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Effect of Organic and Inorganic Nutrient Sources and Foliar Silica Application on Growth and Yield Attributes of Maize (*Zea mays* L.) in Typic Haplustepts

Mohnish Saini[1]*, R.K. Sharma[2], K.K. Yadav[3], S.S. Lakhawat[4], H.L. Bairwa[5]

[1]Research Scholar, Department of Soil Science, Rajasthan College of Agriculture, MPUAT, Udaipur, Rajasthan, 313 001, India
[2,3]Professor, Department of Soil Science, Rajasthan College of Agriculture, MPUAT, Udaipur, Rajasthan, 313 001, India
[4,5]Professor, Department of Horticulture, Rajasthan College of Agriculture, MPUAT, Udaipur, Rajasthan, 313 001, India
*Corresponding author: mohnishsainii@gmail.com

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***Abstract*— *A field experiment was conducted during the Kharif season of 2025 at the Agronomy Instructional Farm, Rajasthan College of Agriculture, Udaipur, Rajasthan, to evaluate the effect of organic and inorganic nutrient sources along with foliar silica application on the growth and yield attributes of maize (Zea mays L.) in Typic Haplustepts. The experiment was laid out in a randomized block design with three replications comprising ten treatment combinations involving different levels of recommended dose of fertilizers (RDF), vermicompost and foliar application of 0.5% silica. The results revealed that the application of 100% RDF + vermicompost @ 5 t ha^{-1} + foliar spray of 0.5% silica (T_{10}) recorded the highest plant height (250.9 cm), dry matter accumulation (222.68 g plant^{-1}), number of cobs plant^{-1} (1.39), grains cob^{-1} (532), cob weight (203.88 g), seed index (29.35 g) and shelling percentage (74.44%). Although several treatments exhibited statistical parity with T_{10} for individual parameters, 75% RDF + vermicompost @ 5 t ha^{-1} + foliar spray of 0.5% silica (T_7) was the only treatment that consistently remained at par with T_{10} across all evaluated growth and yield attributes. The findings indicate that integrated use of organic and inorganic nutrient sources together with foliar silica improved crop growth and reproductive performance by creating a favourable nutrient environment.*

***Keywords*— Maize, Foliar Silica, Vermicompost, Typic Haplustepts.**

I. INTRODUCTION

Maize (*Zea mays* L.), popularly known as the "Queen of Cereals", is one of the most important cereal crops worldwide owing to its high yield potential, remarkable adaptability and diverse utilization as food, feed and industrial raw material (Saritha *et al*., 2020). Globally, maize is cultivated over nearly 210 million ha with a production of about 1234 million tonnes, whereas in India it occupies about 12.09 million ha with an annual production of 43.41 million tonnes (FAO, 2024; Anonymous, 2024–25). Besides being a major source of carbohydrates, protein and essential minerals, maize is a highly nutrient-exhaustive C_4 crop requiring a balanced and continuous nutrient supply to realize its genetic yield potential (Ranum *et al*., 2014; Rathnayaka *et al*., 2018). Sustaining maize productivity has become increasingly challenging because of declining soil fertility, depletion of soil organic matter and the imbalanced use of chemical fertilizers. Although mineral fertilizers have substantially contributed to yield improvement, their indiscriminate use has reduced nutrient use efficiency and adversely affected soil health and long-term productivity (Meena *et al*., 2024). Therefore, nutrient management strategies that combine organic and inorganic nutrient sources are gaining importance for improving crop productivity while maintaining soil fertility.

Organic nutrient sources such as vermicompost not only supply essential plant nutrients but also improve microbial activity, nutrient availability and soil physical conditions, whereas inorganic fertilizers ensure an adequate and timely supply of readily available nutrients required during critical growth stages (Haridha *et al*., 2020; Das *et al*., 2019).

In addition, foliar application of silica has emerged as a promising approach for enhancing plant growth, photosynthetic efficiency and tolerance to biotic and abiotic stresses. Silica deposition in plant tissues improves structural strength, nutrient utilization and overall crop performance, particularly in cereals such as maize (Ma and Yamaji, 2006; Kowalska *et al*., 2021).

However, information on the combined influence of organic and inorganic nutrient sources along with foliar silica application on maize crop is still limited. Therefore, the present investigation was undertaken to evaluate the effect of organic and inorganic nutrient sources along with foliar silica application on the growth and yield attributes of maize (*Zea mays* L.) under typic haplustepts.

II. MATERIALS AND METHODS

2.1 Field location and materials:

The field experiment was conducted during the *kharif* season of 2025 at the B2 Block of the Agronomy Instructional Farm, Rajasthan College of Agriculture, MPUAT, Udaipur, Rajasthan. The experimental site is located at 24°35′ N latitude and 73°42′ E longitude, with an altitude of 582.2 m above mean sea level, and falls under the Agro-climatic Zone IVa (Sub-humid Southern Plain and Aravalli Hills) of Rajasthan. The soil properties of experimental site was clay loam soil in texture, slightly alkaline in reaction (pH 8.21), medium in available nitrogen (282.17 kg ha^{-1}) and available phosphorus (20.32 kg ha^{-1}), while it was high in available potassium (453.75 kg ha^{-1}).

2.2 Experimental detail:

The field experiment was laid out in a randomized block design (RBD) with 10 treatments and three replications during the *kharif* season of 2025. The treatments comprised T_1 (absolute control); T_2 (50% RDF + foliar spray of 0.5% silica); T_3 (50% RDF + vermicompost @ 2.5 t ha^{-1} + foliar spray of 0.5% silica); T_4 (50% RDF + vermicompost @ 5.0 t ha^{-1} + foliar spray of 0.5% silica); T_5 (75% RDF + foliar spray of 0.5% silica); T_6 (75% RDF + vermicompost @ 2.5 t ha^{-1} + foliar spray of 0.5% silica); T_7 (75% RDF + vermicompost @ 5.0 t ha^{-1} + foliar spray of 0.5% silica); T_8 (100% RDF + foliar spray of 0.5% silica); T_9 (100% RDF + vermicompost @ 2.5 t ha^{-1} + foliar spray of 0.5% silica); and T_{10} (100% RDF + vermicompost @ 5.0 t ha^{-1} + foliar spray of 0.5% silica). Maize hybrid DHM-121 was sown using a seed rate of 25 kg ha^{-1} at a spacing of 60 × 25 cm. Vermicompost was incorporated into the soil before sowing, whereas the full doses of phosphorus and potassium and half of the recommended nitrogen were applied as basal at the time of sowing. The remaining nitrogen was top-dressed at the first irrigation. Diatomaceous earth was used as the silica source, and a 0.5% foliar spray was applied at 30 and 45 days after sowing (DAS) in all treatments except the absolute control.

2.3 Determination methods:

At harvest, plant height was measured from the ground level to the tip of the main shoot using a meter scale on five randomly selected plants from each plot. The observations were recorded in centimetres (cm) and the average value was computed. Dry matter accumulation was determined by uprooting five arbitrarily selected plants from each plot at harvest, chopping them into small pieces and oven-drying at 65°C until a constant weight was attained, after which the dry weight was recorded and expressed as g $plant^{-1}$. At harvest, the total number of cobs produced by the five previously tagged plants in each plot was counted and the average number of cobs per plant was calculated for each experimental unit, while the number of grains per cob was obtained by counting the grains from five randomly selected mature cobs from each plot and calculating their average. Dry weight of cobs obtained from the randomly selected plants in each plot was recorded after harvest and expressed as g cob^{-1}. After threshing and proper sun-drying, a sample of 100 seeds was collected from each net plot and weighed. The weight was recorded in grams and expressed as seed index. Shelling percentage was determined by recording the grain weight and cob weight of the selected samples and was expressed as the percentage of grain weight to cob weight.

III. RESULT AND DISCUSSION

3.1 Growth Parameters

Plant height at harvest was significantly influenced by different organic and inorganic nutrient sources along with foliar silica application (Table 1). Treatment T_{10} (100% RDF + vermicompost @ 5 t ha^{-1} + foliar spray of 0.5% silica) recorded the maximum plant height (250.9 cm), which remained statistically at par with T_6, T_7, T_8 and T_9. However, T_{10} registered 38.47% higher plant height over the absolute control (T_1). Improvement in plant height could be attributed to improved nutrient availability and synchronization throughout the crop growth period. Adequate supply of essential nutrients through RDF supported vigorous vegetative growth, while vermicompost ensured a sustained release of nutrients and growth promoting substances, thereby favouring continuous plant development. In addition, foliar application of silica improved photosynthetic efficiency, nutrient utilization and plant water relations, which collectively promoted greater vegetative growth. Similar, findings were also reported by Ngosai *et al*. (2018), Mahato *et al*. (2020) and Ullah *et al*. (2025).

Plant dry matter accumulation at harvest was significantly influenced by different treatment combinations as shown in (Table 1). Treatment T_{10} (100% RDF + vermicompost @ 5 t ha^{-1} + foliar spray of 0.5% silica) recorded the highest dry matter accumulation (222.68 g plant^{-1}), which remained statistically at par with T_7. The lowest dry matter accumulation was recorded under the absolute control (T_1). Compared with T_1, T_2, T_3 and T_4, treatment T_{10} increased dry matter accumulation by 79.00, 43.57, 27.17 and 23.64%, respectively. This might be due to improved nutrient availability and sustained nutrient release throughout the crop growth period. Vermicompost enhanced soil biological activity and nutrient dynamics, while RDF ensured an adequate supply of essential nutrients for continuous biomass production. Besides that, foliar application of silica improved photosynthetic efficiency and assimilate translocation, thereby promoting greater biomass accumulation at harvest. These findings are in close agreement with those reported by Chhetri *et al*. (2019) and Jawahar *et al*. (2019).

3.2 Yield Attributes

As shown in (Table 2), the highest number of cobs plant^{-1} **(**1.39**)** was recorded under T_{10} (100% RDF + vermicompost @ 5 t ha^{-1} + foliar spray of 0.5% silica), which remained statistically at par with T_7, whereas the lowest value was observed under the absolute control (T_1). Treatment T_{10} recorded 32.38, 28.87, 28.87, 19.83 and 15.83% higher number of cobs plant^{-1} over T_1, T_2, T_3, T_4 and T_5, respectively. A similar trend was observed for the number of grains cob^{-1}, where T_{10} produced the maximum number of grains **(**532**),** remaining statistically at par with T_5, T_6, T_7, T_8 and T_9, while the minimum was recorded under absolute control (T_1). Compared with T_1, T_2, T_3 and T_4, treatment T_{10} increased the number of grains cob^{-1} by 30.71, 10.14, 9.69 and 5.14%, respectively. Likewise, the highest seed index (29.35 g**)** was recorded under T_{10}, which remained statistically comparable with T_7 and T_9**,** whereas the lowest seed index was recorded under the absolute control (T_1). The corresponding increase under T_{10} over T_1, T_2, T_3 and T_4 was 24.00, 12.32, 10.63 and 9.03%, respectively. Cob weight also responded significantly to the different treatments. Treatment T_{10} recorded the highest cob weight **(**203.88 g**)** and remained statistically at par with T_7, T_8 and T_9, while the lowest cob weight was observed under T_1. Compared with T_1, T_2, T_3 and T_4**,** cob weight increased by 49.65, 23.92, 22.87 and 12.90%, respectively, under T_{10}. Similarly, shelling percentage was significantly improved by the different nutrient management treatments. The maximum shelling percentage **(**74.44%**)** was recorded under T_{10}, which remained statistically at par with T_4, T_5, T_6, T_7, T_8 and T_9**,** whereas the minimum was recorded under absolute control (T_1). Treatment T_{10} registered 22.11, 15.38 and 13.90% higher shelling percentage over T_1, T_2 and T_3, respectively.

Table 1: Effect of organic and inorganic nutrient sources and foliar silica application on growth parameters

Treatments	**Plant height (cm) at harvest**	**Plant dry matter (g plant^{-1}) at harvest**
T_1: Absolute Control	181.2	124.40
T_2: 50% RDF + Foliar spray 0.5% Si	228.9	155.10
T_3: 50% RDF + Vermicompost 2.5t ha^{-1} + Foliar spray 0.5% Si	232.7	175.11
T_4: 50% RDF + Vermicompost 5t ha^{-1} + Foliar spray 0.5% Si	234.5	180.10
T_5: 75% RDF + Foliar spray 0.5% Si	238.0	186.90
T_6: 75% RDF + Vermicompost 2.5t ha^{-1} + Foliar spray 0.5% Si	244.0	194.42
T_7: 75% RDF + Vermicompost 5t ha^{-1} + Foliar spray 0.5% Si	247.7	222.09
T_8: 100% RDF + Foliar spray 0.5% Si	246.8	198.16
T_9: 100% RDF + Vermicompost 2.5t ha^{-1} + Foliar spray 0.5% Si	248.5	203.32
T_{10}: 100% RDF + Vermicompost 5t ha^{-1} + Foliar spray 0.5% Si	250.9	222.68
S.Em.±	4.16	3.99
C.D. (P=0.05)	12.35	11.85

Table 2: Effect of organic and inorganic nutrient sources and foliar silica application on yield attributes

Treatments	No. of cobs plant^{-1}	No. of grains cob^{-1}	Seed index (g)	Cob weight (g)	Shelling percentage
T_1: Absolute Control	1.05	407	23.67	136.24	60.96
T_2: 50% RDF + Foliar spray 0.5% Si	1.15	483	26.13	164.53	64.52
T_3: 50% RDF + Vermicompost 2.5t ha^{-1} + Foliar spray 0.5% Si	1.15	485	26.53	165.93	65.36
T_4: 50% RDF + Vermicompost 5t ha^{-1} + Foliar spray 0.5% Si	1.16	506	26.92	180.59	68.81
T_5: 75% RDF + Foliar spray 0.5% Si	1.20	506	27.15	183.26	70.69
T_6: 75% RDF + Vermicompost 2.5t ha^{-1} + Foliar spray 0.5% Si	1.25	510	27.08	183.84	71.66
T_7: 75% RDF + Vermicompost 5t ha^{-1} + Foliar spray 0.5% Si	1.37	532	29.01	202.17	74.39
T_8: 100% RDF + Foliar spray 0.5% Si	1.29	517	28.02	187.49	72.35
T_9: 100% RDF + Vermicompost 2.5t ha^{-1} + Foliar spray 0.5% Si	1.32	520	28.54	189.32	73.59
T_{10}: 100% RDF + Vermicompost 5t ha^{-1} + Foliar spray 0.5% Si	1.39	532	29.35	203.88	74.44
S.Em.±	0.01	9	0.30	5.98	2.41
C.D. (P=0.05)	0.04	26.71	0.90	17.77	7.17

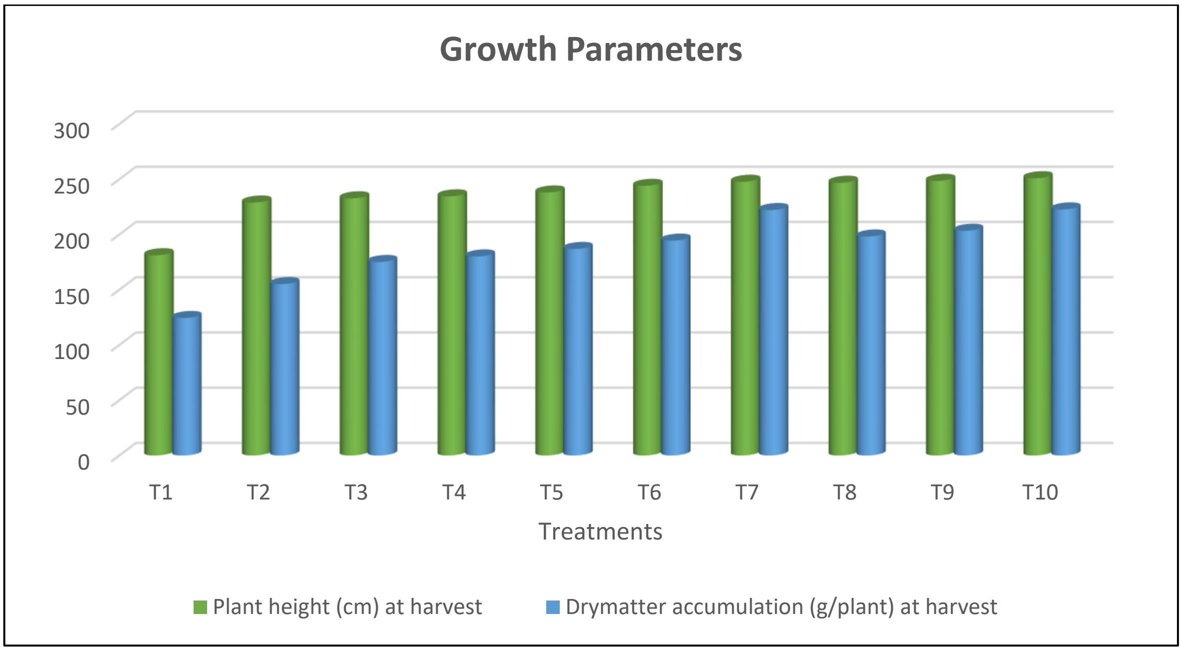

Fig 1: Effect of organic and inorganic nutrient sources and foliar silica application on growth parameters

The improvement in yield attributes under the combined application of organic and inorganic nutrient sources along with foliar silica could be attributed to enhanced nutrient availability and a favourable soil environment throughout the crop growth period. Adequate nutrient supply through RDF supported higher photosynthetic activity and assimilate production, while vermicompost ensured a sustained release of macro and micronutrients, improved soil physical properties, enhanced biological activity and promoted better root growth and nutrient uptake. In addition, foliar application of silica improved the translocation and partitioning of assimilates from source to sink, thereby facilitating better cob development, grain filling and reproductive efficiency. Collectively, these favourable effects resulted in higher number of cobs plant^{-1}, grains cob^{-1}, cob weight, seed index and shelling percentage. The present findings are in line with those reported by Namazi *et al*. (2015), Coulibaly *et al*. (2019), Kalyani *et al*. (2023) and Meena *et al*., 2024)

IV. CONCLUSION

The present investigation demonstrated that the combined application of organic and inorganic nutrient sources along with foliar silica significantly improved the growth and yield attributes of maize under Typic Haplustepts. Among the treatments, T_{10} (100% RDF + vermicompost @ 5 t ha^{-1} + foliar spray of 0.5% silica) produced the highest values for all the evaluated growth and yield parameters. However, T_7 (75% RDF + vermicompost @ 5 t ha^{-1} + foliar spray of 0.5% silica) was the only treatment that consistently remained statistically at par with T_{10} across all evaluated parameters, indicating that comparable crop performance could be achieved with a reduced level of inorganic fertilizer. These findings highlight the potential of balanced integration of organic and inorganic nutrient sources with foliar silica for improving maize productivity. Therefore, treatment T_7 needs to be explored further under farmer field conditions for sustainable maize cultivation in Sub-humid Southern Plain and Aravalli Hills.

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