TITLE:

Effect of Phosphorus and Boron levels on Growth and Yield of Chickpea (*Cicer arietinum* L.)

Article type: *Original Research Article*

Abstract

The field experiment was entitled **"Effect of phosphorus and boron levels on growth and yield of chickpea (*Cicer arietinum* L.)"** conducted during *Rabi* 2021. Department of Agronomy, SHUATS, Prayagraj (U.P). The soil of experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.1), low organic carbon (0.36%), available N (171.48 kg/ha), available P (15.2 kg/ha), available K (232.5 kg/ha). The treatments consisted of viz. Phosphorus 20 kg/ha, 40 kg/ha, 60 kg/ha and Boron 1 kg/ha, 2 kg/ha, 3 kg/ha. The experiment was laid out in Randomized Block Design, nine treatments replicated thrice. Results obtained that Plant height (53.11 cm), number of nodules (44.56), dry weight (30.36 g/plant), number of pods/plant (52.67), number of seeds/pod (1.80), seed yield (2109.93 kg/ha), straw yield (3428.07 kg/ha), Test weight (225.67 g), Harvest index (38.10%), were significantly influenced with treatment combination of Phosphorus 60 kg/ha + Boron 3 kg/ha. Maximum net return of 84,516.0 INR/ha and B:C ratio 2.01 was recorded in treatment combination of phosphorus 60 kg/ha + Boron 3 kg/ha. Therefore, treatment combination of phosphorus 60 kg/ha + Boron 3 kg/ha was most productive and cost effective.

Key words: - *Phosphorus, Boron, Growth, Nodulation, Yield*

INTRODUCTION

Chickpea (*Cicer arietinum* L.) is the largest produced food legume in South Asia and the third largest produced food legume globally, after common bean (*Phaseolus vulgaris* L.) and field pea (*Pisum sativum* L.). Chickpea is grown in More than 50 countries (89.7% area in Asia, 4.3% in Africa, 2.6% in Oceania,2.9% in Americas and 0.4% in Europe. (Gaur *et al.*, 2010) [5]. Chickpea (*Cicer arietinum* L.) belongs to the family Fabaceae, within the tribe Cicerae. It is a self-pollinated, diploid, annual grain legume crop. The global production of chickpea is nearly 13.1 million tonnes from the area of 13.5 M ha and productivity of 0.97 tonnes/ha (FAOSTAT, 2013) [4]. It is a major source of high - quality protein in human diet and also provides high quality crop residues for animal feed. Chickpea is classified into two types, desi and kabuli. Most of the desi types are small in size, angular in shape with dark seed colour and hard seed coat, while kabuli have large beaked seeds with white or beige seed coat colour and larger in size with smoother seed coat.Kabuli chickpea is primarily grown in the temperate climates, whereas the Desi chickpea is primarily grown in the semi-arid tropical climates. Chickpea also helps to maintain soil fertility through biological nitrogen fixation and contributes to the sustainability of cropping systems in the cereal-legume crop rotations. Chickpea crop meets 80% of its nitrogen (N) requirement from symbiotic nitrogen fixation and can fix up to 140 kg N ha from air. It leaves a substantial amount of residual nitrogen for subsequent crops and adds plenty of organic matter to maintain and improve soil health. Because of its deep tap root system, chickpeacan withstand extended periods of drought by extracting water from deeper layers of the soil (Gaur *et al.,* 2010) [5]. Sufficient supply of phosphorus to plant, hastens the maturity and increases the rate of nodulationand pod development. It is also an important constituent of vital substances like phospholipids and phosphoprotein. Since legume is heavy feeder of phosphors, therefore application of phosphatic fertilizer to chickpea promotes the growth, nodulation and the yield. Phosphorus also imparts hardline to shoot, improves the quality and regulates the photosynthesis and covers other physico-biochemical process. Most of the phosphors present in the soil is unavailable to plants which are made available through the activities of efficient micro-organisms like bacteria, fungi and even cyanobactin with production of organic acid and increasing phosphatase enzyme activity (Rajneesh Singh *et al.,* 2018) [11]. Boron is a micronutrient plays an important role in increasing yieldof pulse legumes. It is very important in cell division and in pod and seed formation. Boron ranksthird places among micronutrients in its concentration in seed and stem as well as its total amount after zinc. Boron significantly affected the seed yield of chickpea. The deficiency of boron has been very pronounced under multiple cropping systems due to excess removal by HYV of crops and hence its exogenous supply is urgently required. Boron deficiency limits chickpea productivity less than Zn deficiency. Boron deficiency causes flower drop and, consequently, poor podding inchickpeas and poor yields. Seed yield of chickpea increased with the application of boron @ 1.5- 2.5 kg ha. The application of boron resulted in a higher production of dry matter, due to an increaseof the dry weight of pods including seeds. (Alam *et al.,* 2017) [1]

MATERIALS AND METHODS:

The experiment was conducted during *Rabi* season of 2021-22. The experiment was conducted in Randomized Block Design consisting of nine treatment combinations with three replications and was laid out with the different treatments allocated randomly in each replication. The soil of experimental plot was sandy loam in texture, nearly neutral in soil reaction (pH 7.1), low organic carbon (0.36%), available N (171.48 kg/ha), available P (15.2 kg/ha), available K (232.5 kg/ha). The treatment viz. T1 - Phosphorus 20 kg/ha + Boron 1 kg/ha, T2 - Phosphorus 20 kg/ha + Boron 2 kg/ha, T3- Phosphorus 20 kg/ha + Boron 3 kg/ha, T4- Phosphorus 40 kg/ha + Boron 1 kg/ha, T5- Phosphorus 40 kg/ha + Boron 2 kg/ha, T6- Phosphorus 40 kg/ha + Boron 3 kg/ha, T7- Phosphorus 60 kg/ha + Boron 1 kg/ha, T8- Phosphorus 60 kg/ha+ Boron 2 kg/ha, T9-Phosphorus 60 kg/ha + Boron 3 kg/ha. The observations were recorded on different growth parameters at harvest viz. plant height (cm), number of nodulesper plant, plant dry weight, number of pods per plant, number of seeds per pod, test weight, seed yield and straw yield.

RESULTS AND DISCUSSION

A. Growth Parameters:

Crop growth parameters in chickpea were measured in terms of plant height (cm), plant dry weight at harvesting stage and number of nodules/plant at 60 DAS are shown in Table 1. During research trail, significantly higher plant heigh at harvest, maximum plant height (53.11 cm) was recorded in treatment T9 with application of Phosphorus 60 kg/ha + Boron 3 kg/ha which was significantly at par with treatment T8. Phosphorus application results in increase of plant height, this is possible because Phosphorus is the major constituent of ATP, and ATP are used in the Melvin - Calvin cycle to produce glucose molecule, hence phosphorus plays major role in photosynthesis, phosphorus enhances vigour and vitality of the plants. These results are consistent with that achieved from Dotaniya *et al.,* (2014) [3]. significantly higher number of nodules (44.56) were observed at 60 DAS in treatment T9 with application of Phosphorus 60 kg/ha + Boron 3 kg/ha which was significantly at par with treatment T8. Phosphorus is very much needed by the plants, but soil phosphorus gets fixed due to phosphorus fixation, it is made available to plants by phosphorus solubilizing bacteria, exogenous soil application of phosphorus produces growth promoting materials that helps in proliferation of PSB, PSB provide soil phosphorus to plants and also enhances nodulation in roots. These findings are in accordance with (Singh *et al.,*2014) [12] and (Gupta *et al.,* 2006) [7]. Significantly higher dry weight (30.36) was recorded in treatment T9 with applicationof Phosphorus 60 kg/ha + Boron 3 kg/ha which was significantly at par with treatment T8. Maximum dry matter is observed during application of higher doses of phosphorus as it shows significantly effect on equilibrium of nutrients in the soil and due to higher absorption of phosphorus by chickpea and minimum biomass production is observed under lower doses of phosphorus. Similar findings have also been reported by Jat *et al.,* (2004)[8]

B. Yield attributes

The observation regarding yield and yield attributes viz., number of pods/plants, seeds/pod, test weight, seed yield, straw yield and harvest index were shown in Table 2. Significantly higher number of pods/plant (52.67) was recorded in treatment T9 with application of Phosphorus 60 kg/ha + Boron 3 kg/ha which was significantly at par with treatment T8. Significantly higher number of seeds/pod (1.80) was recorded in treatment T9 with application of Phosphorus 60 kg/ha + Boron 3 kg/ha which were statistically at par with T8 and T6 treatments. Significantly higher test weight (225.67) was recorded in treatment T9 with application of Phosphorus 60 kg/ha + Boron 3 kg/ha which was statistically at par with treatment T8. Significantly higher seed yield (2109.93 kg/ha) was recorded in treatment T9 with application of Phosphorus 60 kg/ha + Boron 3 kg/ha which was statistically at par with treatment T8. Significantly higher straw yield (3428.07 kg/ha) was recorded in treatment T9 with application of Phosphorus 60 kg/ha + Boron 3 kg/ha which wassignificantly at par with treatment T8. Grain yield and straw yield that is biological yield of chickpea increases with increase in phosphorus, this increase is due to significant increase in vegetative characters such as plant height, no. of pods, seed weight etc availability of high doses of phosphorus results in higher photosynthetic activity as phosphorus is major constituent of ATP and ATP is utilized in dark reactions of photosynthesis, phosphorus increases production of carbohydrates, sugars, starch, amino acids and proteins, which enhances pod and seed yield these eventually play role in enhancing biological yield that is grain and straw yield. Similar kind of findings were also observed by Jarande *et al.,* (2006) [9] Nawange *et al.,* (2011) [10] Badini, S. A. *et al.,* (2015) [2]

Higher levels of boron resulted in greater uptake of nutrients by seed and stover, boron also enhances chlorophyll content in leaf and there by bio mass and phosynthates production is increased, which are effectively transferred towards the roots for its development and to provide required energy for nutrient uptake this uptake results in higher biological yields. These findings are in conformity to those reported by Guhey *et al.,* (2008) [6] and Yakubu *et al.,* (2010) [13]

Table 1. Effect of Growth parameters in Chickpea as influenced by Phosphorus and Boron level

Treatments	Plant height (cm) At harvest	Number of nodules per plant At 60 DAS	Plant dry weight (g) At harvest
Phosphorus 20 kg/ha + Boron 1 kg/ha	46.69	39.00	25.12
Phosphorus 20 kg/ha + Boron 2 kg/ha	47.93	39.22	25.38
Phosphorus 20 kg/ha + Boron 3 kg/ha	48.01	40.22	25.56
Phosphorus 40 kg/ha + Boron 1 kg/ha	48.49	41.11	25.74
Phosphorus 40 kg/ha + Boron 2 kg/ha	49.41	42.00	26.02
Phosphorus 40 kg/ha + Boron 3 kg/ha	50.83	42.56	28.56
Phosphorus 60 kg/ha + Boron 1 kg/ha	50.64	42.44	27.28
Phosphorus 60 kg/ha + Boron 2 kg/ha	52.04	43.22	29.63
Phosphorus 60 kg/ha + Boron 3 kg/ha	53.11	44.56	30.36
SEm (±)	0.73	0.60	0.54

CD (p=0.05)	2.19	1.81	1.61

Table 2. Effect of Yield attributes in Chickpea as influenced by Phosphorus and Boron levels.

Treatments	Number of pods per plant	Number of seeds per pod	Test weight (g)	Seed yield (kg/ha)	Straw yield (kg/ha)	Harvest index (%)
Phosphorus 20 kg/ha + Boron 1 kg/ha	47.93	1.27	186.00	1627.20	2992.00	35.20
Phosphorus 20 kg/ha + Boron 2 kg/ha	48.07	1.33	191.00	1709.07	3023.03	36.12
Phosphorus 20 kg/ha + Boron 3 kg/ha	48.67	1.47	196.33	1763.67	3096.70	36.29
Phosphorus 40 kg/ha + Boron 1 kg/ha	49.40	1.53	201.67	1819.30	3166.37	36.49
Phosphorus 40 kg/ha + Boron 2 kg/ha	49.67	1.53	207.33	1866.53	3209.10	36.77
Phosphorus 40 kg/ha + Boron 3 kg/ha	50.47	1.67	213.67	1981.27	3353.77	37.14
Phosphorus 60 kg/ha + Boron 1 kg/ha	50.67	1.60	212.00	1946.63	3303.67	37.08
Phosphorus 60 kg/ha + Boron 2 kg/ha	52.40	1.73	220.33	2044.10	3408.13	37.49
Phosphorus 60 kg/ha + Boron 3 kg/ha	52.67	1.80	225.67	2109.93	3428.07	38.10
SEm (±)	0.43	0.06	3.86	22.21	17.32	0.31
CD (5%)	1.28	0.19	11.56	66.59	51.93	0.94

CONCLUSION

From the above results, Effect of phosphorus and boron levels on chickpea were observed and there by it was concluded that application of Phosphorus 60 kg/ha + Boron 3 kg/ha had performed better in growth parameters and yield attributes. As it was more productive. These findings are based on one season; therefore, further trails need to be conducted for further confirmation.

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