

Optimization of Phosphorus Application Rate on Maize Under Agro-ecological Condition of Urozgan

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ABSTRACT

Phosphorus plays a vital role in crop growth and productivity, thus a field experiment entitled (optimization of phosphorus application rate on maize under agro-ecological condition of Urozgan) was conducted at Urozgan Higher Education Institute research farm, during spring season of 2023 to evaluate the effects of various doses of phosphorus on maize growth and yield. Treatments were consisted of four levels of phosphorus 20, 40, 60, 80 Kg P₂O₅ ha⁻¹ and control, the experiment was laid out in randomized complete block design and replicated thrice, the data was analyzed by IBM SPSS 24. Phosphorus application significantly influenced maize growth, yield and yield attributes compared to control, while the phosphorus doses increased from 20 to 80 kg P₂O₅ ha⁻¹, crop growth, yield, and yield attribute were continuously increased. It can be concluded from the result of experiment that application of phosphorus under agro-ecological condition of Urozgan can increase crop growth, yield and yield attributes.

Keywords- Phosphorus, Maize, Yield, Yield Attributes.

I. INTRODUCTION

Genetically maize (*Zea mays* L.) has the highest yield potential among cereal crops, so it refers as queen of cereals. It is the third most important crop of the world and has higher nutritive value, it contains 72% starch, 10% protein, 4.8% fiber, 3% sugar and 1% ash. cultivated in 160 countries over 150 million ha land and contribute 36% of grain production in the world (Nsanjabaganwa et al., 2014; Rashid & Iqbal., 2012). In Afghanistan maize grown for both purposes as grain and fodder, the grain is not only consumed by human being but also provide feed for livestock and poultry. In the country its growing over 92,144 ha of land, which produced 180,000 tons of grain. On average, production is 1.95 t ha⁻¹ which is several folds less than from developed countries viz, Israel, USA, Italy and Brazil which produced 22.5, 10.8, 8.3, and 5.5 t ha⁻¹, respectively (FAOSTAT., 2021).

The lower yield of maize might be due to selection of improper varieties, inadequate agricultural practices and imbalance application of mineral fertilizer. Adequate and balanced supply of essential mineral fertilizer to crop plants is most important way to exploit genetic potential of crop plants. Phosphorus (P) is one of the essential elements for proper crop growth and yield, it plays a crucial physiological and bio-chemical role in plants. Most of Afghanistan soil suffer from phosphorus deficiency (FAO., 2019; Nazir et al., 2022), thus application of phosphatic fertilizer is necessary to obtain proper crop growth and yield, but so far, the research was not conducted yet to find out the most suitable rate of phosphorus application in maize field in the agro-ecological condition of Urozgan, so, the present investigation was conducted to study the effects of various doses of phosphorus on maize yield attributes and yield.

II. METHODS AND MATERIALS

The field experiment entitled (optimization of phosphorus application rate in maize field) was conducted at Urozgan higher education institute, research farm, in spring season of 2023. The experiment site was located between 32° 37' -14" N latitude and 65° 52' – 10" E longitude 1356 m above sea level. The mean maximum and minimum temperature during growing period were 37.7, and 16.7 °C, respectively. The wind speed during the growing period ranged between 7 to 9.1 km per hour. Moreover, the maximum and minimum relative humidity was recorded at 44 and 21%, respectively. The rainfall was not received during the growing season. the treatments consisted of four levels of phosphorus 20, 40, 60, 80 kg P₂O₅ ha⁻¹ and control, the experiment was laid out in randomized complete block design with three replications. Zoodras variety of maize was selected and grown in all experimental plots. Di ammonium phosphate was used as source of phosphorus fertilizer; nitrogen was leveled through urea application. Yield attributes, grain and straw yield were recorded from each plot and the final yield was expressed as kg ha⁻¹. The final data was analyzed by IBM SPSS 24.

III. RESULTS

Growth parameters

The finding of present studies showed that phosphorus application significantly influenced crop growth parameters (Table 1). Among the phosphorus levels, application of 80 kg P₂O₅ ha⁻¹ recorded significant effects on plant height (42.4) cm, plant fresh weight (127.2) gr plant⁻¹, plant dry weight (42.4) gr plant⁻¹ at 45 DAS compared to rest of the treatments

Yield attributes

The findings expressed that phosphorus fertilization significantly influenced yield attributes (Table 2). Application of 80 kg P₂O₅ ha⁻¹ significantly increased grain cob⁻¹ (204.2) and grain weight cobe⁻¹ (52.3 g) with increasing phosphorus doses the yield attributes found to be increased. Even though application of various rate of phosphorus doesn't have significant effects on cobs plant⁻¹ and 100-grain weight, but higher cobs plant⁻¹ and 100-grain weight were recorded with application of 80 kg P₂O₅ ha⁻¹.

Yield performance

The result of present investigation prove that phosphorus fertilization had significant effects on yield performance of maize (Table 3), with increasing phosphorus doses the yield performance of maize was continuously increased. Application of higher dose of phosphorus (80 kg P₂O₅ ha⁻¹) recorded significantly higher grain yield, straw yield, biological yield and harvest index.

IV. DISCUSSION

Phosphorus is one of the primary essential elements required for proper crop growth and development, it is the part of ATP and play an important role in cell division and elongation, phosphorus also improve root growth and development which enable crop to extract mineral nutrients and moisture efficiently, thus increases crop growth, similar finding obtained in present investigation, application of phosphorus significantly increased plant height, fresh weight and dry weight, similar trend of result was reported by (Seerat et al., 2023; Khaleeq et al., 2023b; Ayub et al., 2002; Fazil et al., 2023) . Yield attributes largely depends on proper crop growth, phosphorus play an efficient role in crop growth and development, it increases root development which wider crop root zone and efficiently extract mineral nutrients and moisture from soil, maximize photosynthetic activity, respiration, energy storage, cell division and elongation which come out in enhancement of yield attribute. Likewise, in present investigation Phosphorus fertilization significantly influenced maize yield attributes. The finding of the study closely related to those reported by (Obaid et al., 2018; Nazir et al., 2022; Nsanabaganwa et al., 2014; Schroetter et al., 2006). Grain yield was significantly increased with phosphorus fertilization which might be due to Number of cob plant⁻¹, number of grain cob⁻¹, grain weight cob⁻¹ and 100-grain weight as well as the source-sink relationship and the rate at which translocation takes place from source to sink during the reproductive stage. The result is in similar pattern with those reported by (Rashid & Iqbal., 2012; Khan et al., 2005; Patil et al., 2012). Application of phosphorus fertilizer significantly increased straw and biological yield which may be due to root development, efficient uptake of nutrients and moisture, maximization of light interception and photosynthetic activity. The similar trend of result was reported by (Khaleeq et al., 2023; Onasanya et al., 2009; Nsanabaganwa et al., 2014; Nazir et al., 2022; Ayub et al., 2002).

Table 1. phosphorus application effects on maize plant height, dry and fresh weight

| Treatments | Plant height | Plant fresh weight | Plant dry weight |
|---|--------------|--------------------|------------------|
| | 45 DAS | 45 DAS | 45 DAS |
| 0 Kg P ₂ O ₅ P ha ⁻¹ | 38.50 | 115.50 | 38.50 |
| 20 Kg P ₂ O ₅ ha ⁻¹ | 39.56 | 118.70 | 39.56 |
| 40 Kg P ₂ O ₅ ha ⁻¹ | 40.96 | 122.90 | 40.96 |

| | | | |
|--|-------|-------|-------|
| 60 Kg P ₂ O ₅ ha ⁻¹ | 41.33 | 124.0 | 41.33 |
| 80 Kg P ₂ O ₅ ha ⁻¹ | 42.40 | 127.2 | 42.40 |
| SEm± | 0.29 | 0.89 | 0.29 |
| CD (P=0.05) | 0.95 | 2.85 | 0.95 |

Table 2. Effect of various rates of phosphorus application on Cobs plant⁻¹, Grain cob⁻¹, Grain weight cob⁻¹ and 100-grain weight

| Treatments | Yield Attributes | | | |
|--|--------------------------|--------------------------|---------------------------------|-----------------------|
| | Cobs plant ⁻¹ | Grains Cob ⁻¹ | Grains weight Cob ⁻¹ | 100-Grains weight (g) |
| 0 K P ₂ O ₅ P ha ⁻¹ | 1.06 | 146.33 | 39.33 | 25.95 |
| 20 Kg P ₂ O ₅ ha ⁻¹ | 1.16 | 163.33 | 43.33 | 26.24 |
| 40 Kg P ₂ O ₅ ha ⁻¹ | 1.33 | 174.72 | 45.07 | 29.52 |
| 60 Kg P ₂ O ₅ ha ⁻¹ | 1.42 | 185.16 | 48.89 | 30.19 |
| 80 Kg P ₂ O ₅ ha ⁻¹ | 1.48 | 204.22 | 52.29 | 29.60 |
| SEm± | 0.10 | 3.75 | 1.65 | 2.24 |
| CD (P=0.05) | NS* | 11.974 | 5.286 | NS* |

Table 3. Effects of phosphorus application on grain yield, straw yield, biological yield and harvest index

| Treatment | Yield Kg ha ⁻¹ | | | |
|--|---------------------------|-------------|------------------|---------------|
| | Grain Yield | Straw Yield | Biological Yield | Harvest Index |
| 0 Kg P ₂ O ₅ ha ⁻¹ | 5,270 | 12,121 | 17,391 | 28.333 |
| 20 Kg P ₂ O ₅ ha ⁻¹ | 5,560 | 12,788 | 18,348 | 29.333 |
| 40 Kg P ₂ O ₅ ha ⁻¹ | 5,830 | 13,409 | 19,239 | 30.369 |
| 60 Kg P ₂ O ₅ ha ⁻¹ | 6,100 | 14,030 | 20,130 | 30.768 |
| 80 Kg P ₂ O ₅ ha ⁻¹ | 6,250 | 14,375 | 20,625 | 31.101 |
| SEm± | 34.35 | 79.08 | 113.35 | 0.41 |
| CD (P=0.05) | 109.64 | 252.17 | 361.81 | 1.32 |

V. CONCLUSION

The research project was conducted at Urozgan Higher Education Institute research farm during spring season of 2023, to evaluate the effects of various levels of phosphorus on maize yield and yield attributes. Finding of the present study explained that application of 80 kg P₂O₅ ha⁻¹ recorded significantly higher yield (grain yield, straw yield, biological yield and harvest index) and yield attributes (number of grain cob⁻¹ & grain weight cob⁻¹) over the rest of treatment and control. Even though, number of cob plant⁻¹ and 100-grain weight wasn't significantly affected by phosphorus application, but higher cob plant⁻¹ and 100-grain weight were recorded with application of 80 kg P₂O₅ ha⁻¹.

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