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The Effect of Row Spacing and Phosphorus Level on Growth and Yield of Broadbeans (*Vicia faba* L.)

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ABSTRACT

A field experiment was carried out at the Faculty of Agriculture Farm of Alfateh University, Tripoli, L.A.R., in the 1974/1975 season. The effect of two spacings (30 and 60 cm between rows) and four phosphorus levels (0, 36, 72, and 108 kg P_2O_5/ha) was studied on growth, yield, and yield components of broadbeans (*Vicia faba* L.)

Row spacing showed no significant effect on plant height which was significantly increased by the increase in phosphorus level. The number of tillers per plant was significantly increased by both the wide row spacing (60 cm) and the highest level of phosphorus (108 kg/ha).

On plant basis, pod weight, seed weight, and number of seeds were not significantly affected by row spacing. However, they were significantly increased by increasing phosphorus level. Moreover, the number and weight of seeds per pod were not significantly affected by both the row spacing and the phosphorus level. The 1,000-seed weight was significantly increased by decreasing row spacing, but was not significantly affected by phosphorus level.

Narrow row spacing (30 cm) and high levels of phosphorus (72 and 108 kg/ha) had significantly increased pod weight per hectare. On the other hand, the seed yield per hectare was significantly increased by narrow row spacing (30 cm) as well as by higher phosphorus level as compared with 60 cm spacing.

It is suggested that further studies are needed to determine the effect of wider range of phosphorus level with different row spacing on broadbeans, since the yield and most of its components showed continuous increase with the increase of phosphorus level.

INTRODUCTION

Broadbeans (*Vicia faba* L.) is one of the commonly cultivated winter seed legumes in the Libyan Arab Republic (L.A.R.). The total production is less than the local consumption. One way to increase the production is through raising the average yield per hectare. This may be achieved by using high-yielding cultivars and by the adoption of improved cultural practices. Few studies were conducted on broadbeans in the L.A.R.

Libyan soils consist mainly of fine and coarse sand with little or no clay fraction

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and organic matter. It is, therefore, expected to apply more or less considerable amounts of chemical fertilizers containing most nutrient elements, especially phosphorus, required by broadbean plant. Plant density is also considered as another factor affecting broadbean yield. The number of plants per unit area can be manipulated through variations in plant spacing between and within rows.

Several workers studied the effect of row spacing and phosphorus fertilizers on broadbean. Kushnir (7) obtained higher seed yields of field beans from close than wide row spacing at the same seeding rate. Kolic (6) showed that the highest plant density of fodder beans (889,000 plants/ha) gave the highest seed yield. The lower plant densities reduced the total yield but increased the yield per plant and the 1,000-seed weight. El Saeed (4) reported that seed yield was reduced by seeding beyond 140 lb/faddan. With high plant density, the yield per plant and stem, and pod production were decreased, whereas the number of seeds per pod and seed size were unaffected. Riepma (10) reported that the highest yield of broadbean was obtained from a density of 200,000 plants/ha. However, with increasing plant density, the number of pods per plant was reduced. He indicated that the relation of 1,000-seed weight to spacing was not clear. Picard and Sigwalt (9) reported that the optimal plant density of field beans was about 450,000 and 550,000 plants/ha for large and small-seeded cultivars, respectively. Hodgson and Blackman (5) reported that the maximal seed production in broadbeans was obtained from a density of 350,000–450,000 plants/ha for winter types and 670,000 plants/ha for spring types. They also found that as plant density increased, the number of pods per plant and the extent of branching fell progressively. However, there was no appreciable change in either seed size or number of seeds per pod.

Last and Nour (8) found that nitrogen fertilization significantly increased the mean yields of broadbeans. They also indicated that phosphorus and potassium, applied separately, did not affect the yield. However, when applied together the yield was increased as much as nitrogen did alone. Bains (3) showed that yield of beans was significantly associated with the rate of nitrogen application, whereas phosphorus and potassium did not affect yield significantly. Phosphorus fertilization gave highly significant increases in fresh and dry weight of plants, seed yield, and seed size in broadbean (2). The critical period for phosphorus application of broadbeans fell between the third and ninth week after sowing (1).

The present study was carried out to investigate the effect of row spacing and phosphorus level on growth, yield, and yield components of a local broadbean cultivar.

MATERIALS AND METHODS

A field experiment was conducted at the Faculty of Agriculture Farm, in Tripoli, during the 1974–1975 season to study the effect of row spacing and phosphorus level on growth, yield, and yield components of a local cultivar of broadbeans (*Vicia faba* L.).

A split-plot design, with four replicates, was used. The main plots were assigned to the two row spacings; namely, 30 and 60 cm, and the sub-plots to the four levels of phosphorus; viz., 0 (control), 36, 72, and 108 kg P_2O_5/ha. Phosphorus was added in the form of superphosphate (18% P_2O_5) just before planting which was done on 8 October, 1974. The sub-plot size was 4 × 4 m and consisted of seven and fourteen rows at 60 and 30 cm spacings, respectively. Ten hills were planted in each row with a single seed each. The average number of plants was 43,750 and 87,500 per hectare, corresponding to the 60 and 30 cm spacings. Sprinkler irrigation was applied whenever needed to supplement the received precipitation.

Five plants were randomly chosen from each plot a week before harvesting. These plants were used in estimating the average number and weight of pods and seeds/plant, number of seeds/pod, number of tillers/plant, and plant height.

At harvest (June 25, 1975), broadbean pods were picked by hand. Pod and seed weights were determined in tons per hectare. The 1,000-seed weight was also estimated.

RESULTS AND DISCUSSION

Data in Table 1 show that, in general, the average plant height of broadbeans was significantly increased by phosphorus application. The highest (110.56 cm) and the lowest (93.81 cm) averages of plant height were obtained from the 108 and zero kg P_2O_5/ha, respectively. Furthermore, Table 1 shows that row spacing did not significantly affect plant height. There was no significant interaction between phosphorus level and row spacing.

Table 1 The effect of phosphorus levels and row spacings on the average plant height at harvest of broadbeans (cm).

Row spacings (cm)	Kg P_2O_5/ha				
	0	36	72	108	Mean
30	96.25	106.50	109.13	115.25	106.78
60	91.38	99.50	100.13	105.88	99.22
Mean[a]	93.81	103.00	104.63	110.56	—

[a] L.S.D. (for P_2O_5 levels): (0.05) = 7.36 & (0.01) = 10.09 cm.

The effect of phosphorus level and row spacing on the average number of tillers per plant is presented in Table 2. It is clear that tillering was significantly increased with the increase in phosphorus level up to 72 or 108 kg/ha of P_2O_5. This indicates that phosphorus had encouraged tillering in broadbeans. Table 2 also indicates that the average number of tillers/plant was significantly influenced by row spacing. There was 50.7% increase in tillering as row spacing was increased (60 cm), compared to narrow spacing (30 cm). This may be attributed to better distribution of light within the canopy as well as less competition among plants for edaphic factors at the 60 cm row spacing. These results were similar to those reported by Hodgson and Blackman (5). A significant interaction was observed between phosphorus level and row spacing. This

Table 2 The effect of phosphorus levels and row spacings on the average number of tillers/plant of broadbeans.

Row spacings (cm)	Kg P_2O_5/ha				
	0	36	72	108	Mean[a]
30	4.25[c]	4.75	5.00	4.00	4.50
60	5.50	6.13	7.50	8.00	6.78
Mean[b]	4.88	5.44	6.25	6.00	—

[a] L.S.D. (for row spacings): (0.05) = 1.98 tillers/plant.
[b] L.S.D. (for P_2O_5 levels): (0.05) = 0.92 tillers/plant.
[c] L.S.D. (for interaction): (0.05) = 1.30 tillers/plant.

explains the higher average number of tillers per plant obtained from the 72 and 108 kg P_2O_5/ha levels than from the lower levels within the 60 cm spacing.

Data in Table 3 indicate the effect of phosphorus level and row spacing on pod yield of broadbeans. This yield was significantly increased with the increase in phosphorus level up to 108 kg P_2O_5/ha. The differences were not significant between the control (zero level) and 32 P_2O_5 level. Also, data in Table 3 show a significant increase of pod weight in the case of narrow row spacing (30 cm) over the wide spacing (60 cm). The respective mean values were 1.797 and 1.184 tons/ha. This increase was due to the higher number of plants per hectare. There was a significant interaction between phosphorus level and row spacing. This was obvious at the highest phosphorus level (108 kg/ha) and the narrow row spacing (30 cm). Comparable results were obtained from the effect of different treatments on the average seed yield (Table 4). These results were in agreement with the findings reported by other workers (4, 5, 6, and 7).

Table 3 The effect of phosphorus levels and row spacings on the average pod weight of broadbeans (tons/ha).

Row spacings (cm)	Kg P_2O_5/ha				Mean[a]
	0	36	72	108	
30	1.352[c]	1.719	1.867	2.250	1.797
60	1.031	0.945	1.391	1.367	1.184
Mean[b]	1.191	1.332	1.629	1.809	—

[a] L.S.D. (for row spacings): (0.05) = 0.452 ton/ha.
[b] L.S.D. (for P_2O_5 levels): (0.05) = 0.199 & (0.01) = 0.273 ton/ha.
[c] L.S.D. (for interaction): (0.05) = 0.281 ton/ha.

Table 4 The effect of phosphorus levels and row spacings on the average seed yield of broadbeans (tons/ha).

Row spacings (cm)	Kg P_2O_5/ha				Mean[a]
	0	36	72	108	
30	1.141[c]	1.430	1.589	1.903	1.516
60	0.884	0.805	1.179	1.147	1.004
Mean[b]	1.013	1.118	1.384	1.525	—

[a] L.S.D. (for row spacings): (0.05) = 0.261 & (0.01) = 0.479 ton/ha.
[b] L.S.D. (for P_2O_5 levels): (0.05) = 0.187 & (0.01) = 0.256 ton/ha.
[c] L.S.D. (for interaction): (0.05) = 0.264 ton/ha.

The results of different yield components are summarized in Tables 5 to 11. Data in Table 5 indicate the effect of phosphorus level and row spacing on the pod number/plant. The P_2O_5 level at 108 kg/ha significantly increased the number of pods/plant over the control. The differences were not significant between the zero, 32, and 72 P_2O_5 levels. Row spacing at 60 cm significantly increased the number of pods/plant over the 30 cm spacing. The mean value of the 60 cm spacing was 45.4% higher than that of the other spacing. This was attributed to the increased tillering and growth vigor of broadbeans in the case of wide spacing (60 cm), as was previously indicated in Table 1. These results agreed with those reported by Hodgson and Blackman (5) and Riepma (10). There was no significant interaction between phosphorus level and row spacing. Similar

Table 5 The effect of phosphorus levels and row spacings on the average number of pods/plant of broadbeans.

Row spacings (cm)	Kg P_2O_5/ha				
	0	36	72	108	Mean[a]
30	6.75	8.88	9.63	10.88	9.03
60	11.38	13.88	12.38	14.88	13.13
Mean[b]	9.06	11.38	11.00	12.88	—

[a] L.S.D. (for row spacings): (0.05) = 2.98 pods/plant.
[b] L.S.D. (for P_2O_5 levels): (0.05) = 2.67 pods/plant.

Table 6 The effect of phosphorus levels and row spacings on the average weight of pods/plant of broadbeans(g).

Row spacings (cm)	Kg P_2O_5/ha				
	0	36	72	108	Mean
30	28.55	36.93	45.63	47.35	39.61
60	40.53	56.15	51.88	58.85	51.85
Mean[a]	34.54	46.54	48.75	53.10	—

[a] L.S.D. (for P_2O_5 levels): (0.05) = 11.83 g/plant.

results were obtained from the effect of different treatments on the mean of pod weight/plant, as shown in Table 6. However, the differences due to row spacing were not significant. Significant increase in pod weight resulted from application of phosphorus up to 108 kg P_2O_5/ha. The highest (53.10 g/plant) and the lowest (34.54 g/plant) mean values corresponded to the 108 and zero levels.

The effect of phosphorus level and row spacing on the average number and weight of seeds/plant is indicated in Tables 7 and 8. It is obvious that the increase in phosphorus level had significantly increased these two components. Tables 7 and 8 further indicate the nonsignificant effect of row spacing on the two components. However, a notable increase was found due to the wider row spacing. These results agreed with those reported by El Saeed (4) and Kolic (6) who found that low plant densities increased the yield per plant of broadbeans.

Table 7 The effect of phosphorus levels and row spacings on the average number of seeds/plant of broadbeans.

Row spacings (cm)	Kg P_2O_5/ha				
	0	36	72	108	Mean
30	19.13	27.38	32.50	38.63	29.41
60	34.25	49.00	41.63	41.75	41.66
Mean[a]	26.69	38.19	37.06	40.19	—

[a] L.S.D. (for P_2O_5 levels): (0.05) = 9.97 seeds/plant.

Table 8 The effect of phosphorus levels and row spacings on the average weight of seeds/plant of broadbeans(g).

Row spacings (cm)	Kg P_2O_5/ha				
	0	36	72	108	Mean
30	24.00	30.63	38.60	40.03	33.31
60	34.55	38.03	44.05	49.98	44.15
Mean[a]	29.28	39.33	41.33	45.00	—

[a] L.S.D. (for P_2O_5 levels): (0.05) = 10.11 g/plant.

Data in Tables 9 and 10 show that neither the phosphorus level nor the row spacing exerted any significant effect on both the average number and weight of seeds/pod. These results were similar to those found by El Saeed (4) and Hodgson and Blackman (5). There was no significant interaction between row spacing and phosphorus level.

Table 9 The effect of phosphorus levels and row spacings on the average number of seeds/pod of broadbeans.

Row spacings (cm)	Kg P_2O_5/ha				
	0	36	72	108	Mean
30	2.80	2.95	3.23	3.63	3.15
60	3.10	3.55	3.38	3.35	3.34
Mean	2.95	3.25	3.31	3.49	—

The 1,000-seed weight was not significantly influenced by the phosphorus level, as presented in Table 11. This weight was not consistent under the different levels of phosphorus. The highest but nonsignificant mean value (1.196 kg) resulted from the 72 kg P_2O_5/ha level. These results disagreed with the findings of Badawy and El-Gayed (2) who reported that phosphorus fertilization gave highly significant increase in seed size of broadbeans. The wider row spacing (60 cm) in the present investigation had significantly decreased the 1,000-seed weight of broadbeans. It was found that the narrow row spacing (30 cm) increased the 1,000-seed weight by 10.9% as compared to the wide row spacing (60 cm).

The present results showed that the wide row spacing (60 cm) increased tillering, pod weight, seed weight, and number of pods and seeds/plant over the narrow row spacing

Table 10 The effect of phosphorus levels and row spacings on the average weight of seeds/pod of broadbeans(g).

Row spacings (cm)	Kg P_2O_5/ha				
	0	36	72	108	Mean
30	3.50	3.55	4.02	3.71	3.69
60	3.11	3.47	3.61	3.47	3.41
Mean	3.30	3.51	3.82	3.59	—

Table 11 The effect of phosphorus levels and row spacings on the average 1000-seed weight of broadbeans (kg).

Row spacings (cm)	Kg P_2O_5/ha				
	0	36	72	108	Mean[a]
30	1.256	1.118	1.269	1.023	1.167
60	1.010	1.038	1.123	1.039	1.052
Mean	1.133	1.078	1.196	1.031	—

[a] L.S.D. (for rows spacings): (0.05) = 0.094 kg.

(30 cm). But the increase in these components did not compensate for the low seed yield/ha obtained from the wide row spacing (60 cm). Furthermore, it was obvious that the number of plants/hectare was more important in affecting the seed yield than the other yield components under the present conditions. Generally, these results indicated that the yield of broadbeans and its components tended to increase with the increase of phosphorus level up to 108 kg P_2O_5/ha and narrow row spacing (30 cm). Accordingly, it is suggested that further studies are necessary to determine the effect of phosphorus level under different plant densities.

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