	1.84	2.56	2.64	2.41	2.75	2.45
	Giza 9	2.36	2.30	1.99	2.22	2.00	2.46	2.13	2.28
	Aver.	2.99	2.28	1.91	2.39	2.32	2.43	2.44	2.36

e—Mean seed weight in grams per 1000 seeds

I	Local	..	10.80	10.58	10.67	10.68	10.57	10.86	10.51	10.79
	Giza 9	..	13.18	13.33	13.81	13.44	13.34	12.71	13.85	13.87
	Aver.	..	11.99	11.96	12.24	12.06	11.96	11.78	12.18	12.33
II	Local	..	12.00	10.70	11.95	11.55	11.57	11.51	11.58	11.54
	Giza 9	..	14.61	15.85	16.57	15.68	15.92	15.82	15.55	15.42
	Aver.	..	13.31	13.28	14.26	13.61	13.74	13.67	13.57	13.48

f—The mean number of seeds per pod

I	Local	..	1.50	1.52	1.50	1.51	1.54	1.53	1.43	1.53
	Giza 9	..	1.18	1.26	1.18	1.21	1.07	1.23	1.25	1.28
	Aver.	..	1.34	1.39	1.34	1.36	1.30	1.38	1.34	1.40
II	Local	..	1.57	1.51	1.57	1.55	1.56	1.50	1.62	1.53
	Giza 9	..	1.44	1.44	1.39	1.42	1.39	1.42	1.42	1.45
	Aver.	..	1.50	1.48	1.48	1.49	1.47	1.46	1.52	1.49

g—The mean number of immature seeds per 100 pods

I	Local	..	6.4	11.8	10.3	9.5	8.9	8.0	13.8	7.2
	Giza 9	..	49.8	61.5	68.0	59.7	54.8	68.4	64.0	51.7
	Aver.	..	28.1	36.6	39.2	34.6	31.9	38.2	38.9	29.5
II	Local	..	13.6	20.1	10.7	14.8	14.1	17.6	13.6	13.9
	Giza 9	..	34.3	17.3	29.1	26.9	27.8	31.6	29.1	19.0
	Aver.	..	24.0	18.7	19.9	20.9	21.0	24.6	21.4	16.5

h—The mean number of pods per plant

I	Local	..	219.8	155.2	121.4	165.5	195.8	169.0	149.5	147.5
	Giza 9	..	110.0	47.0	56.5	71.2	64.0	60.2	53.2	107.2
	Aver.	..	164.9	101.1	88.9	118.3	129.9	114.6	101.3	127.4
II	Local	..	127.0	84.6	75.2	95.6	94.6	91.5	102.2	94.1
	Giza 9	..	94.3	72.1	69.5	78.6	76.0	81.8	81.5	75.3
	Aver.	..	110.6	78.4	72.3	87.1	85.3	86.6	91.8	84.7

TABLE 2. *Mean percentage carbohydrate, crude protein, and ash contents in the lentil whose seeds during* 1963-64 *and* 1964-65 *seasons.*

Season	Varieties	Seed rates (seers per acre)				Fertilizers			
		8	12	16	Aver.	O	N	P	K
		a—Carbohydrate content							
I	Local	57.15	57.88	57.68	57.57	58.67	57.94	56.85	56.82
	Giza 9	57.86	56.96	57.83	57.55	56.97	58.09	57.30	57.84
	Aver.	57.51	57.42	57.75	57.56	57.82	58.01	57.08	57.33
II	Local	..	..	..	..	56.42	57.13	55.64	56.62	56.29
	Giza 9	..	..	..	..	56.80	57.13	57.97	56.29	55.81
	Aver.	..	..	..	..	56.61	57.13	56.81	56.45	56.05
		b—Crude protein content							
I	Local	23.28	22.71	22.44	22.81	22.65	23.62	22.38	22.58
	Giza 9	27.41	26.23	28.07	27.24	26.71	27.75	27.91	26.57
	Aver.	25.34	24.47	25.25	25.02	24.68	25.69	25.15	24.57
II	Local	..	..	..	..	23.59	23.24	23.89	24.05	23.19
	Giza 9	..	..	..	..	25.89	25.69	25.54	25.82	26.52
	Aver.	..	..	..	..	24.74	24.46	24.72	24.93	24.85
		c—Ash content							
I	Local	2.49	2.73	2.56	2.59	2.48	2.55	2.73	2.62
	Giza 9	2.59	2.68	2.35	2.54	2.62	2.37	2.48	2.68
	Aver.	2.54	2.71	2.46	2.57	2.55	2.46	2.61	2.65
II	Local	..	..	..	..	3.04	3.09	2.84	3.29	2.94
	Giza 9	..	..	..	..	3.33	3.47	3.36	3.17	3.33
	Aver.	..	..	..	..	3.18	3.28	3.10	3.23	3.13

TABLE 3. *Organoleptic evaluation of the cooked lentils during 1964-65 season.*

Pressure and Time	Average scores*	
	Local	Giza 9
Whole Seeds		
10-11 lb./sq. in. for 8 minutes		
Flavour ..	6.7	6.6
Colour ..	6.7	6.6
Texture ..	6.7	6.2
Atmospheric pressure for 30 minutes		
Flavour ...	6.2	6.8
Colour ..	6.5	5.3
Texture ...	6.6	6.7
Decorticated Seeds		
10-11 lb./sq. in. for 5 minutes		
Flavour ..	5.2	6.3
Colour ..	6.4	6.9
Texture ..	5.3	5.9
Atmospheric pressure for 10 minutes		
Flavour ..	6.8	6.8
Colour ...	5.9	5.8
Texture ..	6.0	6.3

*Out of ten.

medium seeding rate was non-significant during both seasons. With application of potassium the two varieties showed non-significant difference in pod production per plant during the first season. However, the Local variety yielded higher number of pods than that of Giza 9 at the other three fertilizer levels during the first season and for all levels of fertilizer during the second season. On the other hand, the phosphorus and potassium fertilizers decreased pod production of the Local variety during the first season, whereas with potassium fertilizer the number of pods per plant of Giza 9 appeared to increase. During the second season, there was non-significant effect of fertilizers on pod production per plant.

Chemical Composition

The carbohydrate, crude protein, and ash contents in the lentil whole seeds (Table 2*a*, *b*, *c*) showed non-significant response to either the seeding rates during the first season or to the fertilizer levels during both seasons. Giza 9 seeds recorded significant increases of 4.4 and 2.3 per cent crude protein over that of the Local variety during the first and the second seasons, respectively.

Organoleptic Evaluation

The colour of the Local whole seeds cooked under atmospheric pressure was significantly favoured by judges (Table 3). However, the flavour of Giza 9 decorticated seeds cooked under pressure of 10-11 pounds per square inch was significantly superior to that of the Local variety. Non-significant difference existed between the two varieties regarding other attributes of both whole and decorticated seeds.

LITERATURE CITED

Addison, K. B. 1957. The effect of fertilizing, placement and date of planting on the yield of Jack bean (*Canavalia ensiformis*). *Rhod. Agri. Jour.* **54**: 521-32.

Anonymous. Fertilizer nitrogen improves yield and composition of soybeans. *Illinois Univ. Agri. Expt. Sta. Report for* 1947-49. 19 *pp.*

Anonymous 1962. Spacing and fertilizer applications for soybeans. *Res. Rep. Harrow Res. Sta., Ontario.* 1959-1960.

A.O.A.C. 1960. Official methods of analysis of the Association of Official Agricultural Chemists. 9th Ed. Washington D. C.

Canviness, C. E., and P. E. Smith. 1959. Effect of different dates and rates of planting on soybeans. *Arkansas Agr. Exp. Sta. Rep. Ser.* 88.

Cartter, J. L. 1940. Effect of environment on composition of soybean seed. *Proc. Amer. Soc. Soil Sci.* **5**: 125-30.

Cochran, W. G., and G. M. Cox. 1957. Experimental designs. 2nd Ed. John Wiley & Sons, Inc., New York.

FAO., 1961. Agricultural and Horticultural Seeds: FAO., Rome.

Haque, I. 1964. Effect of various factors on chemical composition and manurial metabolism of soybean. Post-Graduate Res., Ayub Agri. Res. Inst. Lyp. Agri. Deptt. West Pak.

Harris, R. S. 1960. Nutritional evaluation of food processing, R. S. Harris and H. Von Loesecke, John Wiley & Sons, Inc. New York.

Hodgson, G. L., and G. E. Blackman. 1956. An analysis of the influence of plant density on the growth of *Vicia faba*. 1. The influence of density on the pattern of development. *Jour. Exp. Bot.* 7: 147-65.

Krum, J. K. 1955. Truest evaluation in sensory panel testing. *Food Engineering*. 27: 74-83.

LeClerg, E. L., W. H. Leonard, and A. G. Clark. 1962. Field Plot Technique. Burgess Publishing Company, Minnesota.

Lyons, J. C., and E. B. Earley. 1952. The effect of ammonium nitrate applications to field soils on nodulation, seed yield, and nitrogen and oil content of the seed of soybeans. *Proc. Amer. Soc. Soil Sci.* **16**: 259-63.

Muhammad, F. 1964. Effect of sowing dates and phosphorus levels on the growth and yield of lentils. M.Sc. (Agri.) Thesis, West Pakistan Agricultural University, Lyallpur.

Nelson, C. E., and S. Roberts. 1962. Effect of plant spacing and planting date on six varieties of soybeans. *Washington Agri. Exp. Sta. Bull.* 639.

Nelson, Warren L. 1960. Soil fertility in soybean production. *Soybean Digest* **20**: 10-12.

Probst, A. H. 1945. Influence of spacing on yield and other characteristics in soybeans. *Jour. Amer. Soc. Agron.* **37**: 549-54.

Reiss, W. D., and L. V. Sherwood. 1965. Effect of row spacing, seeding rate and potassium and calcium hydroxide additions on soybean yields on soils of southern Illinois. *Agron. Jour.* **57**: 431-33.

Richardson, H. L. 1965. Personal communication. Manager, The Fertilizer Programme, F.A.O., Rome.

Sengupta, K. 1962. Effect of spacing on the yield of grain in lentil (*Lens esculenta* Moench). *Sci. Cult.* 28: 285-86.

Tewari, G. P. 1965. Effects of nitrogen, phosphorus and potassium on flowering and yield of soybeans in Nigeria. *Expl. Agri.* **1**: 185-88.

Veenbaas, A. 1948. (Study of the consumption value and chemical composition of dry pulse, 1942 harvest.) (Dutch) *Med. Landb Voorl Dnst.* 58: 50 (Field Crop Abst. 1949: 592).

Vittum, M. T., D. J. Lathwell, N. H. Peck, and C. B. Sayre 1958. Effect of variable row spacings and plant populations on peas grown for processing and on the subsequent crop of alfalfa. *Agron. Jour.* **50**: 577-80.