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Effects of Sowing Densities and Phosphorus Doses on Some Phenologic, Morphologic Characters and Seed Yield of Dry Bean Under Irrigation Condition in Van, Turkey

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Abstract: In this research, dry bean variety Şeker (*Phaseolus vulgaris* Var *volubilis* Dekapr.) were grown with three different sowing densities, (25, 37.5 and 50 seeds m^{-2}) and five different phosphorus doses (0, 15, 30, 45 and 60 kg P_2O_5 ha^{-1}) to determine the most suitable sowing density and phosphorus doses for the cultivar in terms of phenologic, morphologic and seed yield in Van Turkey in 1997 and 1998 years. As the sowing density increased, as plant characters such as days to flowering, days to maturity, seed yield, first pods height and plant height increased in dry bean cultivar. Whereas numbers of branching showed reduction. Seed yield and number of branches were increased by increasing phosphorus doses. But days to flowering and days to maturity were decreased by phosphorus doses. The highest seed yield was obtained from 50 seed m^{-2} +60 kg P_2O_5 ha with 1920.0 kg ha^{-1} in 1997 and in second year the highest seed yield was obtained from applications of 37.5 seed m^{-2} +45 kg P_2O_5 ha^{-1} with 1701.0 kg ha^{-1}. The lowest seed yields were obtained from application of 25 seed m^{-2} +0 kg P_2O_5 ha^{-1} with, respectively 1457.5 and 1262.5 kg ha^{-1} in both years.

Key words: Sowing densities, phosphorus doses, seed yield phenologic and morphologic characters

INTRODUCTION

Dry bean (*Phaseolus vulgaris* L.) is the most important pulse crop in many developing countries and providing one of the major source of dietary protein and with production of about 18 million tones in 2002 and 0.245 million tones of which was produced in Turkey[1].

Production area are limited in present day and not expanded easily, so that we have to improve yield per unit area in the world. Many researchers have been studied to improve dry bean seed yield and applied many agriculture methods. Fertilizing and sowing densities obtain high seed yield, are two of agricultural techniques.

Sowing density has been recognized as a major factor determining the degree of competition between plants. Yield per plant decreases as the density per unit area increases. Reduction in seed yield may be the result of lower number of pods, lower seed weight or a combination of these components. In dense populations, many grains may not develop. Seed yield per unit area is the product of grain yield per plant and number of plants per unit area. At low densities, seed yield is limited by the number of plants, whereas at higher densities it declines due to increase in number of aborted seed. Therefore, finding the optimum densities that produce the maximum yield per unit area under different environmental conditions and/or genotypes has been the major concern in many investigations.

The effects of sowing densities can be significant on dry bean yields. The yield response to narrow row spacing has been attributed to more even maturity and higher plant populations[2,3]. Kelly[4] concluded that narrow rows generally increased dry bean yields from 5 to 10% under rainfed conditions and potentially even more when higher management inputs like irrigation are used. The disadvantage of narrow rows is the potential for accentuated disease problems[4].

Blackshaw *et al.*[5] conducted a field study that was to determine the combined effects of row spacing and plant density on dry bean (*Phaseolus vulgaris*) yield. An increase in density from 20 to 50 plants m^{-2} increased yield by 17%. Schatz *et al.*[6] reported that solid seeding dry bean in 7-inch rows caused about a 2-day delay in flowering and physiological maturity compared to beans in 30 inch rows. Cakmak and Azkan[7] reported that the highest dry bean (*Phaseolus vulgaris* L.) seed yield (126.8 kg da^{-1}) was obtained with 50 seed/m^2 sowing densities. Latifi *et al.*[8] obtained that 50 cm row spacing influenced seed yield, biological and harvest index significantly.

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Dry bean have consistently shown a positive response to P fertilization; whole plant N concentration, plant dry matter, nodule number, nodule mass, nitrogenase activity and nodule specific nitrogenase activity were found to increase as a result of P fertilization[9,10]. Common bean often faces P deficiency in soils where it is generally grown. Such a deficiency is a major limitation to grain yield improvement[11]. Plant P efficiency has been defined in several ways. The efficiency of absorption is usually related to the ability to acquire maximal amounts of P for minimal investment in root growth and the efficiency of utilization is the relative ability to produce biomass for each unit of P accumulated[12]. Brady[13] reported that P fertilizers increases number of flowers and pod formation in pulses. Barbosafilho and Silva[14] reported that the maximal economic fertilizer level for bean production was equal to 47 kg ha^{-1}. The applications of P levels was varied to according to soil type and ecological contiditions[15]. Güzel[16] reported that phosphorus fertilizers supply caused plant in flowering and physiological maturity earlier.

The objective of this experiment was to determine the effects of different sowing densities and doses of phosphorus fertilizers on the dry bean (*P. vulgaris* Cv. Şeker) yield and some yield components in Van-Turkey in 1997 and 1998 years.

MATERIALS AND METHODS

Dy bean variety Şeker (*Phaseolus vulgaris* var. *volubilis* Dekapr.) were used as a plant material. Field experiments were conducted in 1997 and 1998 in the Gurpınar-Van region. The experimental design was a Randomized Complete Block with a split-plot design of treatments. Sowing density (S_1=25, S_2=37.5, S_3=50 seed m^{-2}) was the main plot and P fertilizers was the subplot (P_0=0 kg P_2O_5ha, P_1=15 kg P_2O_5 ha $^{-1}$, P_2= 30 kg P_2O_5 ha^{-1}, P_3= 45 kg P_2O_5 ha^{-1}, P_4= 60 kg P_2O_5 ha^{-1}), with four replications. Rows were marked 0.5 m apart and each one having five lines, 5 m long. Plot area was 12.5 m^{-2}.

The experiment of first year, sowing date was on 3 May 1997 and harvested all plots from Semptember, 17 to 20 in 1997 and in second year sowing date was on 5 May 1998 and harvested all plots on 18 to 21 September in 1998. Starter fertilizer (NH_4SO_4) at a recommended rate of 30 kg N ha^{-1} was applied to soil. During the course of experiment, all plots were irrigated seven times in 1997 and five times in 1998.

The sample unit consisted of 10 plants harvested from the two middle rows of each plot, at grain maturity, an area of 6 m^2 within each plot provided the seed yield and that was standardized to 14% humidity.

Some important morphologic characters such as plant height, first pod height, main branches and second branches and some important phenologic characters such as days to flowering, days to maturity yield components and seed yield were calculated in both years.

The climatic data of the region are represented in Table 1. Temperate climatic condition is ruled in the region. During the course of experiment, from May to September 1997, the climatic data were: mean temperature 17.6°C, rainfall: 147 mm and in 1998, the climatic data were: mean temperature 18.6°C, total rainfall: 49.2 mm.

According to the results of some physical and chemical analyses in the experimental soil. The soil has sandy-clay loam texture and low organic matter and nitrogen rich potassium and lime content medium phosphorus and is low alkaline (pH 7-7.6) (Table 2).

Phosphorus source was triple supper phosphates (42%) and nitrogen source was ammonium sulphates (21%) in this experiment.

Results were tested in variance analysis and means were grouped in Duncan Multiple Comparison Test.

Table 1: Climatic datas of Van province in 1997 and 1998 and long term*

	Rainfall (mm)			Temperature (°C)			Relative humidity		
Months	1997	1998	Long term	1997	1998	Long term	1997	1998	Long term
May	23.3	36.0	46.3	13.9	14.0	12.9	49.6	67.8	57.0
June	25.0	10.7	18.4	18.7	20.9	17.8	41.3	57.1	50.0
July	31.6	1.0	5.1	21.7	23.6	22.0	44.2	54.0	44.0
August	---	1.2	3.9	22.5	23.1	21.5	27.4	54.4	42.0
September	10.7	-	10.5	17.1	18.0	17.0	51.3	61.3	43.0
October	56.4	0.3	45.4	11.8	11.8	10.3	70.4	62.4	59.0
Total/average	147.0	49.2	129.6	17.6	18.6	16.9	53.4	59.3	49.1

*Taken from the recording of Meteorogical Department in Van province

Table 2: Results of some chemical and physical analysis of experimental soil*

Depth (cm)	Organic matter (%)	pH	Salinity (%)	Lime (%)	P_2O_5 (kg/day)	K_2O (kg/day)
0-20	1.73	7.22	0.4	29.5	5.08	84.8

*Soil analysis were done at the laboratories of Y.Y. University

RESULTS AND DISCUSSION

Seed yield character was examined in this experiment, results of seed yield were tested in variance analysis and means were grouped in Duncan Multiple Comparison Test that were given Table 3. Both the sowing densities and doses of phosphorus fertilizers had significant ($p<0.01$) effects on the seed yield of dry bean in both years. Seed yield was increased by the increasing of phosphorus doses and the highest seed yield obtained the high phosphorus supplies. This might be accounted for high pod formations (datas not shown) per plant. Brady[13] reported that P fertilizers increases number of flowers and pod formation in pulses. Pulse crops benefits from P fertilizers highly.

Similar findings were obtained with sowing densities. Seed yield was increased by increasing of sowing densities. Seed yield per unit area is the product of seed yield per plant and number of plants per unit area. The highest seed yield was found from 37.5 seed/m^2 in 1997, but in 1998 it was 50 seed m^{-2}.

The interaction of sowing densities and doses of phosphorus fertilizers was found significantly on seed yield in both years. The highest seed yield was obtained from first year of this experiment, 50 seed/m^2 +60 kg P_2O_5 ha^{-1} with 1920.0 kg ha^{-1} and in second year the highest seed yield was obtained from applications of 37.5 seed m^{-2} +45 kg P_2O_5 ha^{-1} with 1701.0 kg ha^{-1} (Table 3). The lowest yields were obtained from application of 25 seed m^{-2}+0 kg P_2O_5 ha^{-} with, respectively 1457.5 and 1262.5 kg ha in both years. The lower seed yield in 1998 as compared to 1997 can be accounted for by climatic conditions. This can be explained with number of irrigations and amount of rainfall. Number of irrigation and amount of rainfall (Table 1) were higher in 1997. In 1998, some irrigation problems was occurred, so that irrigation was not done properly in pod formation stage. Şehirali[17] reported that water stress effects are more important in pulses especially in pod formation stage. The yield is decreased by increasing of water stress in pod formation stage. These results implies that obtaining the highest yield in bean occurred when the crop was planted on rows as solid seeding as possible and irrigated with sufficient amount of water when plants needs.

The yield generally increased relatively with the increase in sowing desities. This might be resulted from the increases in leaf unit index in a defined area caused an increase in the photosynthetic capacity of the plants in per area.

These are similar results which indicated that increase in the seed yield by increasing doses of phosphorus fertilizer and sowing desities in the studies of Blackshaw *et al.*[5], Grafton *et al.*[2], Hardwick[3], Kelly[4] and Schatz *et al.*[6].

Phenologic characters: The major morphological characters are such as days to flowering and days to maturity. This characters are examined below, respectively.

Table 3: Mean and compared values of the different sowing densities and doses of phosphorus fertilizers on the seed yield (kg ha^{-1}) in dry bean

Years	Sowing densities (seed m^{-2})	Phosphorus doses (kg ha^{-1}) 0	15	30	45	60 kg	Av of sowing densities
1997	25.0	1457.5d	1567.5cd	1597.5cd	1647.5b-d	1550.0cd	1564.0b
	37.5	1675.0a-d	1800.0a-c	1812.5a-c	1895.0ab	1812.5a-c	1799.0a
	50.0	1690.0a-d	1595.0cd	1890.0ab	1812.5a-c	1920.0a	1781.5a
	Average of P	1607.5b	1654.1b	1766.6a	1785.0a	1760.8a	
1998	25.0	1262.5d	1272.5d	1325.0cd	1345.0b-d	1300.0d	1301.0c
	37.5	1405.0b-d	1497.5a-d	1400.0b-d	1701.0a	1547.5a-c	1510.0b
	50.0	1572.5ab	1652.5a	1700.0a	1675.0a	1687.5a	1659.0a
	Average of P	1413.3b	1476.0b	1477.5b	1573.3a	1511.6ab	

Difference indicated with same letter(s) are non-significant ($p<0.05$)

Table 4: Mean and compared values of the different sowing densities and doses of phosphorus fertilizers on the days to flowering (days) in dry bean

Years	Sowing densities (seed/m^2)	Phosphorus doses (kg ha^{-1}) 0	15	30	45	60	Av. of sowing densities
1997	25.0	75.00	75.00	74.75	74.50	73.50	74.55b
	37.5	75.50	75.50	74.25	73.75	73.75	74.55b
	50.0	77.00	76.75	76.00	75.22	74.25	75.85a
	Average of P.	75.83a	75.75a	75.00b	74.50c	73.83d	
1998	25.0	73.25b-e	72.75de	72.50de	72.25e	72.50de	72.65b
	37.5	74.75b	74.50bc	73.50b-e	73.25b-e	73.00c-e	73.80b
	50.0	76.50a	74.75b	74.50bc	74.00b-d	73.25b-e	74.60a
	Average of P.	74.83a	74.00b	73.50bc	73.16c	72.91c	

Difference indicated with same letter(s) are non-significant ($p<0.05$)

Days to flowering: Both the sowing densities and doses of phosphorus fertilizers had significant ($p<0.01$) effects on the days to flowering dry bean in both years (Table 4).

The speed of flowering was not the same for all applications. In the present investigation, the increased days to flowering was due to sowing densities and applications of phosphorus fertilizers. Days to flowering were extended by solid sowing densities and the highest days to flowering was obtained 75.85 days with applications of 50 seed per meter in first year of experiment. However, days to flowering were decreased by applications of phosphorus fertilizers. Maximum days to flowering was obtained by application of 0 kg P_2O_5 ha^{-1}.

The interaction of sowing densities and doses of phosphorus fertilizers was found significantly in 1998; but it was not in 1997. The highest days to flowering was obtained from 50 seed/m^2 +0 kg P_2O_5 ha^{-1} with 76.50 days and the lowest days to flowering obtained from 25 seed m^{-2} +45 kg P_2O_5 ha^{-1} with 72.25 days.

Güzel[16] reported that phosphorus fertilizers supply caused plant in flowering and physiological maturity earlier. Schatz *et al.*[6] reported that solid seeding dry beancaused about a 2-day delay in flowering and physiological maturity compared to beans in wide rows. Güzel[16] and Schatz *et al.*[6] findings are similar results with present results about days to flowering.

Days to maturity: Both the sowing densities and doses of phosphorus fertilizers had significant ($p<0.01$) effects on the days to maturity dry bean in both years (Table 5).

Maturity delayed with increasing of sowing densities and but maturity was delayed with decreasing of levels of P fertilizers. Days to maturity were extended by solid sowing densities and the highest day to maturity was obtained 140.85 days with applications of 50 seed per meter in first year of experiment. However, days to maturity were shortened by applications of phosphorus fertilizers. The maximum days to maturity was obtained from plots of unapplication of phosphorus fertilizers.

The interaction of sowing densities and doses of phosphorus fertilizers was found non significantly in 1997, but it was found significantly in 1998. The highest days to maturity was obtained from 50 seed m^{-2} +0 kg P_2O_5 ha^{-1} with 141.50 days and the shortest days to maturity obtained from 37.5 seed m^{-2} + 60 kg P_2O_5 ha^{-1} with 137.00 days in 1998.

Güzel[16] reported that phosphorus fertilizers supply caused plant in flowering and physiological maturity earlier. Schatz *et al.*[6] findings are similar results with our results about days to seed maturity.

Morphologic characters: Morphological characters are the physical or visually determinable attributes of a ten plants. The major morphological criteria are plant height, first pod height, main branches and secondary branches.

Plant height: Fertilizer non significantly affected plant height, but plant densities affected plant height significantly ($p<0.01$) in both years (Table 6). The dry bean plants collected in the phosphorus fertilizer supplies plots were not significantly different in their plant height.

Table 5: Mean and compared values of the different sowing densities and doses of phosphorus fertilizers on the days to maturity date (days) in dry bean

Years	Sowing densities (seed m^{-2})	Phosphorus doses (kg ha^{-1}) 0	15	30	45	60	Av. of sowing densities
1997	25.0	140.00	140.00	139.75	139.50	138.50	139.55b
	37.5	140.50	140.25	139.00	138.50	138.50	139.35b
	50.0	142.25	141.25	141.00	140.25	139.50	140.85a
	Average of P.	140.91a	140.50a	139.90b	139.40c	138.83d	
1998	25.0	138.25b-e	137.75c-e	137.50de	137.25e	137.25e	137.60c
	37.5	139.75a-c	139.00b-e	138.25b-e	137.50de	137.00e	138.30b
	50.0	141.50a	139.75a-c	139.50a-d	140.25ab	138.00b-e	139.80a
	Average of P.	139.83a	138.83b	138.41b	138.38b	137.41c	

Difference indicated with same letter(s) are non-significant ($p<0.05$)

Table 6: Mean and compared values of the different sowing densities and doses of phosphorus fertilizers on the plant height (cm) in dry bean

Years	Sowing densities (seed m^{-2})	Phosphorus doses (kg ha^{-1}) 0	15	30	45	60	Av. of sowing densities
1997	25.0	46.00	46.75	47.00	45.75	45.75	46.25c
	37.5	51.00	52.25	52.75	53.25	52.75	52.40b
	50.0	60.00	60.75	60.75	62.00	61.50	61.00a
	Average of P.	52.33	53.25	53.50	53.66	53.33	
1998	25.0	41.50	42.75	42.75	40.50	41.50	41.80c
	37.5	43.75	44.50	46.25	44.00	45.50	44.80b
	50.0	51.50	47.00	45.75	48.00	51.75	48.80a
	Average of P.	45.58	44.75	44.91	44.16	46.25	

Difference indicated with same letter (s) are non-significant ($p<0.05$)

Table 7: Mean and compared values of the different sowing densities and doses of phosphorus fertilizers on the first pod height (cm) in dry bean

Year	Sowing densities (seed m^{-2})	Phosphorus doses (kg ha^{-1}) 0	15	30	45	60	Av. of sowing densities
1997	25.0	11.75	12.00	13.50	13.00	13.00	12.65c
	37.5	15.50	15.00	14.00	13.25	12.75	14.10b
	50.0	16.75	16.25	16.25	16.75	17.00	16.40a
	Average of P.	14.33	14.41	14.58	14.33	14.25	
1998	25.0	10.50	11.50	12.00	12.25	12.50	11.75c
	37.5	11.75	13.75	13.75	13.75	14.00	13.40b
	50.0	13.00	14.50	14.75	14.75	14.75	14.35a
	Average of P.	11.75b	13.25a	13.50a	13.58a	13.75a	

Difference indicated with same letter (s) are non-significant ($p<0.05$)

Table 8: Mean and compared values of the different sowing densities and doses of phosphorus fertilizers on the main branches (number of per plant) in dry bean

Year	Sowing densities (seed m^{-2})	Phosphorus doses (kg ha^{-1}) 0	15	30	45	60	Av. of sowing densities
1997	25.0	2.27b-d	2.37a-c	2.40ab	2.52a	2.50ab	2.45a
	37.5	1.60gh	1.72fg	1.87ef	2.07de	2.15cd	1.88b
	50.0	1.17ı	1.30ı	1.30ı	1.37hı	1.55gh	1.34c
	Average of P.	1.68c	1.80b	1.80b	1.99a	2.06a	
1998	25.0	2.02	2.17	2.25	2.42	2.40	2.25a
	37.5	1.72	1.85	2.02	2.20	2.35	2.03b
	50.0	1.30	1.35	1.47	1.80	1.75	1.43c
	Average of P.	1.68d	1.79c	1.91b	2.14a	2.16a	

Difference indicated with same letter (s) are non-significant ($p<0.05$)

From Table 6 it is clear that there were no significant differences at any intervals on height growth due to fertilizer application.

Plant height was given similar results by applications of phosphorus fertilizer doses. Generally P fertilizes highly effects on root growth according to plant height.

The interaction of sowing densities and doses of phosphorus fertilizers was found non-significantly in both years.

Competition for sun light between plants becomes important, thus increasing plant height and first pod height in solid seeding densities. The highest plant height was obtained in the plots applied 50 seed m^{-2} plant densities with in both years.

First pod height : Phosphorus fertilizers non significantly affected first pod height in 1997, but first pod height was effected by phosphorus fertilizers applications ($p<0.01$) significantly in 1998. Plant densities affected plant height significantly ($p<0.01$) in both years. The interaction of sowing densities and doses of phosphorus fertilizers was found non significantly in both years (Table 7).

The highest first pod height was obtained in the plots applied 50 seed m^{-2} plant densities with in both years. The highest first pod height was obtained in the plots applied 60 kg ha^{-1} phosphorus fertilizers with in 1998. But in 1997 similar result was found all doses of phosphorus fertilizers.

Şehriali[17] reported that first pod height was varied with plant variety and ecological effects.

Main benches: Both the sowing densities and doses of phosphorus fertilizers had significant ($p<0.01$) effects on the number of main branches of dry bean in both years (Table 8).

More branching tendency was noticeable in the wide sowing densities. By application of sowing densities, maximum main branches was obtained from 25 seed per meter and the lowest main branches found from the maximum sowing densities in the present experiment. By P fertilizers supplies, the highest main branches obtained from 45 kg P ha^{-1}. The interaction of sowing densities and doses of phosphorus fertilizers was found significantly in 1997, but it was not found significantly in 1998. The highest number of main branches was obtained in the plots applied 45 kg ha^{-1} phosphorus fertilizers and 25 seed m^{-2} with 2.52 branches per plant in 1997.

While the highest number of main branches was obtained from main year of this experiment, 25 seed m^{-2} with 2.25 branches per plant and the highest number of main branches from applications of 60 kg ha^{-1} with 2.16 branches (Table 8).

Patel *et al.*[18] reported that there are irrigation effects on plant branching, seed yield, 1000 seed weight and this occurred to increasing of use of soil nutriments with irrigation. The highest number of branches might be due to more space for nutrient absorption in presence of proper soil moisture content during the growth period.

Secondary branching: Both the sowing densities and doses of phosphorus fertilizers had significant ($p<0.01$) effects on the number of secondary branches of dry bean in both years (Table 9).

Low branching tendency was noticeable in the solid sowing densities. By application of sowing densities, maximum secondary branches was obtained from 25 seed

Table 9: Mean and compared values of the different sowing densities and doses of phosphorus fertilizers on the secondary branches (number of per plant) in dry bean

Years	Sowing densities (seed m^{-2})	Phosphorus doses (kg ha^{-1}) 0	15	30	45	60	Averages
1997	25.0	6.05a-c	6.22a	6.28a	6.50a	6.75a	6.36a
	37.5	4.12e	5.50a-d	6.10ab	6.12ab	6.35a	5.46b
	50.0	3.90e	4.40de	4.60b-e	4.82b-e	4.82c-e	4.51c
	Average of P.	4.69d	5.37c	5.66b	5.81ab	5.97a	
1998	25.0	4.07f-h	4.80cd	5.20ab	5.50a	5.40a	4.99a
	37.5	3.90gh	4.22e-g	4.72cd	4.82cd	4.90bc	4.51b
	50.0	3.15ı	3.82h	4.10f-h	4.45d-f	4.57c-e	4.02c
	Average of P.	3.70d	4.28c	4.67b	4.92a	4.95a	

Difference indicated with same letter (s) are non-significant ($p<0.05$)

per meter. The lowest secondary branches found from the maximum sowing densities in the present experiment. While increasing of phosphorus fertilizers doses, secondary branches was increased linearly. The highest main branches obtained from 60 kg P ha^{-1}.

The interaction of sowing densities and doses of phosphorus fertilizers was found significantly ($p<0.01$) in 1997 and 1998 ($p<0.05$) The highest number of secondary branches was obtained in the plots applied 60 kg ha^{-1} phosphorus fertilizers and 25 seed m^{-2} with 6.75 branches per plant in 1997. As results of second year of this experiment, similar results were obtained as compared to first year. While the highest number of secondary branches from applications of 45 kg ha^{-1} +25 seed m^{-2} with 5.50 branches (Table 9).

REFERENCES

1. FAO, 2003. http: // www.fao.org.
2. Grafton, K.F., A. Schneiter and B.J. Nagle, 1988. Row spacing, plant population and genotype X row spacing interaction effects on yield and yield components of dry bean. Agron. J., 80: 631-634.
3. Hardwick, R.C., 1988. Review of recent research on navy beans (*Phaseolus vulgaris*) in the United Kingdom. Ann. Appl. Biol., 113: 205–227.
4. Kelly, J.D., 1988. Effect of row-spacing on dry bean yields in michigan. Mich. Dry Bean Dig., 12: 6-8,16.
5. Blackshaw, R.E., H.H. Muendel and G. Saindon, 1991. Canopy architecture, row spacing and plant density effects on yield of dry bean (*Phaseolus vulgaris*) in the absence and presence of hairy nightshade (*Solanum Sarrachoides*). Can. J. Plant Sci., 79: 663-669.
6. Schatz, B.G., S.F. Zwinger and G.J. Endres, 2000. Crop and livestock review. North Dakota State Univ. Carrington Research Extansion Center.
7. Çakmak, F. and N. Azkan, 1997. Effect of sowing date and plant densities on seed yield and yield components. The Second of Congress of Field Crops in Turkey, September, 22-25, pp: 172-179.
8. Latifi, N. and S. Navabpoor, 2000. The response of growth indices and seed yield of two pinto bean to row spacing and plant population. Iranian J. Agri. Sci., 31: 353-362.
9. Pereira, P.A.A. and F.A. Bliss, 1987. Nitrogen fixation and plant growth of common bean (*Phaseolus vulgaris* L.) at different levels of phosphorus availability. Plant and Soil, 104: 79-84.
10. Pereira, P.A.A. and F. Bliss, 1989 Selection of common bean (*Phaseolus vulgaris* L.) for N2 fixation at different levels of available phosphorus under field and environmentally-controlled conditions. Plant Soil, 115: 75-82.
11. Vadez, V., J.H. Lassol, D.P. Beck and J.J. Drevon, 1999. Variability of N2-fixation in common bean (*Phaseolus vulgaris* L.) under P deficiency is related to P use efficiency N2-fixation tolerance to P deficiency Euphytica, 106: 231-242, 1999. Kluwer Academic Publishers. Printed in the Netherlands.
12. Elliott, G.C. and A. Läuchli, 1985 Phosphorus efficiency and phosphate-iron interaction in maize. Agron. J., 77: 399-403.
13. Brady, N.C., 1984. The Nature and Properties of Soils. Macmillan, New York.
14. Barbosafilho, M.P. and O.F. Silva, 1994. Aspectos agro-econimicos da calagem e da adubação nas culturas de arroz e feijão irrigados por aspersão. Pesquisa Agropecuária Brasileira, Brasília, 29: 1657-1667.
15. Akdağ, C., 1996. Pulses. Gaziosmanpaşa Univ., Agriculture Faculty. Publication Number: 10, Book Number, 4, Tokat, pp: 435.
16. Güzel, N., 1982. Soil fertilty and fertilizers. Çukurova Univ., Agriculture Faculty. Publicatins Number: 168, Study Book Number: 13, S: 26-80 Adana. (In Press Turkish).
17. Şehriali, S. 1988. Pulses. Ankara Univ., Agriculture Faculty. Publication Number: 1089, Book Number: 314, Page 435 . Ankara. (In Press Turkish)
18. Patel, J.C., D.D. Malavia, M.N. Vyas and K.P. Patel, 1988. Response of chickpea to ırrıgation and fertilizers. Indian J. Agron., 34: 67-69.