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THE EFFECT OF PHOSPHORUS DOSES ON CHICKPEA CULTIVARS UNDER RAINFALL CONDITIONS

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ABSTRACT. This study was conducted to investigate the effect of different phosphorus doses (0, 15, 30, 40 and 70 kg ha^{-1}) on chickpea (*Cicer arietinum* L.) cultivars at Diyarbakir, Southeast Anatolia of Turkey over two years at late spring. The effect of phosphorus on plant height and number of branches plant-1 was non-significant. Number of branches plant-1 was different response to phosphorus doses, although statistically was not significant. Number of pods and seeds plant-1 were affected by phosphorus treatment. Although 100 seed weight was not affected by phosphorus applications, cultivar x doses interaction was important. Phosphorus doses were significant for yield, but yield apparently did not increase. Start dose, 15 kg phosphorus ha-1, was initially increased the yield, and 30 kg phosphorus ha-1 application slightly was increased. The highest number of pods and seeds at 30 and 70 kg P ha^{-1}, compared only one of these control and 15 kg P ha-1. Grain yield was increased to 16 and 12% with the application of 30 and 40 kg P ha^{-1}, respectively, when compared with control dose. Chickpea cultivars showed low response to P application. Phosphorus fertilization could not be effective due to late sown. Early sown and irrigation supply can be advisable for more effectiveness phosphorus intake in this region.

Key words: Chickpea; *Cicer arietinum* L.; Phosphorus; Yield.

INTRODUCTION

Chickpea (*Cicer arietinum* L.) crop performance is depended on cultivar performance and environmental area. The most important factors of limiting chickpea production and low yield in the Southeast Anatolia of Turkey are anthracnose, inadequate moisture, late sown and poor soil deficit nutrient. Plant nutrient have significant effects on yield and yield component, also suitable cultivars and correct consumption of fertilizers lead to optimum uses of soil and environmental factors that produce

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high yield and yield component (Khourgamy and Farnia, 2009). Phosphorus (P) is a key nutrient element required for high and sustained productivity of grain legumes such as chickpea. For instance, low soil phosphorus and poor utilization efficiency of phosphorus is a major constraint limiting the productivity of most grain legumes (Aulakh *et al.,* 2003; Sheikh Hoseini and Siadat, 2003).

Legume crops usually respond well to phosphorus fertilizers (Shukla, 1964), while the response of chickpea is variable (Saxena, 1980). Many studies found a positive yield response of chickpea to phosphorus fertilizer (Johansen and Sahrawat, 1991; Riley 1994; Islam *et al.,* 2011) but the rate of P required varies according to growth conditions (Chen *et al.,* 2006). Also, the optimal rate of phosphorus application for chickpea appears to be in the range of 15-30 kg P ha^{-1} but mostly in the vicinity of 20 kg P ha^{-1} (Johansen and Sahrawat, 1991). In a vertisol of Australia, chickpea grain yield by 25% were increased in 10 kg P ha^{-1} fertilization application (Lester *et al.,* 2008). Production under dry land farming systems is limited by moisture deficiency and lack of plant available nutrients in the soil (Falah, 2002).

The study was conducted to assess the effect of phosphorus application on seed yield of chickpea at Diyarbakir, Southeast Anatolia of Turkey.

MATERIALS AND METHODS

The experiment was conducted at the experimental farm of the Faculty of Agriculture, Dicle University, Diyarbakir, Southeastern Anatolia of Turkey, during the spring of 2011 and 2012 growing season. The soil was a clay-loam, moderate in organic matter content (1.2%) with a pH of 7.6 and low in phosphorus contents (16.15 kg P ha^{-1}). Normal phosphorus content of the South East Anatolia of Turkey soils is insufficient for phosphorus by 65% (30-60 kg ha^{-1} to 60-90 kg ha^{-1}). Phosphorus fertilizer application is necessary in experiment area soil (16.15 kg P ha^{-1}) due to deficit phosphorus (Eyupoglu, 1999).

Weather conditions of growing period, from January to July, were given in *Table 1*. Total rainfall, during cropping season (March to June) was 303 mm, during first year and 76 mm, during second year of experiment.

Five phosphorus, triple superphosphate (P_2O_5), doses (0, 15, 30, 40 and 70 kg ha^{-1}) and three chickpea cultivars [Aziziye 94, Gökçe and N540 (Diyar 95 x ILC482)] were used. Experiment was arranged using a factorial, split-plot design, within a randomized complete block design with three replicates, over two years. Cultivars were assigned to main plots and phosphorus to sub-plots. Plots were 4 m length with six rows, and seed rate was 40 plant m^{-2}. Sown was in the second week of March, 2011 and 2012. Phosphorus and nitrogen (20 kg N ha^{-1}) fertilization applied at sown. Plants were harvested in the second and first week of July, 2011 and 2012, respectively. Observations were recorded on plant height, number of branches, pods and seeds $plant^{-1}$, 100 seed weight and grain yield kg ha^{-1}.

The data were statistically analyzed by using MSTATC (Michigan State University, East Lansing, MI) (Freed *et al.,* 1989) computer package program.

Table 1 - Climatic conditions in 2011 - 2012 crop seasons at Diyarbakir, Turkey

Months	Year	Temperature (°C)			Precipitation (mm)	Humidity (%)
		Mean	Max.	Min.		
Jan.	2011	4.7	15.5	-7.5	49.9	69.1
	2012	1.9	14.8	-8.4	74.4	68
	Long term	3.6	15.4	-8.7	68	72
Feb.	2011	9	22.4	-4.5	46.6	56.1
	2012	5.1	18.1	-5.8	44	59
	Long term	8.2	21.5	-4.5	65.4	65
March	2011	12.9	22	-0.5	209	75.6
	2012	15.2	27.8	2	26.2	58
	Long term	13.8	27.3	0.9	69.8	63
April	2011	17.6	32.2	7.5	80.1	67.8
	2012	19.6	33	8.6	41	58
	Long term	19.2	33.2	5.8	41.8	55
May	2011	25.4	38.9	11.7	13.6	38.3
	2012	27.7	41.7	9.4	7	27.8
	Long term	26.1	38.7	10.8	7.9	35
June	2011	31.9	44.7	17.1	0.6	22.7
	2012	31.3	43.7	14.5	1.6	20.9
	Long term	31.1	42.3	16.4	0.7	26

RESULTS AND DISCUSSION

Analysis of variance and mean values of the effect of phosphorus dosses on agronomic traits in chickpea were given at *Tabs. 2 and 3*. Analysis of variance revealed that the effect of phosphorus application on plant height did not significant, but cultivar (Cv), year (Y) and Cv. × phosphorus doses (P) were significant (*Table 2*). Maximum plant height (49.3 cm) was obtained from N540 × 70 kg P_2O_5 ha-^{1}. However, short plant height value was 42.8 cm in Gökçe × 70 kg P ha^{-1} (*Table 3*). Since phosphorus content of the soil of experimental area was deficient, crop response could be waiting, but results different and small. Dahiya *et al.* (1993) reported that P applications increased plant height and number of branches. Number of branches plant^{-1} showed different response to phosphorus doses, although statistically did not significant (*Table 2*), compared with control (0 kg P ha^{-1}); the different doses phosphorus decreased number of branches plant^{-1} (*Table 3*).

The differences among varieties were significant, and Cv. N540, which had a more branching showed high number of branches plant^{-1} in high doses. The effect of phosphorus fertilizer application on number of

pods and seeds plant^{-1} was important (*Table 2*). The highest number of pods and seeds at 30 and 70 kg P ha^{-1} compared to control and 15 kg P ha^{-1}, in this study. Gökçe produced maximum pods and seeds in 30 kg P ha^{-1}, Aziziye 94 showed maximum values in 70 kg P ha^{-1}. While almost all cultivars had minimum pods and seeds in 15 kg P ha^{-1}, but Aziziye 94 had high value for number of pods and seeds plant^{-1} in 15 kg P ha^{-1}. Control dose gave more pods and seeds than 15 kg P ha^{-1}, except Aziziye 94. Cv. N 540 among cultivars was produced minimum pods and seeds (*Table 3*).

The 100 seed weight was no affected by phosphorus doses. Maximum 100 seed weight was observed in Aziziye 94. Cultivar x doses interaction was important. Gökçe had positive response to P doses for 100 seed weight, from 39.74 in 0 kg P ha^{-1} g to 42.06 g in 70 kg P ha^{-1}. Aziziye 94 had maximum 100 seed weight in 30 kg P ha^{-1}, but minimum seed weight was obtained from high doses, 40 to 70 kg P ha^{-1} (*Table 3*). Khourgami and Farnia (2009) reported in Iran, grain yield, number of seeds pod plant^{-1} and 100 seed weight of chickpea were increased by phosphorus applications. Basir *et al.* (2008) showed that, as compared to other phosphorus treatments 60 kg P ha^{-1}, significantly improved agronomic traits. Maximum plant height, number of pods plant^{-1}, 100 seed weight and grain yield were recorded for 60 kg P ha^{-1}.

Table 2 - The combined analysis of variance of agronomic traits for chickpea cultivars and phosphorus doses

Variation sources	Df	Plant height (cm)	Number of branches plant^{-1}	Number of pods plant^{-1}	Number of seeds plant^{-1}	100 Seed weight (g)	Grain yield (kg ha^{-1})
Year	1	**		**	**	*	*
Error 1	4						
Cultivars	2	**	**	**	**	**	**
Y × Cv.	2	**	**	**	**	**	
Error 2	8						*
Phosphorus	4			**	**		**
Y × P	4	**	*	**	**	*	
Cv × P	8	**		**	**	*	**
Y × Cv. × P	8		*	**	**		**
Error 3	48				**		**
Cv%		3.48	15.8	10.18	18	3.15	19

**:0.01,*: 0.05 significant levels

Table 3 - The effect of phosphorus doses on agronomic traits in chickpea

P Doses (kg ha^{-1})	Plant height (cm)	Number of branches plant^{-1}	Number of pods plant^{-1}	Number of seeds plant^{-1}	100 seed weight (g)	Grain yield (kg ha^{-1})
Control	46.0	2.59	14.0	13.8	41.07	115.2
15	45.6	2.42	12.9	13.5	40.89	125.6
30	46.5	2.72	15.6	16.4	41.80	133.9
40	46.0	2.41	14.1	14.2	41.49	128.3
70	46.0	2.43	15.6	15.6	41.79	117.8
LSD	-	-	0.98	0.7	-	7.2
Cultivars						
Gökçe	44.0	2.38	14.5	14.7	41.09	147.5
N540	47.7	3.12	13.5	13.6	36.61	92.78
Aziziye 94	46.3	2.18	15.4	15.6	46.52	132.1
LSD	0.79	0.16	0.37	1.2	0.78	6.4
Interaction (Cv.×P)						
Gökçe × Control	44.2	2.61	13.4	13.0	39.74	1376
Gökçe × 15	44.1	2.11	12.7	12.5	40.44	1455
Gökçe × 30	44.2	2.38	17.4	18.9	40.50	1633
Gökçe × 40	45.0	2.31	13.6	14.0	42.71	1540
Gökçe × 70	42.8	2.31	15.3	15.1	42.06	1373
N540 × Control	47.6	2.96	13.5	13.0	36.97	849
N540 × 15	48.0	2.95	10.5	10.9	36.31	948
N540 × 30	47.5	3.51	14.4	14.5	36.47	946
N540 × 40	46.1	3.00	14.3	14.2	35.33	1089
N540 × 70	49.3	2.66	14.7	15.4	37.99	805
Aziziye 94× Control	46.1	2.20	15.1	15.3	46.52	1230
Aziziye 94 × 15	44.6	2.20	15.8	16.6	45.93	1365
Aziziye 94 × 30	47.8	2.26	15.2	15.7	48.42	1437
Aziziye 94 × 40	46.8	1.91	14.4	14.1	46.44	1219
Aziziye 94 × 70	46.0	2.31	16.9	16.3	45.30	1355
LSD	1.86	-	1.01	1.37	-	133
Year 1	52.3	2.51	17.46	18.07	43.44	1267.1
Year 2	39.7	2.52	11.51	11.26	39.37	1215.6

Phosphorus doses were significant for yield (*Table 2*), but yield apparently did not increase (*Table 3*). Start dose, 15 kg P ha^{-1}, could be initially increased the yield, and 30 kg P ha^{-1} application slightly was increased, then, 40 to 70 kg P ha^{-1}. Phosphorus doses substantially decreased the yield. Grain yield was increased to 16 and 12% with the application of 30 and 40 kg phosphorus ha^{-1}, respectively, when compared with control dose. Chickpea cultivars showed low response to phosphorus application. The result from chickpea experiment was affected by late sown and rainfall conditions.

Earlier, researchers Johansen and Sahrawat (1991) reported that as

chickpea is usually grown under rainfed conditions, where the topsoil often dries out during the growing season, reduced surface soil moisture might have contributed to the low response of chickpea to phosphorus fertilizer. Also, Riley (1994) found that, in the clay soil of Australia, application of 100 kg P/ha had no effect on yield. He noted the yield response of chickpea at up to 50 kg P/ha in a high phosphorus sorbing newly-cleared. Islam *et al.* (2011) showed that P application resulted in significant increase in seed yield, and higher and lower level of phosphorus differed for seed yield. In this study, yield difference between control dose and 70 kg P ha^{-1} was no found.

The grain yield of chickpea showed a positive response to phosphorus fertilizers from control to 40 kg P ha^{-1}. Walley *et al.* (2005) reported that phosphorus fertilizer had no effect on seed yield for kabuli chickpea. For desi yield, 20 kg P ha^{-1} application had no significant, but 40 kg P ha^{-1} increased desi yield. In our study, maximum grain yield was observed in Gökçe cultivar, minimum yield was in N540 Cv. (*Table 3*).

Differences among years were significant. This result may be due to different climatic conditions. There are many researchers reported that grain yield was affected by years or locations under phosphorus fertilization. For example, Chen *et al.* (2006) reported that phosphorus application of at first location in one year increased pea and chickpea yields slightly, but did not increase yields at second location in either year, despite having lower initial in Olsen P levels. It is likely that water, more than P, limited crop yield.

CONCLUSIONS

In light of our results, we aimed to investigate the effect of phosphorus on chickpea yield and its components under rainfed and late sown conditions. According to analysis of experiment area soil, phosphorus fertilization is necessary for high yield due to low phosphorus in the soil (16.15 kg P ha^{-1}). The effect of phosphorus on plant height was non-significant. Number of branches $plant^{-1}$ showed different response to phosphorus doses, although statistically did not significant, compared with control (0 kg P ha^{-1}), decreased number of branches $plant^{-1}$. The effect of phosphorus fertilizer application on number of pods and seeds $plant^{-1}$ was important. The highest number of pods and seeds at 30 and 70 kg P ha^{-1} compared with to control and 15 kg P ha^{-1} in this study. Grain yield was increase up to 16 and 12% with the application of 30 and 40 kg P ha^{-1}, respectively, when compared with control dose.

Chickpea cultivars showed low response to phosphorus application, since the chickpea experiment exposed to drought stress due to late sown. Also, phosphorus fertilization completely could not be effective since late sown caused short growing season. Early sown and supply irrigation can be advisable for more effectiveness phosphorus intake in this region.

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