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Effects of Phosphorus Fertilization on Growth, Yield and Economic Efficiency of Cotton (*Gossypium hirustum L.)* under Northeast climate of Afghanistan

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Authors' contributions

This work was carried out in collaboration between both authors. both authors read and approved the final manuscript.

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ABSTRACT

A Cotton experiment was laid out at the agronomic research farm of agriculture faculty of Kunduz University in spring season of 2023 to investigate effects of phosphorus fertilization of growth and yield parameters of cotton crop (*Gossypium hirustum* L.) under Northeast climate of Afghanistan. The experiment conducted in Randomized complete block design with 3 replications. The treatment consists: control without phosphorus fertilizer application, application of 30, 60 and 90 kg P_2O_5/ha. Result showed that the highest plant height (98.44 cm), Leave area index (2.78), Sympodial Branches/plant (12.88), Bolls/plant (27.66), cotton lint yield (1750 kg/ha), cotton seed yield (3979 kg/ha), cotton lint yield (182742 AFN/ha), cotton seed yield (77964 AFN/ha), gross return (260707 AFN/ha), net return (209867 AFN/ha) and benefit Cost of ratio (6) were recorded from treatment with 90 kg p_2o_5/ha following with application 60, 30 and Control treatments respectively. It can be possible to conclude that proper phosphorus fertilization is crucial for optimizing cotton production in

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this region. The study highlights the potential for improved cotton cultivation practices and increased economic returns for farmers in the Kunduz province of Afghanistan through the implementation of optimal P fertilizer application rates.

Keywords: Cotton; economic efficiency; growth; phosphorus; yield.

1. INTRODUCTION

In Afghanistan Cotton crop (*Gossypium hirsutum* L) is cash and important crops in tropical, warm and temperate regions of the world including Afghanistan. It is the best for foreign exchange and the most important commercial fiber crops in Afghanistan [1]. Cotton crop is (*Gossypium* spp.) growing nearly 77 countries with covering more than 32 million ha worldwide, in different environment conditions in worldwide, world cotton crop commerce is nearly USD$20 billion annually [2,3]. Cotton crop growth parameters and yield are affected by phosphorus fertilizer, fertility levels and environment conditions [4,5]. Phosphorus is an important fertilizer for plant nutrition needed for all growth processes during plant progress, imitation, and ecological variation [6]. Phosphorus fertilizer is a significant nutrient for growth and yield of plant cells, as well as the sugar phosphate of respirations and photosynthesize and that make up plant tissues [7]. Rate of leaf development and photo syntheses per unit leaf area index reduce due to phosphorus deficiency [8,9]. P fertilizer is movable in the plant. Leaves and emerging bolls can be nurtured from the Phosphorus which is existing in older soft tissue of the plant. In cotton crop the critical Phosphorus application ranges from 0.20 to 0.31% [10]. Phosphorus absence is one of the most important factor restrictive crop efficiency. It is stated that 40% of production of crop in the world is arable lands is limited by Phosphorus fertilizer accessibility and sub optimum level of Phosphorus can effect in 5 to 15% yield victims [11,12]. Objective of the research were to assess the impact of level of phosphorus fertilization on the growth and yield parameters, economic efficiency in cotton production in the northeast climate of Afghanistan.

2. MATERIALS AND METHODS

An experiment trial was laid out at the farm of Kunduz University located in northeast of Afghanistan during cropping season of 2023 to evaluate effects of phosphorus fertilizer on growths and yield parameters of cotton, The experiment site location is at 367388884, N latitude and 68.869858 E longitudes, an elevation of 356 meter from the sea level. Temperatures during the cropping period was between 17.50oC to 47.3oC, the experiment was in randomized complete block design (RCBD) with three replications, The experiment consist of 4 treatments, viz. Absolute control, 30, 60 and 90 kg P_2O_5/ha. Cotton variety (K-01) was obtained from Kunduz Spinzar Owned Corporation. The net plot size was 3×5 (15 m^2), row and plant to plant spacing were 75 and 25 cm, respectively. The experiment site was ploughed two time with tractor drawn disc plough and harrowing was done by rotivator to achieve optimum soil. Seeds were drilled at the depth of 4 cm. Uniform all agronomic practices, irrigation, hoeing and weeding were carried out while needed, all phosphorus fertilizer according treatments applied basal at sowing time while nitrogen fertilizer applied 100 kg N/ha at sowing time, 30 and 60 days after sowing respectively, experiment site was sandy loam, free from salinity, low in phosphorus and nitrogen and medium in potassium content. The organic matter content of the soil was low and textural class varying between sandy loams to loamy sand. The soils had lower Cation-exchange capacity due to coarse texture and low in organic carbon content, All Growth parameters were taken by taking the average of five tagged plants, yield attributes and yields were taken from net plot and recorded using standard procedure. One way ANOVA was used to define treatments effect. Standard errors of mean and LSD (P=0.05) level of significant worked out for each parameter.

3. RESULTS AND DISCUSSION

Phosphorus fertilizer was significantly affected on plant height, Leave Area Index, no. of Sympodial Branches/plant and no. of Bolls/plant revealed on (Table 1). Highest plant height (98.44 cm), Leave Area Index (2.78), no. of Sympodial Branches/plant (12.88) and no. Bolls/plant (27.66) were recorded from application of 90 P_2O_5/ha following with the application of 60 P_2O_5/ha. The lowest growth parameters were from the Control plot. Our result is similar with finding of Saleem et al. [13] and Khaleeq et al.,

[14] detected that Phosphorus fertilizer applications improved plant height, no. of Sympodial branches/plant and no. of monopodial branches/plant compared to control. (*Copur, 2006*). Number of monopodial branches/plant reduced while no. of sympodial branches/plant improved with the increasing phosphorus levels. Khaleeq et al., [1] reported significant differences among the phosphorus levels for the no. of bolls/plant while increase in no. of bolls/plant with increasing phosphorus levels is also well documented. Boll weight is an important yield defining factors that varies among varieties *Hofs et al., 2006* and Nazir et al., [15] and with P levels (*Sawan et al., 2008*) stated that optimistic relationship exists between seed cotton weight per boll and seed cotton yield per plant, the same was definite in present studies [16,17].

Phosphorus fertilizer doses significantly affected on lint cotton yield and seed cotton yield revealed on Fig. (1, 2), the highest cotton lint yield (1750 kg/ha), cotton seed yield (3979 kg/ha), cotton lint yield (182742 AFN/ha), cotton seed yield (77964 AFN/ha) were in application of 90, following with treatment phosphorus application of 60, 30 p_2o_5/ha and absolute Control treatments. Economic analysis revealed on Fig. (3) phosphorus fertilizer was significantly affected on gross return, net return and benefit Cost of ratio, the highest gross income (260707 AFN/ha), net income (209867 AFN/ha) and B: Cost ratio (6) were in 90 kg P_2O_5/ha followed by phosphorus application of 60 P_2O_5/ha, 30 p_2o_5/ha and absolute Control treatments respectively. Our result support the finding of Khaleeq et al., [1] who reported the highest Cotton Lint yield (1,627.50 kg/ha), Cotton Seed yield (3,110.38 kg/ha), Cotton Lint Yield (174,370AFN/ha), Cotton Seed yield (142,144 AFN/ha). Our finding similar with Khaleeq et al., [1] gross return (316,515 AFN/ha), net return (297,790 AFN/ha) and benefits Cost ratio (7.67) were in 90 kg P_2O_5 kg ha^{-1} following wth phosphorus application of 60 kg P_2O_5 kg ha^{-1}, 30 kg P_2O_5 kg ha^{-1} and control respectively. Saleem et al., [13] Farkhari et al. [18] also reported application of phosphorus fertilizer at optimum level (90 kg ha^{-1}) was best for improvement of cotton seed yield, cotton lint yield and maturation than other phosphorus rates.

Table 1. Effect of phosphorus fertilizer on plant height, Leaves Area Index, Leaves/plant, Sympodial Branch/plant and no. Boll/plant

Treatments	Plant Height (cm)	Leave Area Index	Leaves/plant	Sympodial Branches/plant	Bolls /plant
Absolute Control	83.22^{c}	1.70^{c}	46.03	9.77^{c}	17.89^{c}
30 P_2O_5/ha	86.15^{bc}	2.15^{bc}	53.99	10.59^{c}	22.00^{b}
60 p_2o_5/ha	91.36^{ab}	2.49^{ab}	57.92	11.81^{b}	21.55^{bc}
90 P_2O_5/ha	98.44^{a}	2.78^{a}	46.07	12.88^{a}	27.66^{a}
SEm±	15.786	0.093	63.914	0.228	4.007
CD (P=0.05)	7.938	0.608	NS	0.955	3.999

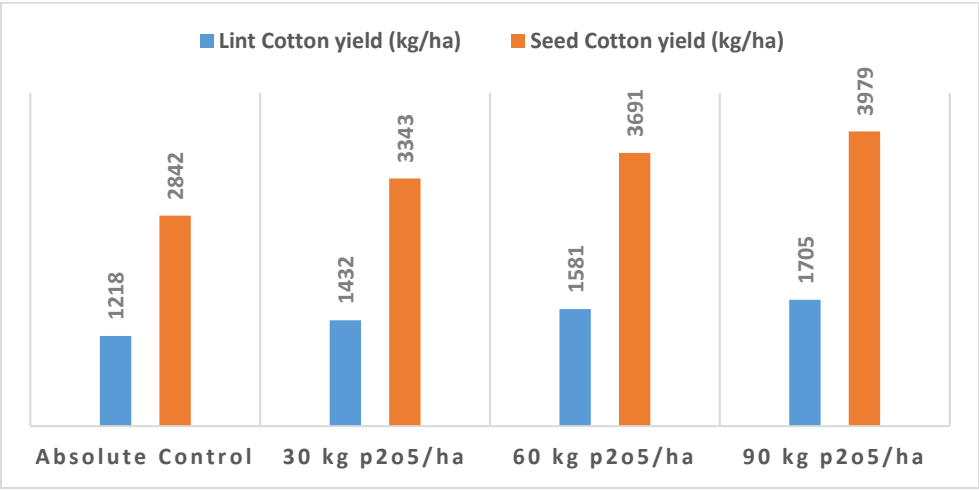

Fig. 1. Effect of phosphorus on cotton lint yield (kg/ha) and cotton seed yield (kg/ha)

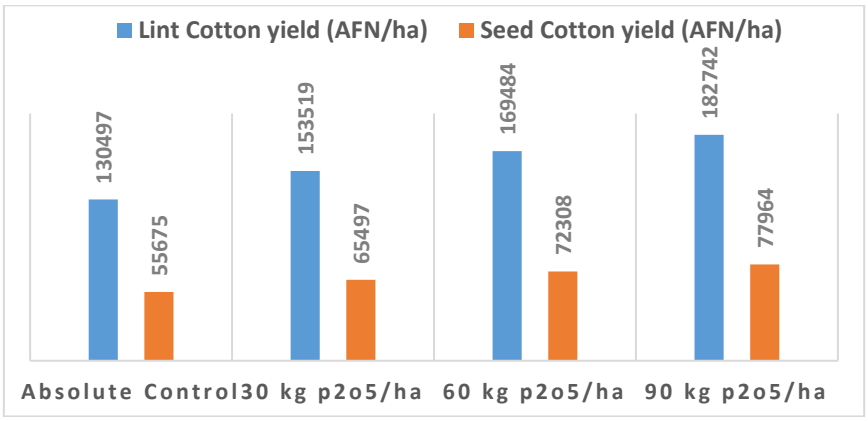

Fig. 2. Effect of phosphorus on cotton lint yield (AFN/ha) and cotton seed yield AFN/ha)

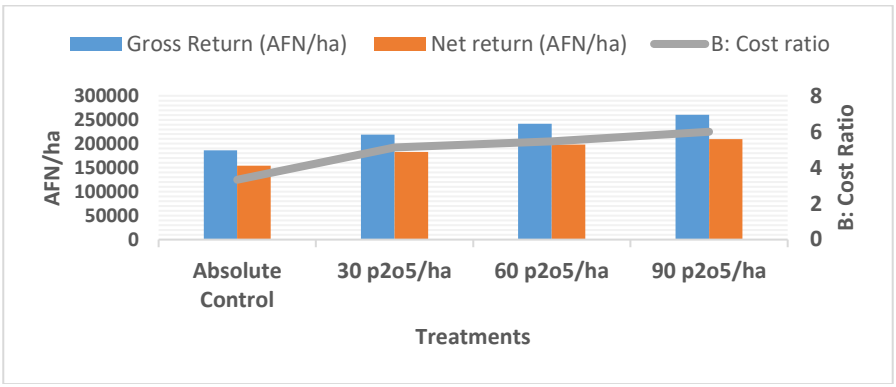

Fig. 3. Effect of phosphorus fertilizer on gross return, net return and B: Cost of Ratio

4. CONCLUSION

The study demonstrates that phosphorus fertilization has significantly effects on cotton growth, yield parameters and economics of cotton in the Northeast climate of Afghanistan. The application of 90 kg P_2O_5/ha resulted in the highest level of growth, yield and economic efficiency. This finding suggests that proper phosphorus fertilization is crucial for optimizing cotton production in this region. Further research and practical implementation of this optimal phosphorus application rate could lead to improved cotton cultivation practices and increased economic returns for farmers in the Northeast climate of Afghanistan.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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