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Response of fertilizer and silicon on yield attributes and yield of maize (*Zea maize* L.)

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ABSTRACT

The present study was carried out to examine the combined effects of varying fertilizer and silicon levels on maize yield during the two-year investigation, at RCA, Udaipur. The experimental plots were designed in a split-plot design with three replications and sixteen treatment combinations comprised of four fertility levels in main-plots and four silicon levels in sub-plots. The results showed that the application of 100% recommended dose of fertilize recorded higher cobs plant^{-1}, grain rows cob^{-1} and grains row^{-1} and yield of maize over control. However, the application of 300 kg diatomaceous earth ha^{-1} observed significantly higher cobs plant^{-1}, grain rows cob^{-1} and grains row^{-1} and yield of maize.

Key words: *Maize, Silicon, Fertilizer, Diatomaceous earth, Yield*

Introduction

Among cereal crops, maize is considered the third most important cultivated grain worldwide owing to its improved adaptability to a wide spectrum of arid and semi-arid conditions (Shahzad *et al.*, 2020). It can beutilized as food, feed for animals and as a raw material for industry (Parveen and Ashraf, 2010). Since maize is an all-inclusive crop, the nutrient requirement cannot be supplied only through native nutrient reserve; the additional nutrients can be met by application of fertilizer. In Rajasthan, maize yields less due to the imbalanced application of fertilizers. The recommendation of a fertilizer dose is a challenge to scientists as it should meet both crop nutrient demand and sustain the production system.

Fertiliser use has become an important aspect in improving agricultural production, and its use in agriculture is rapidly expanding, making it crucial to investigate fertilisers' effects on crop yields, quality, and soil. Nitrogen is the essential nutrient for the growth and development of plants. Phosphorus feeding is the basic requirement in plant metabolism. As a component of DNA and RNA, it facilitates the transfer and storage of energy in the form of ATP and ADP, as well as the conversion and transmission of hereditary traits. Potassium controls photosynthesis, cell structure, and protoplasm hydration (Tisdale *et al.*, 2016).

Silicon is ubiquitous and the second most abundant element in the earth's crust after O_2 (Pallavi and Prakash, 2019). It makes up as much as 28% of the earth's crust by weight. Plant-accessible Si is produced by weathering rocks that contain SiO_2 into monosilicate acid (Kowalska *et al.*, 2021). Silicon fer-

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tilizer frequently uses diatomaceous earth as a source of silicon (Aksakal *et al*., 2012). It is anextremely effective adsorbent, fertilizer, aimal/ bird food additive, and contact pesticide for the environmentally friendly control of pests in grains, fruits, and decorative plants. It is vital to perform soil protection measures in addition to adding mineral and organic fertilizers to the soil (Sannikova *et al.,* 2021).

Materials and Methods

The experiment was laid out at the Instructional farm in Rajasthan College of Agriculture (MPUAT), Udaipur during *kharif* 2022 and 2023. The location was situated at an elevation of 582.2 metres above mean sea level, at 24°.35' N latitude and 73°.42' E longitude. From the analysis, it was revealed that the soil of the experimental site was clay loam in texture, medium in organic carbon, low in available nitrogen and medium in available phosphorous and potassium in all plots. The field experiment was laid-out in split-plot design in three replications. The field experiment has four main plot treatments (control, 50, 75 and 100% RDF) and four sub-plot treatments (control, 100, 200 and 300 kg DE ha^{-1}). Application of recommended dose of fertilizer viz., nitrogen, phosphorous and potassium (90, 60, 40 kg ha^{-1} NPK) were applied from urea, diammonium phosphate and muriate of potash. However, the diatomaceous earth (DE) as a source of Si is commonly usedas a fertilizer. The crop was sowed on 15 July 2022, and 8 July 2023, respectively. Using a seed rate of 25 kg ha^{-1}, seeds were manually planted in rows at a depth of 3 to 4 cm, with a spacing of 60 cm x 25 cm. The crop was harvested on 26th October 2022 and 22nd October 2023. The observations were recorded on yield attributes and yield periodically. The harvest indices were estimated with the formulae as mentioned below:

$$\text{Harvest index (\%)} = \frac{\text{Grain yield (kg ha}^{-1})}{\text{Biological yield (kg ha}^{-1}) \times 100}$$

The statistical analysis of experimental data for analysis of variance through the procedure suitable to the experiment was carried out in split plot design described by Panse and Sukhatme (1985). The interpretation of results was based on 'F' test. The comparison between means was calculated by critical difference (CD) at 5 per cent level of significance. The data of pooled analysis for both years was done by the method described by Panse and Sukhatme (1985).

Results and Discussion

Fertility Levels

Yield attributes

The investigation revealed that yield contributing characters, *viz.*, cobs plant^{-1}, grain rows cob^{-1} and grains row^{-1} were significantly increased up to 75% RDF compared to control and 50% RDF. But, 100% RDF was statistically at par with 75% RDF (Fig. 1, 2 and 3). The higher length of cob observed under100% RDF might be due to a sufficient supply of N to the crop because nitrogen being a necessary constituent of plant tissue is involved in cell division and cell elongation. Rasheed *et al*. (2003), Khan *et al*. (2012) and Chisanga *et al*. (2019) have also reported similar findings.

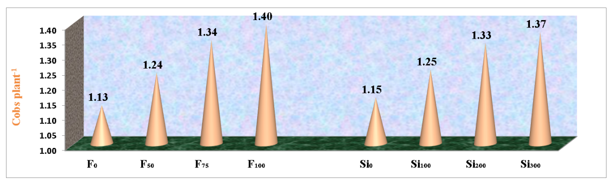

Fig. 1. Effect of fertility and silicon levels on the cobs plant^{-1} in maize crop

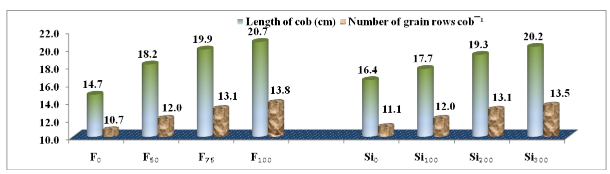

Fig. 2. Effect of fertility and silicon levels on the length of cob and number of grain row cob^{-1} in maize crop

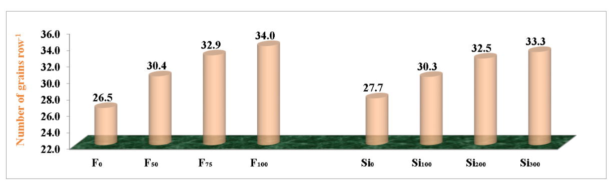

Fig. 3. Effect of fertility and silicon levels on the number of grains row^{-1} in maize crop

Yield

The study revealed that increased the grain yield of maize with increasing fertility levels but the increase was significant only up to 75% RDF. The application of 75% RDF enhanced the grain yield of maize by 43.2 and 11.6 per cent in pooled mean compared to control (F_0) and 50% RDF, respectively (Fig. 5). The grain yield of maize remained statistically at par under 75% RDF and 100% RDF. The stover yield also showed increasing trends as that of grain yield (Fig. 4). 100% RDF and 75% RDF at par with one another recorded significant increases in stover yield over F_0 and F_{50} levels during both the years of study. The higher nutrient uptake by the crop produced higher plant height and yield attributes meaning more production of photosynthates leading to higher dry weight production in terms of grain and stover yield. Mukhtar *et al*. (2012) and Tesfay *et al*. (2024) also reported similar findings. The harvest index was not significantly influenced due to various levels of fertility.

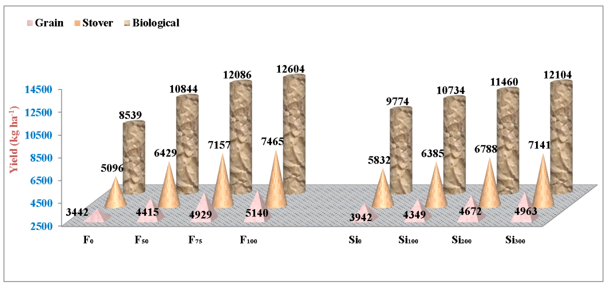

Fig. 4. Effect of fertility and silicon levels on the yield of maize

Silicon levels

Yield attributes

The investigation revealed that yield attributes *viz.*, cobs plant^{-1}, grain rows cob^{-1} and grains row^{-1} were significantly increased up to 200 kg DE ha^{-1}compared to control and 100 kg DE ha^{-1}, but, which was statistically at par with 300 kg DE ha^{-1} silicon level (Fig. 1, 2 & 3). This might be due to the fact that silicon application increases erectness of leaves and leaf blades which allow better light transmittance through plant canopies and thus indirectly improves whole plant photosynthesis as reported in maize (Zhou *et al*., 2002). The application of Si might have led to higher grain filling through an increased rate of photosynthesis (Lavinsky *et al*., 2016).

Yield

The grain yield of maize increased significantly with the increasing levels of silicon and consequently, the application of 300 kg DE ha^{-1} recorded the highest grain yield (Fig. 4). The increase in grain yield under 300 kg DE ha^{-1} was 25.9, 14.1 and 6.2 per cent in pooled mean over control, 100 and 200kg DE ha^{-1}, respectively. The stover yield of maize increased significantly with the rising levels of silicon, and thus the application of 300 kg DE ha^{-1} recorded the highest stover yield (Fig. 4). The increase in stover yield under 300 kg DE ha^{-1} was 22.5, 11.8 and 5.2 percent in pooled mean over control, 100, and 200 kg DE ha^{-1}, respectively. The increase in grain, stover and biological yield of maize might be attributed to the increase in growth and yield attributing characteristics of maize and also to the stimulating effect of silicon in reducing biotic and abiotic stress situations. Silicon increases the above ground biomass, stem rigidity and abundance of plant stand and its addition can stimulate a higher rate of photo-assimilate translocation, consequently enhancing carbon sink strength. Silicon application may enhance yield of crop by several indirect action such as reduced shading due to greater leaf erectness. Silicon Application promotes physio-biochemical activities such as cellular redox homeostasis and increases polyamines putrescine and this alleviates oxidative stress during the ripening stage of crop growth due to abiotic and biotic factors increase yield and yield attributes (Verma *et al*., 2019). Similar studies were also reported by Cuong *et al*. (2017), Minden *et al.* (2021) and Nagaratna*et al.* (2023). The harvest index was not significantly influenced due to various levels of silicon.

Conclusion

The present investigation and observation showed that yield attributes and yield were discernibly influenced by different levels of fertility and silicon. The application of 300 kg DE ha^{-1} and 75% RDF was determined to be an appropriate treatment for maize production, according to the results, and farmers in this region might consider using it.

Statement for data availability

The data pertaining to the research entitled, "response of fertilizer and silicon on yield attributes and yield of maize (*Zea maize* L.)" is available on special request basis and will be submitted to you if needed.

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