e-planet **15** (2): 91-95 (December 2017)

Response of chickpea (*Cicer arietinum* L.) to variable levels of phosphorus fertilization in Ghazni province, Afghanistan

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Date of receipt: 21.09.2017 Date of acceptance: 02.11.2017

ABSTRACT

Chickpea (*Cicer arietinum* L.) is one of the major legume crops grown in Afghanistan having considerable importance as food, feed and fodder, but due to imbalanced use of fertilizers, its productivity is low. To find the optimum level of phosphorus application for chickpea and study their effect on growth and characteristics a field experiment was conducted during spring 2017 at Agronomy Research Farm, Agriculture Faculty of Ghazni University, Ghazni, Afghanistan with cold and semi-arid climate. The experiment was laid out in randomised block design having four replications with five levels of P (0, 15, 30, 45 and 60 kg P_2O_5 ha^{-1}). Results revealed that application of increasing levels of phosphorus significantly increased growth parameters, yield attributes and yield. With successive increase in levels of phosphorus there was significant increase plan height, branch per plant, pod per plant, seed per plant, test weight, grain yield, straw yield, biological yield up to 60 kg P_2O_5. However, maximum plant height (66.1 cm), branch per plant (8.8), pod per plant (64.10), seed per pod (1.36), seed per plant (83.7), test weight (234.75), grain yield (2035.3 kg ha^{-1}), straw yield (4047.9 kg ha^{-1}), biological yield (6083.2 kg ha^{-1}) were recorded with 60 kg P_2O_5 ha^{-1}, which were significantly greater than control, 15 and 30 kg P_2O_5 ha^{-1},but these parameters were at par with 45 kg P_2O_5 ha^{-1}.

Key words: Chickpea, growth, phosphorus levels, yield

INTRODUCTION

Pulses occupy a unique position in every known systems of farming all over the world. Among the pulse crops. Chickpea is a major pulse crop grown in Afghanistan for food and also used as a feed for animals.It is predominantly grown as irrigated and rainfed in some parts of the country. Chickpea is mostly consumed in the form of processed whole seed (boiled, roasted, parched, fried, steamed, sprouted, etc.). Chickpea is a good source of protein (18-22%), carbohydrate (52-70%), fat (4-10%), minerals (calcium, phosphorus, iron) and vitamins (Choudhary, 2014). Chickpea is not only a source of dietary protein but it also helps in the maintenance of soil fertility due to its nitrogen fixing capability. The balanced nutrient application for crop production is essential and their imbalance use reduces crop yields. Phosphorus (P) is major nutrient element for grain legumes crops. In many soil types, P is the most limiting nutrient for the production of crops (Jiang et al., 2006). It plays primary role in many of the physiological processes such as the utilization of sugar and starch, photosynthesis, energy storage and transfer. Legumes generally have higher P requirement because the process of

symbiotic nitrogen (N) fixation consumes a lot of energy (Schulze et al., 2006). 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 N-fixing capacity of legumes, improvements in crop quality, and increased resistance to plant diseases (Cross and Schlesinger, 1995; Magid et al., 1996; Griffith, 2010). Despite its importance as a pulse and forage crop yield of chickpea is low in Afghanistan compare to the other countries of world. Fertilization of P is one of the important agronomic practices which greatly affects yield and profit of many crops including chickpea. It is, therefore, necessary to evaluate the need for judicious use of P fertilizer. The current research was conducted to find out best dose of phosphorus with different levels for obtaining higher agronomic characters and yield in Ghazni province situation.

MATERIALS AND METHODS

Experiment site

The present investigation was conducted at Research Farm of Agronomy Department, Agriculture Faculty of Ghazni University, during spring season of 2017. Geographically, the experimental field is located at longitude 68° 28' 52"East and latitude 33°31' 58" North at an elevation of 2204 m above mean sea level.

Climate and soil

The Ghazni province is located in the southeast region of Afghanistan. Climate of the region is transitional between cold semi-arid and warm-summer humid continental climate. It has cold, snowy winters and warm dry summers. Precipitation is low and mostly falls in winter (when it mostly falls as snow). The soil of experimental field was sandy clay loam in texture, low in organic matter and available phosphorus (1.0 mg kg^{-1}) having pH (8.5).

Experimental design and treatments

The experiment was laid out with five levels (0, 15, 30, 45 and 60 kg P_2O_5 ha^{-1}) of phosphorus as a basal application in randomize block design. With five treatments and each treatment was replicated four times. The recommended dose of nitrogen (120 kg h^{-1}) was applied through urea. The half dose of nitrogen was given as basal and remaining half dose of nitrogen was top dressed at 30 DAS. The local chickpea cultivar (*Waghaz nakhud*) was used in the experiment. Observations were recorded for different traits. In order to secure the effect of different treatments, the following observations such as plant height at (30, 60 DAS and harvest) and the number of branch per plant; number of pod per plant; number of grain per pod; number of grain per plant; 1000-grain weight (g); grain yield; straw yield and biological yield were recorded at harvest.

Table 1. Response of growth attributes of chickpea to variable levels of phosphorus fertilization in Ghazni province of Afghanistan

Phosphorus rates (kg P_2O_5 ha^{-1})	Plant height (cm)			Branch per plant
	30 DAS	60 DAS	at harvest	
Control	9.8	26.8	47.6	3.5
15	12.5	34.0	55.4	4.8
30	12.3	38.5	63.4	7.3
45	15.4	42.8	66.2	8.3
60	15.3	43.5	66.1	8.8
(SEm±)	0.9	2.4	2.5	0.4
CD (P=0.05)	2.6	7.0	7.4	1.2

RESULTS AND DISCUSSION

Growth parameters

Data pertaining to growth parameters of chickpea under different phosphorus (P) levels are presented in Table 1. Data showed that application of phosphorus influenced plant height significantly over control at every stage of crop growth. At 30, 60 DAS and at harvest the highest levels of phosphorus 60 kg P_2O_5 ha^{-1} recorded significantly greater plant height (66.1 cm) compared to 0 kg P_2O_5 ha^{-1} and 15 kg P_2O_5 ha^{-1}. These results agree with the findings of Kumar et al. (2017). The number of branches per plant was maximum (8.8) when phosphorus was applied @ 60 kg ha^{-1} which was significantly higher over the treatments *viz.* 0, 15 and 30 kg P_2O_5 ha^{-1} but was at par with 45 kg P_2O_5 ha^{-1} at the growth stage of 90 DAS. In general, control treatment produced significantly lowest number of branches per plant than nutrient applied (P) plots. These results are in conformity with the findings of Singh et al. (2010) and Pingoliya et al. (2014) who reported that maximum number of branches per plant (8.05) observed with the application of 60 P_2O_5 ha^{-1} but it was found at par with 40 kg P_2O_5 ha^{-1}. The reasons may be the effect of phosphorus on plant process as phosphorus is a major constituent of plant cell nucleus and growing root tips which helps in cell division and root elongation which results in vigorous growth of plants and extensive root system leading to increased growth parameter and number of branch per plant.

Yield parameters

Data in relation to yield and yield attributes of chickpea as influenced by different phosphorus levels are indicated in (Table 2). The number of pods per plant of chickpea improved positively due to application of different phosphorus levels. Use of phosphorus @ 60 kg P_2O_5 ha^{-1} resulted in production of maximum number of pods per plant (64.10) of chickpea. 60 kg P_2O_5 ha^{-1} remained statistically superior from control, 15 and 30 kg P_2O_5 ha^{-1} respectively, while it was on par with 45 kg P_2O_5 ha^{-1}. This increase in the number of pods per plant with the application P_2O_5 has resulted from more pronounced growth of the plant which in turn had increased the number of pods per plant. Khan et al. (2003) and Hussena et al. (2013) had noticed that application of phosphorus at higher levels resulted in increased pod per plant. The number of grain per pod did not differ significantly due to various rates of phosphorus application.

Table 2. Response of yields and yield attributes of chickpea to variable levels of phosphorus fertilization in Ghazni province of Afghanistan

Phosphorus rates (kg P_2O_5 ha^{-1})	Pod per plant	Seed per pod	Seed per plant	Test weight (g)	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Biological yield (kg ha^{-1})
Control	50.95	1.22	70.43	160.15	1665.2	3314.9	4980.1
15	56.38	1.27	73.00	178.08	1736.2	3568.4	5304.6
30	57.63	1.28	74.63	205.05	1831.1	3636.1	5467.3
45	62.58	1.33	83.18	230.10	1992.9	3854.1	5847.0
60	64.10	1.36	83.70	234.75	2035.3	4047.9	6083.2
(SEm±)	1.80	0.06	2.38	9.92	67.6	133.3	169.7
CD (P=0.05)	5.28	NS	7.00	29.13	198.6	391.3	498.3

These results are in line with the results of Muhammad (1998) who showed that the effects of phosphorus level on the number of seeds per pod were not significant. The number of grain per plant increased positively due to different phosphorus levels in chickpea. During the study of investigation, it was observed that the application of 60 kg P_2O_5 ha^{-1} produced the highest number of grain per plant (83.70) which was statistically on par with 45 kg P_2O_5 ha^{-1}. Treatment having 60 kg P_2O_5 ha^{-1} had significantly more number of grain per plant over control, 15 and 30 kg P_2O_5 ha^{-1}. These results are further supported by the findings of Frossard et al. (2000) and Badini et al. (2015), who reported that application phosphorus at higher levels resulted in increased crop growth, particularly positive impact was noted on branching, pods, seeds per pod and increased seed yield. Result of the present study clearly indicated that 1000-grain weight of chickpea considerably affected due to phosphorus application. Maximum thousand-grain weight of chickpea (234.75 g) was recorded from application of 60 kg P_2O_5 ha^{-1} and it was observed significantly more than control, 15 and 30 kg P_2O_5 ha^{-1}. But it was remained statistically at par with application of 45 kg P_2O_5 ha^{-1}. Also Khourgami and Farnia (2009) observed in Iran, that grain yield, number of seeds pod per plant and 1000 seed weight of chickpea were increased by phosphorus applications, similarly Basir et al. (2008) was also recorded significantly maximum 1000 grain weight for 60 kg P_2O_5 ha^{-1}. Grain yield of chickpea improved remarkably due to different phosphorus levels. Application of phosphorus @ 60 kg P_2O_5 ha^{-1} had resulted in the highest grain yield (2035.3 kg ha^{-1}) of chickpea. This treatment was significantly better over control, 15, and 30 kg P_2O_5 ha^{-1}, but was at par with 45 kg P_2O_5 ha^{-1}. The fertilization of increasing levels of phosphorus significantly increased the seed yield, due to the active biotic role of phosphorus in metabolic processes of plants and photosynthesis, tended to increase flowering, fruiting and grain formation which ultimately increased the yield attributes and subsequently the yield. Similar observations were also noted by Meena et al. (2010), Rathore et al. (2010) and Muhammad et al. (2012), who reported that there was significant increase in seed yield of chickpea with P application, seed yield increased as P rate increased from 0 to 80 kg P_2O_5 ha^{-1}. The highest level of phosphorus @ 60 kg P_2O_5 ha^{-1} produced highest straw yield (4047.9 kg ha^{-1}) of chickpea. This treatment was significantly superior over control, 15 and 30 kg P_2O_5 ha^{-1}, but it was statistically similar with 45 kg P_2O_5 ha^{-1}. This may be due to adequate supply of P_2O_5 that played a vital role in physiological and developmental processes in plant life and the favorable effect of these important nutrients might have accelerated the growth processes that in result increased straw yield of the crop. These finding are in conformity with the results of Basir et al. (2008) and Pingoliya et al. (2014), who stated that P_2O_5 increased dry matter production at various growth stages. The maximum biological yield (6083.2 kg ha^{-1}) of chickpea was noted from phosphorus application @ 60 kg P_2O_5 ha^{-1}, which was significantly more over control, 15 and 30 kg P_2O_5 ha^{-1}, but it was statistically similar with 45 kg P_2O_5 ha^{-1}. Similar results were also obtained by Ali et al. (2004) and Asif et al. (2007), who revealed that P_2O_5 increased the growth and yield parameters.

CONCLUSION

Chickpea is a legume crop mostly grown in irrigated and rainfed areas in some parts of Afghanistan. It is mostly consumed in the form of processed whole seed (boiled, roasted, parched, fried, steamed, sprouted, etc.). Phosphorus plays a key role in many of the physiological processes such as the utilization of sugar and starch, photosynthesis, energy storage and transfer. Legumes generally have higher P requirement because the process of symbiotic nitrogen (N) fixation consumes a lot of energy. After going through the finding of the present study, it was concluded that the growth and seed yield parameters of chickpea consecutively improved with increasing phosphorus levels; and highest P level of 60 kg ha^{-1} resulted in maximum seed yield ha^{-1}. Hence phosphorus may be applied at the rate of 60 kg ha^{-1} for maximizing the chickpea yields for the Ghazni province farmers.

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