MEDWIN PUBLISHERS
Committed to Create Value for Researchers

Open Access Journal of Agricultural Research
ISSN: 2474-8846

Effect of Phosphorus on Growth, Yield and Economics Attributes of Chickpea (*Cicer arietinum* L) the Semi–Arid Condition of Kandahar Afghanistan

Modasir MM[1], Ebrahimi N[1]*, Kakar NM[2]

[1]Department of Agronomy, Ghazni University, Afghanistan
[2]Department of Agronomy, Farah University, Afghanistan

***Corresponding author:** Najibullah Ebrahimi, Department of Agronomy, Ghazni University, Afghanistan, Tel: 796200336; Email: najebullahebrahimi@gmail.com

Research Article
Volume 9 Issue 3
Received Date: April 15, 2024
Published Date: July 29, 2024
DOI: 10.23880/oajar-16000363

Abstract

An experiment was conducted at the Agronomy farm, Afghanistan National Agricultural Science and Technology University, during the period from 2 March to 12 June 2020 to find the optimum level of phosphorus application for chickpea and study the effect of phosphorus on the growth, yield attributes and economics attributes of chickpea. The experiment was laid out in a Split Plot design having four replications with pour levels of P (0, 30, 45 and 60 kg P2O5 ha^{-1}).with three replications. All the nutrients were applied as basal on land preparation operation. Seeds were sown manually @ 30 kg ha^{-1} for flatbed as well as @ 45cm x 10 cm spacing for raised bed. Observations were recorded for various growth parameters and yield attributes at 30 DAS, 60 DAS and at harvest. Statistical analysis of data was done online through OPSTAT software. 60 kg phosphorus significantly enhanced growth parameters of chickpea viz., plant height (5.03cm, 8.96 cm and 26.03 cm at 30 DAS, 60 DAS and at harvest), dry matter plant-1 (4.25 g, 6.38 g and 16.15 g at 30 DAS, 60 DAS and at harvest. Yield attributes viz., number of pod plant-1 (21.21), number of grain pod-1 (1.66), and 1,000 grain weight (208.03 g) .Yield of chickpea viz., grain yield (1.48 t ha^{-1}), Stover yield (1.63 t ha^{-1}) biological yield (4.03 t ha^{-1}) and harvest index (28.03 t ha^{-1}) were recorded significantly higher with 60 kg phosphorus. Similarly, significantly higher economics attributes viz., Cost of cultivation (29081 AFN ha^{-1}), gross returns (123798AFN ha^{-1}), net returns (94716 AFN ha^{-1}), and benefit cost ratio (3.26) recorded with 60 kg P_2O_5.

Keywords: Agriculture; Agronomy; Chickpea

Abbreviations

SPD: Split Plot Design.

Introduction

Pulses occupy a unique position in every known systems of farming all over the world [1]. Among the pulse crops Chickpea (*Cicer arietinum* L.) is a major pulse crop grown in Afghanistan for food and also used as a feed for animals [2]. It is predominantly grown as irrigated and rain fed in some parts of the country [3].

Chickpea is mostly consumed in the form of processed whole seed (boiled, roasted, parched, fried, steamed, sprouted, etc.) [4,5]. Chickpea is a good source of protein (18-22%), carbohydrate (52-70%), fat (4-10%), minerals (calcium, phosphorus, iron) and vitamins [6]. 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. Despite its importance as a pulse and forage crop, yield of chickpea is low in Afghanistan compare to the other countries of world. 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. 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. 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 Kandahar Afghanistan condition [7].

Materials and Methods

Experimental Site

The present investigation entitled effect of phosphorus on the growth, yield and economics attributes of chickpea. "An experiment was conducted at the Agronomy farm, Afghanistan National Agricultural Science and Technology University, during the period from 2 March to 12 June 2020, Geographically, Kandahar is situated in southern part of Afghanistan, low-latitude semi-arid hot climate south of Afghanistan between latitude ranging from 310 30' north and longitude from 650 50' east's and is located on an elevation of about 1010 meters above mean sea level.

Climate and Soil

Kandahar has a subtropical steppe/low-latitude semi-arid hot climate. According to the Hold ridge life zones system of bioclimatic classification, Kandahar is situated in or near the warm temperate desert scrub biome. The annual mean temperature is 18.5 degrees Celsius. Average monthly temperatures in Kandahar is 26.8°C. Total annual average precipitation is 190.6 mm which is equivalent to 190.6 liters/ m^2. On an average there are 3464 sunshine hours per year. Average sunshine hours of the region ranged from 6:39 per day during February to 12:14 per day during August month. The mean relative humidity varies from 23% in June to 59% in February (http://www.kandahar.climatemps.com). During the crop growth period the maximum temperature was 32 °C in (7-13 of May) and the minimum temperature was 0°C from (1-7 of Jan). Moreover, the maximum relative humidity was 60.8% during 23-29 of January and the minimum relative humidity was 15.3% in (7-13 of May). The crop received total 49.8 mm of water from rainfall in five rainy days during crop growth period. The soil was having a texture of sandy clay loam. Organic matter of soil (0.69%) and PH (8.3).3-

Experimental Design and Treatments

The experiment was laid out with four levels (0, 30, 45 and 60 kg P2O5) of phosphorus as a basal application in Split Plot Design (SPD). There were 8 treatments and each treatment was replicated 3 times. The plot size was 16 m2 (4.00 m×4.00 m), total No. of plots (24) and Varity of Kabuli chickpea. The blocks and unit plots were separated by 0.75 m and 0.5 m. Nitrogen, phosphorus and potassium were uniformly applied @ 35, 60 and 30 kg ha^{-1} in all plots as basal with last land preparation operation in the form of Urea and potassium sulphate respectively.

Results and Discussion

Growth Parameter

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 26.03 (cm) . These results agree with the findings of Das SK, et al. Data showed that application of phosphorus influenced dry matter 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 dry matter (16.15) . These results agree with the findings of Das SK, et al.

Phosphorus Rates (kg P_2O_5 ha^{-1})	Plant Height			Dry Matter		
	30 DAS	60 DAS	at harvest	30 DAS	60 DAS	at harvest
Control	3.2	7.16	24.21	1.95	4.06	14.21
30	3.58	7.53	24.55	2.05	4.23	14.56
45	4.73	8.75	25.76	3.5	6	15.81
60	5.03	8.96	26.03	4.25	6.38	16.15
(SEm ±)	0.1	0.1	0.1	0.04	0.05	0.09
CD (P=0.05)	0.31	0.31	0.33	0.12	0.17	0.29

Table 1: Growth Attributes of Chickpea to Variable Levels of Phosphorus Fertilization in Kandahar Province of Afghanistan.

Yield Parameters

Data on the yield and yield attributes of chickpea, as influenced by phosphorus levels, are indicated in Table 2. The maximum number of pod per plant is (21.21) this was recorded with 60 kg P_2O_5 with the findings of Hemat, M et al. The number of grains per pod of chickpea improved positively due to levels of phosphorus. The highest grain weight per pod was recorded with 60 kg P_2O_5 ha^{-1} (1.66) and lowest was recorded with control (Table 2). Similar findings were supported by Hussen S, et al. Successive increase in levels of phosphorus caused significant improvement in 1000-grain weight of chickpea up to 45 kg P_2O_5 ha^{-1}. Maximum 1000-grain weight was (208.03gr) observed with 60 kg P_2O_5 ha^{-1} treated plot which was at par with 45, and 60 kg P_2O_5 ha^{-1}. All were markedly higher over 30 kg P_2O_5 and control. Significant variation in grain yield was recorded due to phosphorus level.

Table 2 with successive increase in phosphorus levels significant increase in grain yield was (1.48 t ha^{-1}) recorded up to 60 kg P_2O_5. Such a findings were also supported by Das SK, et al. Straw yield increased significantly due to phosphorus application (Table 2). Maximum straw yield was recorded with 60 kg P_2O_5 (1.63 t ha^{-1}) which was at par with 45 and 30 kg P_2O_5 but significantly higher over control.

These results are similar with the findings of Bicer BT, et al. Different levels of phosphorus application showed significant differences on biological yield of chickpea. Maximum biological yield was recorded with treatment 60 kg P_2O_5 (4.03t ha^{-1}). Treatment with 60 kg P_2O_5 was significant over control and 30 kg P_2O_5 but it was statistically similar with treatment 45 kg P_2O_5. Significant effect of successive increase in phosphorus levels on biological yield was up to 60 kg P_2O_5 only. These results are comparable with the findings of Hemat M, et al. Effect of phosphorus levels on harvest index of chickpea was significant. The highest harvest index was recorded with treatment of 60 kg P_2O_5 (28.03) and the lowest was recorded with control (26.20). Treatment with 60 kg P_2O_5 was significant over control but it was statistically at par with treatment of 30 and 45 kg P_2O_5 ha^{-1}. These results are supported with the findings of Hemat M, et al.

Phosphorus rates (kg P_2O_5 ha^{-1})	Pod plant-1	Grain pod-1	Test Weight (gr)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Biological yield (t ha^{-1})	Harvest index
0	18.95	0.73	206.2	0.7	0.85	2.2	26.2
30	19.1	1.2	206.58	1.08	1.11	2.58	26.58
45	20.5	1.5	207.73	1.3	1.4	3.73	27.73
60	21.21	1.66	208.03	1.48	1.63	4.03	28.03
SE m ±	0.03	0.04	0.1	0.03	0.03	0.1	0.1
CD(P=0.05)	0.11	0.13	0.31	0.11	0.09	0.1	0.1

Table 2: Yield Attributes of Chickpea to Variable Levels of Phosphorus Fertilization in Kandahar Province of Afghanistan.

Economics Attributes

Data pertaining to cost of cultivation, gross returns, net returns and benefit cost ratio have been presented in Table 3. Cost of cultivation (AFN ha^{-1}) was worked out treatment wise. The common cost of cultivation to all treatment was added to respective additional cost involved in each treatment. Cost of cultivation was varied with different phosphorus level applied to chickpea crop. Levels of phosphorus had significant effect on cost of cultivation (29081) up to 60 kg P_2O_5. Further increase in phosphorus levels failed to induce perceptible increase in economic parameters. Similar results already reported by Kumar, P et al., Chaudhary et al. Gross returns (AFN ha^{-1}) were calculated plot wise. For this purpose, grain yield was converted in to AFN ha^{-1} at prevailing market price of chickpea grain and straw.

The sum was used for statistical analysis. Gross returns enhanced remarkably due to phosphorus level of chickpea. The maximum gross returns (123798 AFN) of wheat were recorded with the 60 kg ha^{-1}. Similar results were also obtained by Singh V et al., Paul et al. who revealed that 60 kg ha^{-1} increased the Gross returns. Gross returns (AFN ha^{-1}) = Economic yield market price of produce for obtaining the net returns (AFN ha^{-1}), the cost of cultivation was reduced from the gross returns of each plot. Net returns followed almost the same trend of gross returns and positively influenced due to different phosphorus level. The highest net return (94716AFN) of chickpea was obtained from phosphorus level of 60 kg ha^{-1}.

Similar results were also obtained by Kumar P, 2017 et al. Net returns (AFN ha^{-1}) = Gross returns – cost of cultivation. For the calculation of benefit cost ratio, the gross return was divided with the cost of cultivation [15]. The value obtained was considered as benefit cost ratio [16]. Benefit: cost ratio improved markedly due to various phosphorus levels [17]. The highest benefit: cost ratio (3.26) of chickpea was recorded with the 60 kg ha^{-1} [18]. The finding are in conformity with Kumar P, et al. who stated that level of phosphorus increased benefit: cost ratio [19].

Phosphorus rates (kg ha^{-1})	Cost of cultivation (AFN ha^{-1})	Grass returns (AFN ha^{-1})	Net returns (AFN ha^{-1})	Benefit: Cost ratio
0	25169	84573	59404	2.36
30	26473	98325	71852	2.71
45	27777	105508	77731	2.8
60	29081	123798	94716	3.26
SE m ±	-	3536.71	3536.58	0.12
CD(P=0.05)	-	11018.38	11017.97	0.38

Table 3: Economics Attributes of Chickpea to Variable Levels of Phosphorus Fertilization in Kandahar Province of Afghanistan.

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 Kandahar province farmers.

References

1. Albanese MA, Mitchell S (1993) Problem-based learning: A review of literature on its outcomes and implementation issues. Academic Medicine-Philadelphia 68(1): 52-81.

2. Akibode CS (2011) Trends in the production, trade, and consumption of food-legume crops in sub-Saharan Africa. Electronic Theses & Dissertations pp: 1-76.

3. Basir A, Shah Z, Naeem M, Bakht J, Khan ZH (2008) Effect of phosphorus and farm yard manure on agronomic traits of chickpea (*Cicer arietinum* L.). Sarhad J Agric 24(4): 567-572.

4. Badini SA, Khan M, Baloch SU, Baloch SK, Baloch HN, et al. (2015) Effect of phosphorus levels on growth and yield of chickpea (*Cicer aretinum* L.) varieties. Journal of Natural Sciences Research 5(3): 169-176.

5. Dotaniya ML, Pingoliya KK, Lata, M, Verma R, Regar KL, et al. (2014) Role of phosphorus in chickpea (*Cicer arietinum* L.) production. African Journal of Agricultural Research 9(51): 3736-3743.

6. Choudhary AK (2014) Agronomy of Pulse and Oilseed Crops. Indian Agricultural Research Institute New Delhi Desai.

7. Prajapati BJ, Gudadhe N, Gamit VR, Chhaganiya HJ (2017) Effect of integrated phosphorus management on growth, yield attributes and yield of chickpea. Farming and Management 2(1): 36-40.

8. Das SK, Biswas B, Jana K (2016) Effect of farm yard manure, phosphorus and sulphur on yield parameters, yield, nodulation, nutrient uptake and quality of chickpea (*Cicer arietinum* L.). Journal of Applied and Natural Science 8(2): 545-549.

9. Hemat M, Ghafari SR, Mangal MQ, Derwish HLHO, Omari MA (2017) Response of chickpea (*Cicer arietinum* L.) to variable levels of phosphorus fertilization in Ghazni province, Afghanistan. E-planet 15(2): 91-95.

10. Hussen S, Yirga F, Tibebu F (2013) Effect of phosphorus fertilizer on yield and yield components of chickpea (Cicer arietinum) at Kelemeda, south Wollo, Ethiopia. Int J Soil Crop Sci 1(1): 1-4.

11. Bicer BT (2013) The effect of phosphorus doses on chickpea cultivars under rainfall conditions. Agronomic Research in Moldova 47(2): 158.

12. Kumar P, Prajapat OP, Parihar R (2017) Effect of different

levels of phosphorus, sulphur and cultivars on growth and economics of chickpea (*Cicer arietinum* L). Int J Farm Sci 7(2): 57-59.

13. Omran AH, Dass A, Rajanna GA, Dhar S, Choudhary AK, et al. (2020) Root-shoot characteristics, yield and economics of mungbean (Vigna radiata L.) under variable rates of phosphorus and nitrogen. Bangladesh Journal of Botany 49(1): 13-19.

14. Singh V, Thenua OVS, Shivay YS (2017) Effect of phosphorus nutrition on chickpea (*Cicer arietinum* L.) in sunflower-chickpea cropping system. Progress Res Int J 12(3): 2371-2378.

15. Pinney A, Ronchini S (2007) Food security in Afghanistan after 2001: from assessment to analysis and interpretation to response. Reconstructing agriculture in Afghanistan pp: 119-164.

16. Roy SK (1995) Effect of planting method on growth and seed yield of chickpea under rainfed conditions. In Proceedings Agronomy Society of NZ 25(59).

17. Shoman H (2017) Effect of phosphorus and sulphur on productivity of chickpea (*Cicer arietinum* L.) under New Valley conditions. Egyptian Journal of Desert Research 67(2): 305-318.

18. Tripathi LK, Thomas T, Kumar S (2013) Impact of nitrogen and phosphorus on growth and yield of chickpea (*Cicer arietinum* L.). Asian Journal of Soil Science 8(2): 260-263.

19. Islam M, Akmal M, Khan MA (2013) Effect of phosphorus and sulphur application on soil nutrient balance under chickpea (*Cicer arietinum*) monocropping. Romanian Agric Res (30): 1-10.