Journal of Natural Sciences Research www.iiste.org
ISSN 2224-3186 (Paper) ISSN 2225-0921 (Online)
Vol.5, No.3, 2015

Effect of Phosphorus Levels on Growth and Yield of Chickpea (Cicer aretinum l.) Varieties

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Abstract
A field experiment was conducted during 2011-12 to investigate the effect of different phosphorus levels on the growth and seed yield of chickpea at Pulses Research Station, Agriculture Research Institute, Tandojam. Two chickpea varieties (V1=D.G-92 and V2=D.G-89) were evaluated against and six phosphorus levels (F1=36-00 kg, F2=36-15 kg ha-1, F3=36-25 kg ha-1, F4=36-35 kg ha-1, F5=36-45 kg ha-1 and F6=36-55 kg ha-1). The experiment was laid out in a three replicated Randomized Complete Block Design (Factorial). Having plot size 5x3m = 15m2. The results revealed that the germination and all other growth and yield traits of chickpea were significant at ($P<0.05$) and positively influenced by increasing phosphorus levels; and chickpea varieties also responded differently to phosphorus levels. On the basis of seed yield ha-1, the phosphorus application at the rate of 55 kg ha-1 ranked first with 72.98 % germination, taking 75.50 days to flowering, 44.50 pods plant-1, 49.33 seeds plant-1, 1.38 cm pod length, 415.80 g seed index and 1691.21 kg ha-1 seed yield. Phosphorus level of 45 kg, 35 kg, 25 kg and 15 kg ha-1 categorically ranked 2nd, 3rd, 4th and 5th in almost all the studied traits. However, least performance was resulted by the crop receiving no phosphorus (control). In case of varieties, D.G-92 showed its superiority with 72.43 % germination, took 71.30 days to flowering, resulting 42.88 pods plant-1, 47.66 seeds plant-1, 1.31 cm pod length, 407.93 g seed index and 1564.15 kg ha-1 seed yield. On the other hand variety D.G-89 resulted in 70.25 % germination, took 72.50 days to flowering, resulting 39.16 pods plant-1, 43.44 seeds plant-1, 1.25 cm pod length, 363.06 g seed index and 1269.80 kg ha-1 seed yield. It was concluded that the growth and seed yield of chickpea varieties consecutively improved with increasing phosphorus levels; and highest phosphorus level of 55 kg ha-1 resulted in maximum seed yield ha-1; while chickpea variety DG-92 showed its superiority over D.G-89 for all the growth and yield traits. Hence, variety D.G-92 may preferably be cultivated and alongwith recommended N (36 kg ha-1), phosphorus may be applied at the rate of 55 kg ha-1 for maximizing the chickpea yields.
Keywords: Chickpea, Phosphorus Levels, Growth And Yield

1. Introduction

The chickpea (Cicer arietinum) is an edible legume of the family Leguminose; high in protein and one of the earliest cultivated vegetables (Zohary and Maria, 2000). Chickpeas are a helpful source of zinc, folate and protein. They are also very high in dietary fibre and hence a healthy source of carbohydrates for persons with insulin sensitivity or diabetes (Deppe, 2010). One hundred grams of mature boiled chickpeas contains 164 calories, 2.6 grams of fat (of which only 0.27 grams is saturated), 7.6 grams of dietary fiber and 8.9 grams of protein. Chickpeas also provide dietary phosphorus (49–53 mg/100 g). In the semi-arid tropics, chickpea seeds contain on average 23% protein, 64% total carbohydrates (47% starch, 6% soluble sugar), 5% fat, 6% crude fiber, phosphorus (340 mg/100 g), calcium magnesium (140 mg/100 g), iron (7 mg/100 g) and zinc (3 mg/100 g) (Deppe, 2010). Pulse crops play an important role in Pakistan agriculture. Besides being rich in protein, they sustain the productivity of cropping systems. The pulses in Pakistan are cultivated on an area of 1.492 million hectares, with a production of 983,000 tons. Gram is the largest Rabi pulses crop in Pakistan and during the year 2010-11, the gram was cultivated on an area of 1068 thousand hectares with a production of 523 thousand tons indicating 6.9 percent decrease in production against last year crop. For the years 2010-11, and during the year 2009-2010, the chick pea production stood at 5.2 million tons against 5.6 million tons of last year, showing a reduction of 6.9 percent during 2010-11 mainly because of unfavorable climate. The area under cultivation of lentil, mung and mash during the year 2010-11 was 24.0, 137 and 23.8 thousand hectares with a production of 10.6, 77.1 and 11.2 thousand tons, respectively showing decrease in production by 2.7 percent and 35.00 percent in lentil and mung, while the production of mash was increased by 1.00 percent over the last year (GOP, 2011). The balanced nutrient application for crop production is essential and their imbalance use reduces crop yields. The leaves are green factories where the complex chemical processes of photosynthesis produce the compounds, plants needed for growth. All sources of nutrients may be applied to crops and advocated that foliar fertilization is widely used practice to correct nutritional deficiencies in plants caused by improper supply of nutrients to roots (Frossard et al., 2000). Phosphorus (P) is an essential nutrient both as a part of several key plant structure compounds and as a catalysis in the conversion of numerous key biochemical reactions in plants. P is noted especially for its role in capturing and converting the sun's energy into useful plant compounds; thus P is essential for the general health and vigor of plants. Some specific growth factors that have been associated with P are: stimulated root development, increased stalk and stem strength, improved flower formation and seed production, more uniform and earlier crop maturity, increased nitrogen N-fixing capacity of legumes, improvements in crop quality, and increased resistance to plant diseases (Griffith, 2010; Magid et. al., 1996; Cross and Schlesinger, 1995). Phosphorus transformations and mobility in the soil-plant system are controlled by a combination of biological, chemical and physical processes. The amounts, forms and associated dynamics of soil P are influenced by a number of factors including soil type and environmental conditions, as well as land-use and management practices. In natural ecosystems plant growth is often limited by P availability, while P is generally recycled and retained efficiently (Attiwell and Adams, 1993; Frossard et. al., 2000). However, in managed ecosystems continued inputs of P in the form of fertilizers and imported fodder profoundly affect the quantity, availability and dynamics of soil P (Pierzynski et. al., 2000). A pronounced effect of P application on chickpea yields has been reported by Fairhurst and Witt (2002). The number of pods and seed index was improved under higher P applications (Kumar and Sreenivasulu, 2004). Gruhn et al. (2000) reported higher grain yield in gram due to organic P application. Long-term fertilizer experiments have revealed that the efficiency of P and K increased appreciably when both are applied in conjunction, suggesting their positive interactions (Kumar and Sreenivasulu, 2004; Mahajan et al., 2002; Mahajan et al., 2003). Roy et al. (2001) examined combined application of 50, 100 and 150% of the recommended rates of inorganic nitrogen, phosphorus and potassium; and found improved results as compared to straight fertilizers. Long term fertilizer experiments involving intensive cereal based cropping systems reveal a declining trend in productivity even with the application of recommended levels of N, P and K fertilizers (Mahajan and Sharma, 2005; Gawai and Pawar, 2006).

1.1 Material and Methods

The effect of phosphorus levels on growth and yield of chickpea (cicer aretinum L.) varieties were investigated in an experiment conducted at the experimental fields of Agricultural Research (Pulses Section), Agriculture Research Institute, Tandojam. The experiment was laid out in a three replicated randomized complete block design (RCBD) with plot size of 5 x 3m (15m2). Two commercial chick pea varieties and six fertilizer levels were used in this study. Nitrogen (36 kg ha-1) was split applied at sowing, 2nd and 3rd irrigations as per treatments in the form of Urea. All P (at varying levels) was applied in the form of single super phosphate at the time of sowing. The experimental crop was managed in accordance with the recommended cultural and other field management practices.

Procedures for taking observations

Seed germination (%): The number of seedlings emerged from an area of one m-2 from the total number of seeds sown in this particular area in each treatment was counted and averages were worked out.

Days taken to flowering: The number of days from sowing to initiation of flowering was counted in each treatment and mean was worked out.

Number of pods plant-1: The number of pods plant-1 was counted at maturity of the crop in labeled plants in each treatment.

Number of seeds plant-1: The number of seeds plant-1 was counted at maturity of the crop in labeled plants in each treatment.

Pod length (cm): The pod length of ten pods in each labelled plant in each plot was measured and accordingly the average was worked out.

Seed index (1000 seeds, g): Seed index value was observed on the basis of 1000 seeds manually separated by counting in each treatment and were weighed to record seed index in grams.

Seed yield (kg ha-1): The seed yield (kg ha-1) was worked out by using the following formula:

$$\textbf{Seed yield (kg ha}^{-1}\textbf{)} = \frac{\text{Yield plot}^{-1}\text{ of given treatment (kg)}}{\text{Plot area (m}^2\text{)}} \times 10000$$

Statistical analysis

The data thus collected were subjected to analysis of variance using MSTAT-C computer software (Russel and Eidensmith, 1983) and analysis of variance were derived to examine the significance of treatments. The LSD test was applied to determine the superiority of treatment means.

RESULTS

1. Germination (%): The effect of various phosphorus levels on the germination percentage of chickpea varieties was investigated and the results are presented in Table-1. The analysis of variance (Appendix-I) showed that germination percentage was affected significantly (P<0.05) by different varieties, phosphorus levels, as well as by interaction between chickpea varieties and phosphorus levels. It was noted from the data (Table-1) that highest germination (73.38%) was recorded in plots given phosphorus at the rate of 55 kg ha-1, followed by phosphorus levels of 35 kg and 25 kg ha-1 with average germination of 73.01 and 72.98 percent, respectively. A decrease in the germination upto 72.80 and 68.44 percent was recorded in plots where the phosphorus was applied at the rate of 45 kg and 15 kg ha-1. However, the minimum germination of 67.44 percent was observed in case of control, where no phosphorus was applied. In case of varieties, relatively higher seed germination (72.43 %) was recorded in variety D.G-92 as compared to 70.25 seed germination in variety D.G-89. The results clearly suggest that there was significant – (P<. 0.05) impact of phosphorus levels on germination percentage of chickpea, because the variation in the germination percentage was proportion to increasing phosphorus application rate.

Table 1. Germination percentage of chickpea varieties as affected by different phosphorus levels

Treatments	Varieties		Mean P levels
	D.G-92	D.G-89	
36-00 kg NP ha^{-1}	68.470	66.413	67.44 b
36-15 kg NP ha^{-1}	69.48	67.40	68.44 b
36-25 kg NP ha^{-1}	74.09	71.87	72.98 a
36-35 kg NP ha^{-1}	74.13	71.90	73.01 a
36-45 kg NP ha^{-1}	73.91	71.69	72.80 a
36-55 kg NP ha^{-1}	74.50	72.26	73.38 a
Mean Varieties	**72.43 a**	**70.25 b**	**-**

	P Levels (P)	Varieties (V)	P x V
S.E.	1.0151	0.7015	1.7183
LSD 0.05	2.5199	1.4548	3.5636

2. Days to flowering: The results in relation to the number of days taken to flowering of chickpea varieties as influenced by various phosphorus levels are given in Table-2 and its analysis of variance as Appendix-II. The analysis of variance indicated that the days to initiate flowering were significantly (P<0.05) influenced due to different phosphorus levels and varieties, while the effect of interaction between phosphorus levels and varieties was statistically non-significant (P>0.05). It is evident from the results that highest phosphorus level of 55 kg ha-1 delayed the days to flowering and initiation of flowering was noted in 75.50 days, while the chickpea crop supplied with 45 kg and 35 kg ha-1 initiated flowering in 73.16 and 72.16 days, respectively. The crop fertilized with phosphorus at the rate of 25 kg and 15 kg ha-1 initiated flowering in 71.83 and 70.16 days, respectively. However, the crop took lowest number of days (68.83) to flowering when received no phosphorus (control). In varieties, the chickpea variety D.G-89 delayed flowering taking maximum days (72.50) to flowering, while the variety D.G-92 showed earliness in flowering (71.30 days) when compared with D.G-89. It was observed that with increasing the level of phosphorus fertilizer, the chickpea crop delayed the flowering initiation due to prolonged growth period which is proved from the control plots, where the flowering was observed earlier than the plots receiving different levels of phosphorus. Moreover, the delay in flowering of chickpea was proportional to level of phosphorus application. The LSD test showed that the differences in days to flowering between 25 kg and 35 kg phosphorus levels were non-significant (P>0.05) and significant (P<0.05) when compared with rest of the treatments and varieties.

Table 2. Days to flowering of chickpea varieties as affected by different phosphorus levels

Treatments	Varieties		Mean P levels
	D.G-92	D.G-89	
36-00 kg NP ha^{-1}	68.33	69.33	68.83 e
36-15 kg NP ha^{-1}	69.66	70.66	70.16 d
36-25 kg NP ha^{-1}	71.33	72.33	71.83 c
36-35 kg NP ha^{-1}	71.66	72.66	72.16 bc
36-45 kg NP ha^{-1}	72.66	73.66	73.16 b
36-55 kg NP ha^{-1}	71.44	76.33	75.50 a
Mean Varieties	**71.30 a**	**72.50 b**	**-**

	P Levels (P)	Varieties (V)	P x V
S.E.	0.4863	0.2808	0.6878
LSD 0.05	1.0086	0.5823	

3. Pods plant-1: The data in regards to number of pods plant-1 of chickpea varieties as affected by various phosphorus levels are presented in Table-3 and its analysis of variance as Appendix-III. The analysis of variance demonstrated that the number of pods plant-1 was significantly (P<0.05) influenced by varying phosphorus levels and varieties, while non-significant (P>0.05) due to their interaction. It is apparent from the data (Table-3) that highest phosphorus level of 55 kg ha-1 resulted in maximum pods (44.50) plant-1, followed by 43.50 and 42.66 pods plant-1 recorded in chickpea crop supplied with phosphorus at the rate of 45 kg and 35 kg ha-1, respectively. Similarly, the crop fertilized with lower phosphorus levels of 25 kg and 15 kg ha-1 produced 41.50 and 39.00 pods plant-1, respectively. However, the minimum pods (35) plant-1 was noted in control, where phosphorus was not applied. In case of varieties, the variety D.G-92 produced significantly highest number of pods (42.88) plant-1, while the lowest number of pods (39.16) plant-1 was observed in case of variety D.G-89. The interaction studies showed that interaction of “variety D.G-92 × 55 kg ha-1 P” resulted in maximum pods (46.66) plant-1; while the minimum pods (33.33) plant-1 was recorded in interaction of “variety D.G-89 × 0 P (control)”. The results indicated that increasing phosphorus levels simultaneously increased the number of pods plant-1, while variety D.G-92 was relatively superior over D.G-89 for this trait. LSD test showed that differences in pods plant-1 between 55 kg and 45 kg ha-1 were non-significant (P>0.05) indicates that that 45 kg phosphorus level was an optimum level for this trait.

Table 3. Pods plant-1 of chickpea varieties as affected by different phosphorus levels

Treatments	**Varieties**		**Mean P levels**
	D.G-92	**D.G-89**	
36-00 kg NP ha^{-1}	36.66	33.33	35.00 d
36-15 kg NP ha^{-1}	41.00	37.00	39.00 c
36-25 kg NP ha^{-1}	43.33	39.66	41.50 bc
36-35 kg NP ha^{-1}	44.33	41.00	42.66 ab
36-45 kg NP ha^{-1}	45.33	41.6	43.50 a
36-55 kg NP ha^{-1}	46.66	42.66	44.50 a
Mean Varieties	**42.88 a**	**39.16 b**	**-**

	P Levels (P)	**Varieties (V)**	**P x V**
S.E.	0.6660	0.3845	0.9419
LSD 0.05	1.3813	0.7175	

4. Pods plant-1: The results in relation to number of seeds plant-1 of chickpea varieties as influenced by different phosphorus levels are indicated in Table-4 and its analysis of variance as Appendix-IV. The analysis of variance demonstrated that the number of seeds plant-1 was significantly (P<0.05) affected by different phosphorus levels and varieties, while the effect of their interaction was non-significant (P>0.05). The results showed that highest phosphorus level of 55 kg ha-1 resulted in maximum seeds (49.33) plant-1, followed by 48.33 and 47.33 seeds plant-1 observed in chickpea crop fertilized with phosphorus at the rate of 45 kg and 35 kg ha-1, respectively. Similarly, the crop fertilized with lower phosphorus levels of 25 kg and 15 kg ha-1 resulted in 46.00 and 43.33 seeds plant-1, respectively. However, the minimum seeds (39.00) plant-1 was observed in control, where no phosphorus was applied. In varieties, D.G-92 resulted in significantly highest number of seeds (47.66) plant-1, while the lowest number of seeds (43.44) plant-1 was noted in case of variety D.G-89. The interaction studies indicated that interaction of “variety D.G-92 × 55 kg ha-1 P” resulted in maximum seeds (51.66) plant-1; while the minimum number of seeds (37.33) plant-1 was observed in interaction of “variety D.G-89 × 0 P (control)”. It was observed that increasing phosphorus levels showed a positive impact on the number of seeds plant-1, while variety D.G-92 showed its superiority for this trait over D.G-89. The LSD test suggested that differences in seeds plant-1 between 55 kg and 45 kg ha-1 were non-significant (P>0.05) showing that increase in phosphorus beyond 45 kg would not be uneconomical.

Table 4. Seeds plant-1 of chickpea varieties as affected by different phosphorus levels

Treatments	Varieties		Mean P levels
	D.G-92	D.G-89	
36-00 kg NP ha^{-1}	40.66	37.33	39.00 d
36-15 kg NP ha^{-1}	45.66	41.00	43.33 c
36-25 kg NP ha^{-1}	48.33	43.66	46.00 bc
36-35 kg NP ha^{-1}	49.33	45.33	47.33ab
36-45 kg NP ha^{-1}	50.33	46.33	48.33 a
36-55 kg NP ha^{-1}	51.66	47.00	49.33 a
Mean Varieties	**47.66 a**	**43.44 b**	**-**

	P Levels (P)	Varieties (V)	Px V
S.E.	0.7956	0.4593	1.1252
LSD 0.05	1.6500	0.9526	2.3334

5. Pod length (cm): The data pertaining to pod length of chickpea varieties as affected by various phosphorus levels are presented in Table-5 and its analysis of variance as Appendix-V. The analysis of variance described that the pod length was significantly ($P<0.05$) influenced by different phosphorus levels and varieties, while their interaction showed non-significant ($P>0.05$) effect on this trait. It can be seen from the data (Table-5) that the pod length was maximum (1.38 cm) under highest phosphorus level of 55 kg ha-1, followed by average pod length of 1.37 cm and 1.36 cm noted in crop fertilized with phosphorus levels of 45 kg and 35 kg ha-1, respectively. The pod length in chickpea fertilized with lower phosphorus levels of 25 kg and 15 kg ha-1 was 1.30 cm and 1.22 cm, respectively. However, the lowest pod length of 1.05 cm was recorded in control, where no phosphorus was applied. In varieties, the maximum pod length (1.31 cm) was observed in variety D.G-92, while minimum pod length (1.25 cm) was noted in case of variety D.G-89. Hence, the interaction of “variety D.G-92 × 55 kg ha-1 P” resulted in maximum pod length (1.42 cm); while the minimum pod length (1.02 cm) was noted in interaction of “variety D.G-89 × 0 P (control)”. The results showed that increasing phosphorus levels caused increase in the pod length when applied at the rate upto 35 kg ha-1, further increase in phosphorus level did not improve the pod length significantly. It looks that genetically, the variety D.G-92 was relatively superior for this parameter over D.G-89. The LSD test indicated that differences in pod length between 55 kg, 45 kg and 35 kg ha-1 were statistically non-significant ($P>0.05$), and significant when compared with rest of the treatments and control.

Table 5. Pod length (cm) of chickpea varieties as affected by different phosphorus levels

Treatments	Varieties		Mean P levels
	D.G-92	D.G-89	
36-00 kg NP ha^{-1}	1.07	1.02	1.05 d
36-15 kg NP ha^{-1}	1.25	1.19	1.22 c
36-25 kg NP ha^{-1}	1.33	1.26	1.30 b
36-35 kg NP ha^{-1}	1.40	1.33	1.36 a
36-45 kg NP ha^{-1}	1.40	1.33	1.36 a
36-55 kg NP ha^{-1}	1.42	1.35	1.38 a
Mean Varieties	**1.31 a**	**1.25 b**	**-**

	P Levels (P)	Varieties (V)	P x V
S.E.	0.0179	0.0103	0.0253
LSD 0.05	0.0371	0.0214	

6. Seed index (g): The results in regards to seed index (1000 seeds weight)g of chickpea varieties as affected by various phosphorus levels are shown in Table-6 and its analysis of variance as Appendix-VI. The analysis of variance showed that the effect of various phosphorus levels and varieties on the seed index value was statistically significant ($P<0.05$), while non-significant ($P>0.05$) effect was noted on seed index due to interaction between phosphorus levels and varieties. The highest seed index value (415.80 g) was observed when the chickpea was fertilized with highest phosphorus level of 55 kg ha-1, followed by phosphorus levels of 45 kg and 35 kg ha-1 with average seed index value of 401.00 g and 387.14 g, respectively. The seed index value was declined to 378 g and 372.33 g when the phosphorus levels were decreased to 25 kg and 15 kg ha-1, respectively. However, the lowest seed index of 1.05 g was recorded in control, where no phosphorus was applied. In varieties, the maximum seed index (407.93 g) was noted in variety D.G-92, while minimum seed index (363.06 g) was observed in variety D.G-89. The interaction of “variety D.G-92 × 55 kg ha-1 P” resulted in maximum seed index (440 g); while the minimum seed index (337.71 g) was observed in interaction of "variety D.G-89 × 0 P (control)". It was observed that with increasing phosphorus levels, the seed index was also increased. The results also indicated that variety D.G-92 showed better seed index value over D.G-89. The LSD test indicated that differences in seed index between 35 kg and 25 kg ha-1 were statistically non-significant (P>0.05), and significant when compared with rest of the treatments or control.

Table 6. Seed index (g) of chickpea varieties as affected by different phosphorus levels

Treatments	Varieties		Mean P levels
	D.G-92	D.G-89	
36-00 kg NP ha^{-1}	379.58	337.83	358.71 e
36-15 kg NP ha^{-1}	394.00	350.66	372.33 d
36-25 kg NP ha^{-1}	400.00	356.00	378.00 c
36-35 kg NP ha^{-1}	409.67	364.60	387.14 c
36-45 kg NP ha^{-1}	424.33	377.66	401.00 b
36-55 kg NP ha^{-1}	440.00	391.60	415.80 a
Mean Varieties	**407.93 a**	**363.06 b**	**-**

	P Levels (P)	Varieties (V)	P x V
S.E.	2.8163	1.6260	3.9829
LSD 0.05	5.8407	3.3721	

7. Seed yield (kg ha-1): The data in relation to seed yield ha-1 of chickpea varieties as influenced by various phosphorus levels are presented in Table-7 and its analysis of variance as Appendix-VII. The analysis of variance suggested that the effect of various phosphorus levels, varieties as well as for their interaction on seed yield ha-1 was statistically significant (P<0.05). It is evident from the results (Table-7) that highest seed yield (1691.21 kg ha-1) was recorded when the chickpea was fertilized with highest phosphorus level of 55 kg ha-1, followed by phosphorus levels of 45 kg and 35 kg ha-1 with seed yield of 1593.30 kg and 1505.50 kg ha-1, respectively. The seed yield ha-1 was diminished to 1350.30 kg and 1256.70 kg ha-1 when the phosphorus levels were reduced to 25 kg and 15 kg ha-1, respectively. However, the lowest seed yield of 1104.17 kg ha-1 was recorded in control, where no phosphorus was applied. In varieties, the maximum seed yield (1564.15 kg ha-1) was produced by variety D.G-92, while lowest seed yield (1269.80 kg ha-1) was observed in variety D.G-89. The interaction of "variety D.G-92 × 55 kg ha-1 P" resulted in maximum seed yield (1851.20 kg ha-1); while the minimum seed yield (995.30 kg ha-1) was noted in the interaction of "variety D.G-89 × 0 P (control)". The seed yield ha-1 was gradually increased with increasing phosphorus levels, which suggested that the soil under experiment was deficient of this nutrient element and the crop responded its increased application positively.

Table 7. Seed yield (kg ha-1) of chickpea varieties as affected by different phosphorus levels

Treatments	Varieties		Mean P levels
	D.G-92	D.G-89	
36-00 kg NP ha^{-1}	1214.00	995.30	1104.17 f
36-15 kg NP ha^{-1}	1381.00	1132.30	1256.70 e
36-25 kg NP ha^{-1}	1493.70	1207.00	1350.30 d
36-35 kg NP ha^{-1}	1664.30	1346.70	1505.50 c
36-45 kg NP ha^{-1}	1780.70	1406.70	1593.30 b
36-55 kg NP ha^{-1}	1851.20	1531.22	1691.21 a
Mean Varieties	1564.15 a	1269.80 b	-

	P Levels (P)	Varieties (V)	P x V
S.E.	33.715	19.465	47.680
LSD 0.05	69.920	40.369	98.882

DISCUSSION

The soils, particularly of Sindh province have become severely deficient of N, P and K and in result the farmer get crop yields far below the potential yields. Moreover, the cropping pattern in the province is not balanced and only a marginal land is dedicated to pulses cultivation. The phosphorus is one of the essentially required nutrient elements that play role in plant growth and seed development. Hence, a field study was carried out to investigate the effect of different phosphorus levels on the growth and seed yield of chickpea. It was noted from the findings of the present research that growth and yield traits of chickpea were significantly (P<0.05) and positively influenced by increasing phosphorus levels. The phosphorus application at the rate of 55 kg ha-1 ranked first with 72.98 % germination, taking 75.50 days to flowering, 44.50 pods plant-1, 49.33 seeds plant-1, 1.38 cm pod length, 415.80 g seed index and 1691.21 kg ha-1 seed yield. Phosphorus level of 45 kg, 35 kg, 25 kg and 15 kg ha-1 categorically ranked 2nd, 3rd, 4th and 5th in almost all the studied traits. However, least performance was resulted by the crop receiving no phosphorus (control). These results are further supported by the findings of Frossard et. al., (2000) who reported that application phosphorus at higher levels resulted in increased crop growth, particularly positive impact was noted on branching, pods, seeds pod-1, seed index and increased seed yield. A pronounced effect of P application on chickpea yields has also been reported by Fairhurst and Witt (2002). The number of pods and seed index was improved under higher P applications (Kumar and Sreenivasulu, 2004). Gruhn et al. (2000) reported higher grain yield in gram due to P application. Kumar and Sreenivasulu (2004) reported that higher P levels alongwith recommended dose of N increased seed yield substantially. Similarly, Ramesh et al. (2010) obtained maximum net returns from chickpea crop when supplied with higher phosphorus levels alongwith recommended N application. In a similar study, Islam et al. (2011) recommended P application at the rate of 80 kg ha-1 for achieving higher chickpea yields. The study further showed that variety D.G-92 showed its superiority over D.G-89 with 72.43 % germination, took 71.30 days to flowering, resulting 42.88 pods plant-1, 47.66 seeds plant-1, 1.31 cm pod length, 407.93 g seed index and 1564.15 kg ha-1 seed yield. The development and use of high yielding, tolerant cultivars may offer as one of the suitable components of eco-friendly practice. Singh et al. (1998) and Keita et al. (2000) screened out a number of varieties of Cicer arietinum which were found high yielding and free from insect pest damage due to their echinate, spiny and tuberculate seed coat. The genotypes, ICC-4969 and ICC-4957 proved to be superior varieties in terms of yields and completely resistant to the test chickpea genotypes. Riaz et al. (2000) found that NCS-960003 and Bittle-98 chickpea genotypes are high yielding. Bashir et al. (2008) used different chickpea varieties and found that variety Chholla-1 showed better performance over rest of the varieties tested; while Erler et al. (2009) reported quite a different behaviour of chickpea varieties in response to different input application. In a similar investigation, Hossain (2009) examined a series of varieties and all varieties responded differently to P application. Nawale et al. (2009) assessed the yield performance of chick pea (cv. Digvijay) cropping sequence on vertisol during 2006-2007. The results indicated that significantly higher values were observed for growth and yield attributes with highest grain and straw yield (22.4 qha-1 and 24.2 qha-1) of succeeding chick pea cv. Digvijay in rabi season. Sarwar et al. (2009) evaluated the performance of 10 chickpea genotypes and reported that C-727 found to be a high yi3elding genotype as compared to CM-88 which is relatively poor in yield least productive.

Conclusion

After going through the findings of the present study, it was concluded that the growth and seed yield of chickpea varieties consecutively improved with increasing phosphorus levels; and highest phosphorus level of 55 kg ha-1 resulted in maximum seed yield ha-1; while chickpea variety DG-92 showed its superiority over D.G-89 for all the growth and yield traits. Hence, variety D.G-92 may preferably be cultivated and alongwith recommended N (36 kg ha-1), phosphorus may be applied at the rate of 55 kg ha-1 for maximizing the chickpea yields.

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