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Effects of Phosphorus Fertilizer Levels on Growth, Yield and Economic Efficiency of Groundnut Under Semi-Arid Regions of Afghanistan

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A B S T R A C T

A field experiment was laid out at the Afghanistan National Agricultural Science and Technology University (ANASTU) Farm in cropping season of 2020 to investigate optimization of phosphorus doses on growth, yield and economic efficiency of groundnut in semi-arid region of Afghanistan, the experiment laid out in Randomized Complete Block Design (RCBD) with three replication, the treatments consist of 5 phosphorus doses viz. absolute control, 20, 40, 60 and 80 kg p2o/ha, the result of the investigation revealed the highest plant height (34.42 cm), Branches/plant (10.88), leave area (2260 cm2), pods/plant (40.25), Kernel/pod (2.97), pod yield (3.39 t/ha), haulm yield (6.11 t/ha) and Biological yield (9.50 t/ha) were in phosphorus application at the rate of 60 kg p2o/ha. From the result it should be concluded by the applying optimum level of phosphorus fertilizer groundnut production will increase up to 3.39 t/ha, the farmers should apply phosphorus application at the rate of 60 kg p2o5/ha for enhancing groundnut productivity and profitability

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INTRODUCTION

Groundnut (Arachis hypogaea L.) is the most generally grown oilseed crop in the world, especially in the semi-arid regions and contributes to 12% of the world groundnut oil production (Khaleeq et al., 2024b). Production of groundnuts is evaluated at 47 million tonnes, 65.1% of this production comes from China and India (Faostat, 2017). The crop residues particularly the shell are often used as livestock feed or as fuel (Nazir et al., 2022; Hemmat et al., 2023). Like most of the legumes, it is used for soil fertility replenishment due to its potential as natural nitrogen fixation source and it can also be used as green manure to expand nitrogen balance in the cropping systems (Smaling et al., 2008; Farkhari et al ., 2023). Groundnut is the second important pulses crop in the world after soybean as it provides food for humans and livestock (Khleeq et al., 2023c). Groundnuts are simply marketed as a cash crop that increases farmer's income and in Afghanistan mostly grown as a sole crop in rotation with cereals to reduce infestation by the farm weed. Deficiency of phosphorus fertilizer is the most frequent fertilizer stress for growth and progress of grain legumes including groundnut (Kamara et al., 2008). In Afghanistan phosphorus fertilizer is major limiting nutrient for legume crops including groundnut and it is significantly responding to the phosphorus fertilizer doses (Khaleeq et al 2023e). Groundnuts offer an opportunity to develop the supply of Nitrogen fixation from symbiotic microorganisms with useful strains of Rhizobium. Nitrogen-fixation in groundnut is approximately 150-250 kg N/ha which offers strong remaining benefits of the other crops will be cultivated (Choudhary et al., 2015; Rathore et al., 2020; Khaleeq et al., 2024b). However, the yield and quality of groundnuts can be developed by precise nutrient management, groundnut productivity is very poor in Afghanistan due to non-availability of recommended dose fertilizer and poor nutrient management, especially phosphorus fertilizer (Nazir et al., 2022; Sadiq et al. al., 2023). Keeping in view the significance of phosphorus fertilizer levels to develop groundnut productivity, the present experiment was conducted to know the effect of Phosphorus fertilizer levels on growth, yield and yield components of groundnut (Samim et al., 2023; Khaleeq et al., 2024c)

THEORETICAL REVIEW

Groundnuts are growing on a large scale in Afghanistan and phosphorus is a main nutrient lacking in most soil of the country, in Afghanistan only few research on this crop and Phosphorus levels have been reported. So, the objective of the present investigation was to determine the response of groundnut to phosphorus doses on growth, yield, economic efficiency and biological yield in the semi-arid region of Afghanistan.

METHODOLOGY

A field experiment was conducted during the spring season of 2020 at the research farm of Afghanistan National Agricultural Sciences and Technology University to investigate the effect of phosphorus levels on growth, yield and yield components of groundnut. The experiment was laid out in a randomized complete block design (RCBD) with three replications. The treatments consist of 5 treatments viz. control, 20, 40, 60 and 80 kg P2O5/ha) with a basal dose of

nitrogen @ 40 kg/ ha. Single Super phosphate and urea fertilizer were used as source of phosphorus and nitrogen fertilizer respectively. All phosphorus levels applied according treatments just before sowing and half dose of nitrogen fertilizer were applied just before sowing remaining nitrogen fertilizer was applied 35 and 70 days after sowing. The soil of the experiment site was low in available nitrogen, low in available phosphorus and medium in available potassium. The kernel was sown in crop spacing 30 cm row to row and 10 cm plant to plant respectively, hand weeding were done at 35, 50 days after sowing. The data on plant height, branches/plant, number of pods/plant, number of seeds/pod, pod length, 100 pod weight, pod yield, haulm yield and biological yield were recorded and analyzed statistically using Fisher's analysis of variance technique.

RESULTS AND DISCUSSION

Phosphorus fertilizer doses were significantly affected on groundnut growth parameters revealed on table (1), the highest pant height (34.42), branches/plant (10.88) and Leave area (2260.19 cm2) were in phosphorus application of 60 kg P2O5 ha-1, followed by 80 kg P2O5 ha-1, 40 kg P2O5 ha-1 and 20 kg P2O5 ha-1 respectively, the minimum plant height, branches/plant and Leave area were in treatments absolute control plots. Our finding is similar with the result of Khaleeq et al., (2023b) who are reported phosphorus fertilizer application at rate of 60 kg p2o5/ha was revealed the highest pant highest, branches/plant, Leave area Index and dry matter accumulations. Khaleeq et al., (2024d) also reported application of 60 p2o5/ha had the maximum growth parameters of groundnut, the highest plant height, Leave area Index, branches/plant and dry matter accumulations were in 60 p2o5/ha.

Different levels of phosphorus application were significantly affected on yield components and yield of groundnut depicted on table (2) , the maximum pods/plant (40.25), Kernels/pod (2.97), pod yield (3.39 t/ha), Haulm yield (6.11t/ha) and Biological yield (9.50t/ha) were in treatment with application of 60 kg P2O5 ha-1, followed by 80 kg P2O5 ha-1, 40 kg P2O5 ha-1, 20 kg P2O5 ha-1 respectively and the minimum was in absolute control treatments, this improvement might be due to applied optimum level of phosphorus for enhancing groundnut productivity and profitability, while phosphorus fertilizer did not significant on shelling%, 100-seed weight (gr) and Pod Length (cm), this non-significant might be due to some environment effects such as temperature, irrigation and some available weeds. Our result support the finding of Khaleeq et al., (2023c) who also reported 60 kg p2o5/ha was significantly affected on yield parameters the highest groundnut yield components such as pods/plant, kernel/plant, pod yield, haulm yield, biological yield and harvest index were in application of 60 kg p2o5/ha. Similar result reported with the finding of Khaleeq et al., (2023a) who also reported application of phosphorus doses significantly increased yield of common bean, the highest seeds/pod, pods/plant, pod length and seed yield was in application of 60 p2o5/ha. Our result support by the finding of Samim et al., (2023) who was reported the maximum pods/plant,

seeds/pod, 100 seeds weight, seed yield and straw yield was in phosphorus application of 60 p2o5/ha followed by 80 p2o5/ha.

Application of phosphorus fertilizer doses were significantly affected on gross return, net return and net benefit cost of ratio on figure (1,2), the highest gross return (326062 AFN/ha), net return (288342 AFN/ha) and net benefit Cost of ratio (7.64) were in treatments 60 kg p2o5/ha, followed by 80 kg p2o5/ha, 40 p2o5/ha, 20 p2o5/ha respectively, the minimum gross return, net return and Benefits Cost of ratio were in absolute Control plots. Our finding is similar with the finding of Kahleeq et al., (2023d) also reported the maximum gross return, net return and Benefit Cost of ratio were with the treatment of 60 p2o5/ha. Nazir et al., (2022); Seerat et al., (2023); Khaleeq et al., (2024a) also reported with the application of 60 p2o5/ha were the maximum gross return, net return and net benefit of cost of ratio.

Table 1. Effect of Phosphorus Levels on Plant Height, Branches/Plant and Leave Area Index

Treatments	Plant Height (cm)	Branches/plant	Leave Area (cm^2)
Absolute control	28.90c	6.74c	1489.24c
20 kg P_2O_5 ha^{-1}	29.58c	8.33b	1564.94c
40 kg P_2O_5 ha^{-1}	31.16b	8.81b	1735.72bc
60 kg P_2O_5 ha^{-1}	34.42a	10.88a	2260.19a
80 kg P_2O_5 ha^{-1}	31.47b	10.18a	1957.20ab
SEm±	0.483	0.147	37207.952
CD (P=0.05)	1.309	0.723	363.188

Table 2. Effect of Phosphorus Levels on Yield Components and Yield of Groundnut

Treatments	Pods / plant	Kernel/pod	shelling%	100-seed weight (gr)	Pod Length (cm)	Pod yield (t/ha)	Haulm yield (t/ha)	Biological yield (t/ha)
Absolute control	28.15 b	1.65c	65.30	66.02	2.72	2.46c	3.76c	6.22d
20 kg P_2O_5 ha^{-1}	27.98 b	1.75bc	65.59	66.28	2.82	2.74bc	4.33c	7.08cd
40 kg P_2O_5 ha^{-1}	29.12 b	1.84bc	67.63	68.77	3.12	3.01b	4.80bc	7.81bc
60 kg P_2O_5 ha^{-1}	40.25 a	2.97a	68.15	72.53	3.59	3.39a	6.11a	9.50a

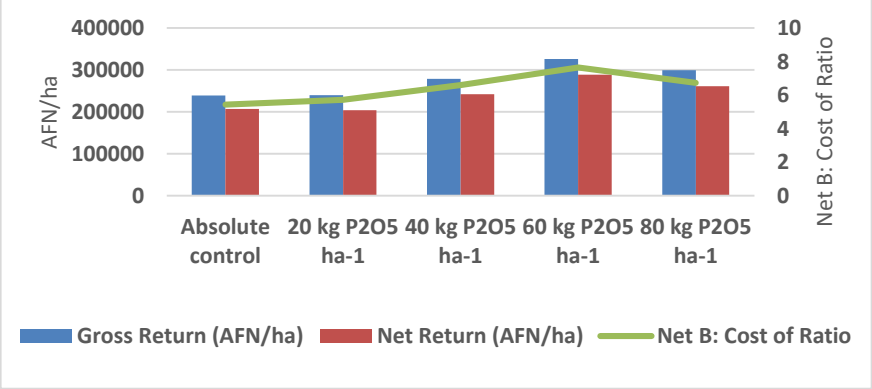

Figure 1. Effect of Phosphorus Levels on Gross Return, Net Return and Benefit Cost of Ratio

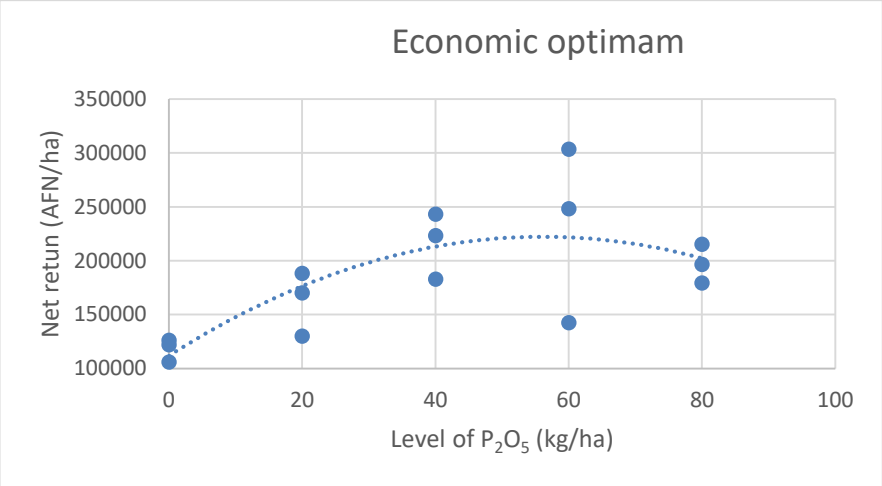

Figure 2. Effect of Phosphorus Levels on Economic Optimum

CONCLUSIONS AND RECOMMENDATIONS

From the result and discussions it can be concluded application of phosphorus fertilizer at the rate of 60 kg p2o5/ha enhance growth, yield and economic efficiency of groundnut under semi-arid region of Afghanistan, therefore farmers are recommended to apply 60 kg p2o5/ha for better groundnut productivity and profitability.

FURTHER STUDY

This research still has limitations so further research needs to be carried out related to the topic of the Effect of Phosphorus Fertilizer Levels on the Growth, Yield and Economic Efficiency of Peanuts in Semi-Arid Regions in order to perfect this research and increase insight for readers.

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