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COMBINED EFFECT OF FERTILIZERS AND DIATOMACEOUS EARTH ON YIELD AND YIELD ATTRIBUTES OF MAIZE IN TYPIC HAPLUSTEPTES

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ABSTRACT

The effect of combined application of fertilizers and diatomaceous earth on yield and yield attributes of maize was investigated in Typic Haplusteptes in 2022 and 2023, in order to provide support for using diatomaceous earth to improve the efficiencies of fertilizers in this area. A split plot field experiment was conducted continually in two years with four levels of fertilizers (control, 50, 75 and 100% RDF) in main plots and four levels of diatomaceous earth (control, 100, 200, and 300 kg ha^{-1}). The dry matter accumulation, cob weight, shelling percentage and yield of maize were investigated at harvest. Application of 100% RDF with 300 kg DE ha^{-1} ($F_{100}Si_{300}$) was recorded highest plant dry matter accumulation (254.7 g $plant^{-1}$), cob weight (258.6 g cob^{-1}), shelling percentage (77.50%), grain yield (5808 kg ha^{-1}), stover yield (8391 kg ha^{-1}) and biological yield (14199 kg ha^{-1}) of maize. Combined application of fertilizers and diatomaceous earth (DE) could significantly improve the nutrient supply of soil during growth stage, increase yield attributes and yield of maize. So the combined application of fertilizers and diatomaceous earth effectively increases yield attributes and yield in Typic Haplustepts.
***Keywords*: fertilizers, diatomaceous earth, yield, cob weight, maize etc.

Introduction

Maize plant (*Zea mays*) is a common type of crop that is being grown in many countries as a staple food for humans and a source of animal feed (Ursa, 2015). Countries that do not have sufficient supply of rice declare maize as an important source of crop in countries like Ghana, Bangladesh, and Pakistan (Sashi *et al*., 2018, Abukari, 2014, Khan *et al.,* 2017). Apart from this, it is also widely used as a feed mill and thus can be classified as a major supply of energy for poultry (Dei and Herbert, 2017).

Fertilizer use can increase crop production because inadequate fertilizer use delays maturity and affects grain yield. Excessive and unbalanced amounts also reduce grain yield and quality, and high soil fertilizer pollution and degradation. Irrational fertilizer use in irrigated agriculture is uneconomical and causes great damage to the environment (Nanganoa *et al*., 2020; Yahya *et al*., 2023). Therefore, the main task is not to ban mineral fertilizers in agriculture, but to improve agricultural practices, especially to balanced and environmentally correct fertilizers.

On the other hand, silicon benefits plant growth and promotes plant development by enhancing plant resistance and tolerance to various biotic and abiotic stresses (Kostic *et al*., 2017, Yongchao *et al*., 2015). In addition, silicon is listed as the fourth most important element after nitrogen, phosphorus, and potassium by the international soil classification system (Swe *et al*., 2021). It can also be used to stimulate photosynthesis, enhance tissue strength, and reduce plant transpiration rate (Xie *et al.,* 2014).

The application of fertilizers and diatomaceous earth helps to improve growth and yield of maize. Limited research has reported on the combined effect of fertilizers and DE on maize production in Typic

Haplustepts especially in Rajasthan. Hence the main objective of the study was to evaluate the effect of fertilizers and DE on the growth, yield attributes and yield of maize plants in Typic Haplustepts.

Material and Methods

Location and experimental details

The field experiment was laid out at Rajasthan College of Agriculture (MPUAT), Udaipur during *kharif* season of 2022 and 2023. The site was located at 24°.35' N latitude and 73°.42' E longitude, at an elevation of 582.2 metre above mean sea level. This region has a sub-tropical and semi-arid climate receives 637.0 mm average annual rainfall and most of which (80-85 %) is received through South-West monsoon during July to September. A split plot field experiment was conducted continually in two years with four levels of fertilizers (control, 50, 75 and 100% RDF) in main plots and four levels of diatomaceous earth (control, 100, 200, and 300 kg ha^{-1}). Recommended Dose of Fertilizers for maize is 90 kg ha^{-1} N, 60 kg ha^{-1} P_2O_5 and 40 kg ha^{-1} K_2O under agro climatic zone IVa. In order to test statistical significance of the data, standard procedure as suggested by Panse and Sukhatme (1985) was employed by using split plot design.

Application of fertilizers

The recommended dose of fertilizers like nitrogen, phosphorus and potash as per treatments were applied as basal application at the time of sowing through urea, diammonium phosphate (DAP) and murate of potash (MOP). The 50% of nitrogen was applied as basal application with phosphorus and potassium. The remaining quantity of nitrogen was supplied in two split doses first at 30 DAS and second at 45 DAS.

Application of diatomaceous earth

Different doses of Si were applied in experimental plots by band application as per treatment during crop period. Diatomaceous earth was used as source of silicon application into soil. The soil application of 50% of silicon was applied at the time of sowing as basal and rest were applied in two equal split at 30 DAS and at 45DAS of maize.

Five plants were randomly chosen from each plot, removed at 45 DAS and at harvest stage from a sample row. Following the cutting, individual plant samples were put in perforated paper bags and oven dried at 65 °C until a constant weight was achieved. At the time harvest, dry matter accumulation in the plant was calculated without cob. The dry matter was then represented as g $plant^{-1}$ after these were weighed.

After each harvest of cobs from randomly chosen plants, the dried weight of cob was measured and recorded as g cob^{-1}.

Shelling percentage indicate in percentage of grains in cobs.

$$\text{Shelling percentage} = \frac{\text{Weight of grains (g)}}{\text{Weight of cobs (g)}} \times 100$$

The crop was harvested on 26th October, 2022 (first year) and 22nd October 2023 (second year), respectively from a net size 3.6m x 4.0 m (18 m^2) separately, tied in bundles, tagged and sun dried. After complete drying, bundles were weighed to record biological yields. Thereafter, shelling was done by beating the plants with sticks. The seed and stover were separated by manual winnowing and their yield in kg $plot^{-1}$ was recorded and converted into kg ha^{-1}.

Shelling and winnowing

After proper dried cobs of maize were shelled with the help of cob sheller. The power operated cob sheller was used for shelling. The produce was winnowed, cleaned and sundried and weighed individually to record seed yield in each plot.

Result and Discussion

Growth and yield attributes

Application of 100% RDF with 300 kg DE ha^{-1} ($F_{100}Si_{300}$) was recorded highest plant dry matter accumulation (g $plant^{-1}$), cob weight (g cob^{-1}) and shelling percentage (%) which was significantly increased over rest of the treatment combinations but found at par with the application of 75% RDF with 300 kg DE ha^{-1} ($F_{75}Si_{300}$), 100% RDF with 100 kg DE ha^{-1} ($F_{100}Si_{100}$), 100% RDF with 200 kg DE ha^{-1} ($F_{100}Si_{200}$) in pooled mean (Table 1).

The results enunciated that using nitrogen, phosphorus and potassium fertilizer mixture and in combination with the application of diatomaceous earth significantly enhanced plant dry matter accumulation at harvest , cob weight and shelling percentage of maize crops. The synthesis of tryptophan, the building block of auxin, increases the plant cell division and elongation, boosting the plant's stature and structure. Nitrogen is also vital in producing plant hormones that stimulate leaf-forming cells and increase the number of plant leaves. Phosphorus helps plants complete the various physiological processes that boost plant growth and its yield components (Izadi and Eman, 2010; Al-Yasari and Al-Jbwry, 2024). Potassium also increases disease and drought resistance in plant.

The maize plant performance improved as the leaf area increased because the leaf is the chief source of the plant food processing. Nitrogen, phosphorous and potassium are crucial in increasing the leaf area, enhancing the plant's ability to intercept light to form more chlorophyll (Anwar *et al.,* 2017). The maize plant's response to application of diatomaceous earth may be due to it contributing to increased vital activities of the plant and absorbing nutrients.

With fertilization, the increased accumulation of dry matter accumulation and improved growth increased fertilization because of reducing the rate of ovarian abortion that eventually increased grains per ear (Iqbal *et al*., 2014). In maize, it led to an upsurge in the efficiency of the carbon assimilation process and the transfer of its products to the grains.

The chlorophyll content, which is a reflection of increasing the yield components, as well as the role of diatomaceous earth in the conversion efficiency of carbon metabolism and the division process in the cells responsible for seed formation, increased the grain size and weight (Abbas, 2017; Nigussie, 2021).

Yield

Application of 100% RDF with 300 kg DE ha^{-1} ($F_{100}Si_{300}$) was recorded highest grain yield, stover yield and biological yield of maize (Fig 1, 2 & 3) which was significantly increased over rest of the treatment combinations but found at par with the application of 75% RDF with 300 kg DE ha^{-1} ($F_{75}Si_{300}$). Application of N, P & K with diatomaceous earth can significantly improve maize yield by enhancing nutrient uptake, boosting stress resistance and promoting robust growth. Similar result obtained by Sudhakara *et al.*, 2020.

Conclusion

The combined application of fertilizers and diatomaceous earth significantly enhances the yield attributes and overall yield of maize. Diatomaceous earth improve soil physical properties, nutrient retention and water-holding capacity. When integrated with fertilizers, it optimizes nutrient availability and uptake by plants, leadind to improved growth parameters such as plant dry matter accumulation, cob weight, shelling percentage and yield of maize.

Table 1 : Interaction effect of fertilizers and DE levels on growth and yield attributes in maize

F x Si	DMA plant^{-1} at harvest				Cob weight (g cob^{-1})				Shelling percentage			
	Si_0	Si_{100}	Si_{200}	Si_{300}	Si_0	Si_{100}	Si_{200}	Si_{300}	Si_0	Si_{100}	Si_{200}	Si_{300}
F_0	152.7	156.0	198.6	204.1	157.6	160.9	203.5	209.0	57.77	61.20	69.34	70.84
F_{50}	194.5	201.4	207.9	209.7	199.4	206.3	212.8	214.6	67.48	69.89	70.80	71.41
F_{75}	200.8	220.3	234.5	242.6	205.7	225.2	239.4	247.5	70.09	73.71	75.37	76.81
F_{100}	208.5	243.4	243.4	254.7	212.4	247.3	247.3	258.6	70.77	75.85	75.85	77.50
SEm±	4.62				4.69				0.79			
C.D. (P=0.05)	13.14				13.33				2.25			

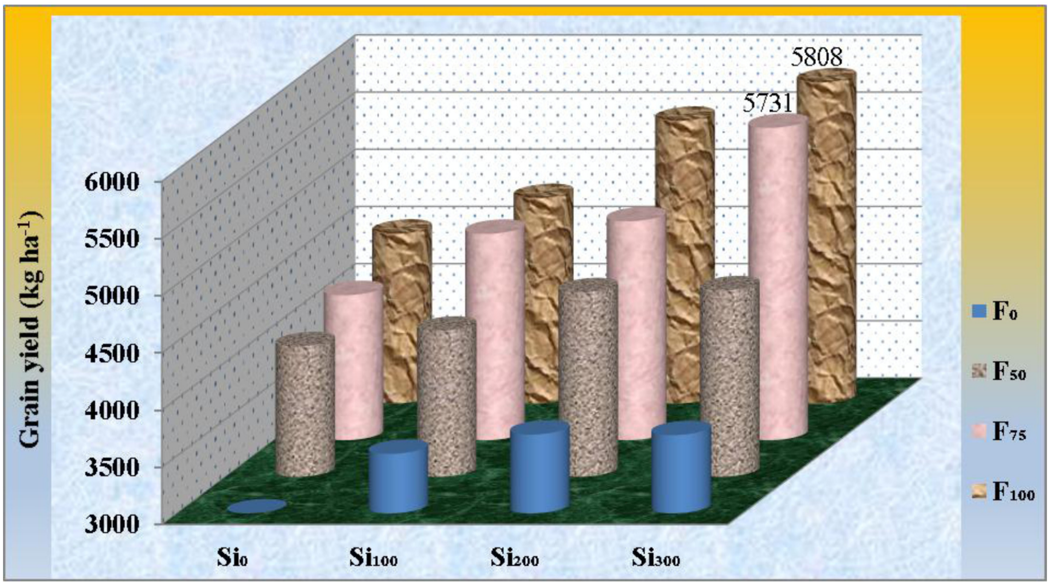

Fig. 1 : Interactive effect of fertilizers and DE levels on grain yield of maize

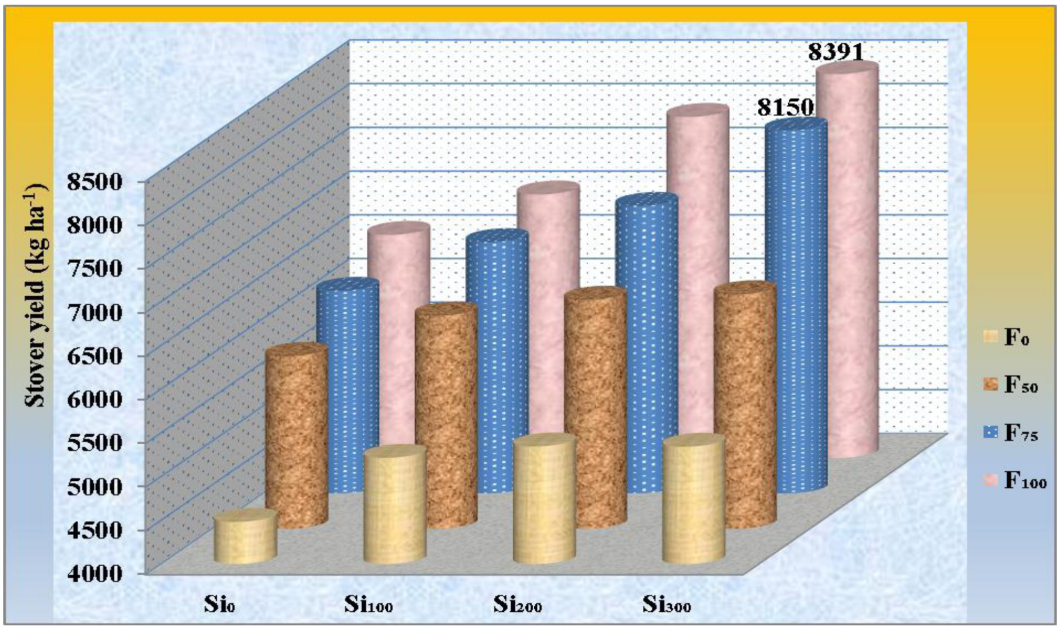

Fig. 2 : Interactive effect of fertilizers and DE levels on stover yield of maize

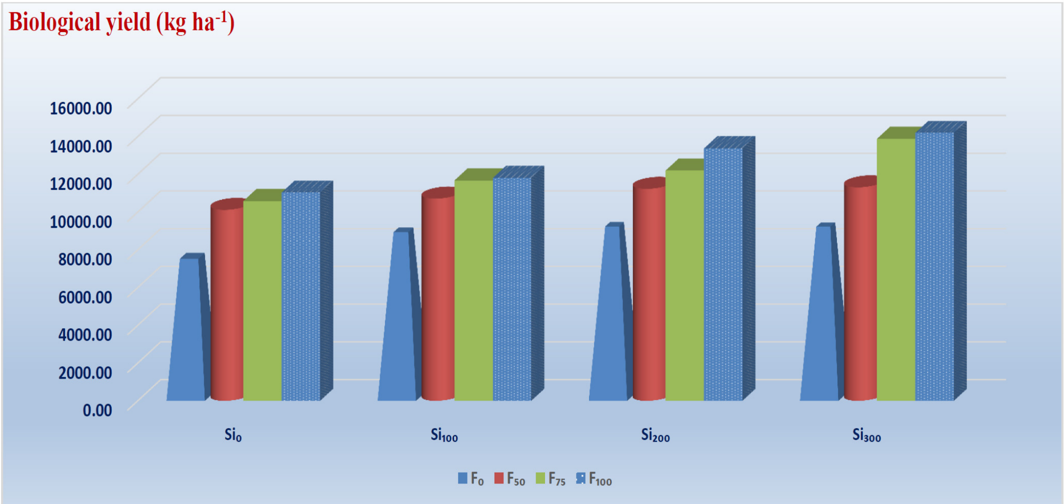

Fig. 3 : Interactive effect of fertilizers and DE levels on biological yield of maize

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