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Effect of integrated nutrient management practices on the productivity enhancement of hybrid maize (*Zea mays* L.)

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Abstract
A field experiment was conducted during rabi season of 2022-23 on loamy sand of in the rural area of Kanpur district of Mandhana, located 10 km from Kanpur in Uttar Pradesh to Effect of integrated nutrient management practices on the productivity enhancement of hybrid maize (*Zea mays* L.).The soil was normal in pH of 7.66, electrical conductivity (EC) of 0.26 dSm^{-1}, organic carbon content of 0.40%, and available nutrients including nitrogen (N), phosphorus (P), and potassium (K) at levels of 215.70, 19.57, and 149.56 kg ha^{-1}, respectively. The experiment was laid out during Rabi season of 2022-23. The experiment consisted of 14 treatment combinations, was laid out in Randomized Block Design (RBD) with three replications.

Keywords: RDF, vermicompost, poultry manure, vermiwash

Introduction
One of the most versatile developing crops is maize (*Zea mays* L.), which can flourish in a wide variety of agroclimatic conditions. Since maize has the highest potential for genetic production of any cereal, it is referred to as the "Queen of Cereals" throughout the world. It contributes 39% of the world's grain production and is grown on 190 million hectares in about 165 countries with a wider variety of soil, temperature, biodiversity, and management techniques. In India, maize has a market value of 100 billion at current prices, making up 9% of the country's agricultural GDP (Balaji *et al.*, 2022) [1].

It is grown on 203.89 million hectares of land worldwide, yielding productivity and production of 5.94 t ha^{-1} and 1210.45 million tonnes, respectively. It covers 9.9 million hectares and produces 32.50 million tonnes in India in 2021–2022, with a productivity of 3.28 t ha–1 (USDA, 2022). With a production and productivity of 2.61 million tonnes and 7.83 t ha^{-1}, it is grown on 0.33 million hectares in Tamil Nadu (Salient statistics on agriculture, 2021) [3].

The decline in maize yield can be attributed to a number of factors, the most important being inadequate management of crop nutrition and declining soil fertility. Fertilizers are responsible for one-third of crop yield, with the remaining two-thirds derived from the effective application of other agricultural inputs. But according to Safa and Hayyawi *et al.* (2021) [4], traditional fertilizers only utilize between 30 and 40 percent of their nutrients efficiently.

Consequently, the best course of action in this situation for preserving soil fertility and agricultural productivity is integrated nutrient management. Low agricultural yield has primarily been caused by improper fertilizer management. Nutrient management requires the use of organic sources such as FYM, vermicompost, poutry manures, bio fertilizer, inorganic fertilizer, and micronutrients to maximize crop yield. One of the factors that most affects the growth and yield of maize crops is fertilizer management (Adhikary *et al.*, 2020) [5]. Thus, soil fertility and yield can be maintained by using these combinations carefully (Sindhi *et al.*, 2018) [6].

Composted poultry manure is an organic material rich in nutrients, high in nitrogen and all other essential plant nutrients. It contains significant amounts of micronutrients such as Cu, Zn, Fe, and Mn, as well as nitrogen (4.55 to 5.46%), phosphorus (2.46 to 2.82%), potassium (2.02 to2.32%), calcium (4.52 to 8.15%), and magnesium (0.52 to 0.73%).

Poultry waste also contains cellulose (2.26 to 3.62%), hemicellulose (1.89 to 2.77%), and lignin (1.07 to 2.16%). Applying chicken manure is a better way to raise the yield of maize by increasing its carbon content, water-holding capacity, leaf area, and overall chlorophyll content. In order to achieve sustained productivity, profitability, and soil health, it is crucial to decrease the use of chemical fertilizers and replace them with organic manure (Baradhan *et al*., 2022) [7].

The amount and quality of agricultural output will be greatly enhanced by the application of balanced fertilizer during critical growth phases (Dobrinoiu and Dumbrava, 2022) [8]. 2% DAP is currently advised when foliar spraying pulses to prevent blossom drop and enhance seed establishment. Di ammonium phosphate (DAP) is a water-soluble fertilizer that is frequently sprayed on plants to promote growth and boost crop yields. Milan Mori *et al*., 2021 [9]. By favorably enhancing metabolic processes like photosynthesis, nucleic acid levels, soluble proteins, and carbohydrates through foliar application of 0.5% polyfeed, dry matter output and sink size were increased (Maravelli and Shekh, 2019) [10]. The application of 100% RDF + polyfeed spray at 1% (19: 19: 19 NPK) during the tasseling and six-leaf growth stages led to a significant increase in the yields of maize kernels, stover, and total dry matter accumulation. (Nirere-Drocelle *et al*., 2019) [11].

More efficiently than soil application, foliar application of humic compounds raises the availability of humic colloids to plant tissues. (Olaetxea and others, 2017) [12]. Corn production was significantly impacted by the productivity and yield maximization of baby corn (*Zea mays* L.), as influenced by integrated nutrient management strategies and foliar application of 100% RDN + vermicompost @ 5 t ha^{-1} + 3 sprays of 3% panchagavya (Priyanka, 2020). To increase crop yield, seaweeds are now applied as fertilizer using foliar spray, granules, powder, and manure. 10% concentration seaweed foliar sprays show the highest CGR, RGR, and dry matter buildup. Additionally, it generates the maximum vegetative growth and affects growth indices. As of 2022, Meshram *et al*. [13]. Vermiwash remained on the leaf surface and improved yield, plant physiology, internode growth, photosynthetic activity, and leaf thickness. Vermiwash applied topically at a rate of 8% increased plant height, LAI, DMP, grain yield, and stover yield on days 20, 40, and 60 of growth. (Ramesh and others, 2016) [14].

Materials and Methods

A field experiment was conducted during rabi season of 2022-23 on loamy sand of in the rural area of Kanpur district of Mandhana, located 10 km from Kanpur in Uttar Pradesh to assess the importance of weed control techniques for Indian mustard (Brassica juncea) and their yield and economic. The soil was normal in pH of 7.65, electrical conductivity (EC) of 0.27 dSm^{-1}, organic carbon content of 0.41%, and available nutrients including nitrogen (N), phosphorus (P), and potassium (K) at levels of 217.0, 19.5, and 149.50 kg ha^{-1}, respectively. The experiment was laid out during Rabi season of 2022-23. The experiment consisted of 14 treatment combinations, was laid out in Randomized Block Design (RBD) with three replications. T_1 – Control,T_2 - RDF 100%,T_3 - RDF 100% + vermicompost @ 5 t ha^{-1},T_4 - RDF 100% + poultry manure @ 2.5 t ha^{-1} T_5 - RDF 125% + vermicompost @ 5 t ha^{-1}, T_6 - RDF 125% + poultry manure @ 2.5 t ha^{-1}, T_7 - T_3 + vermiwash foliar spray @ 2% at 20 and 45 DAS, T_8 - T_4 + vermiwash foliar spray @ 2% at 20 and 45 DAS,T_9 - T_5 + vermiwash foliar spray @ 2% at 20 and 45 DAS, T_{10} - T_6 + vermiwash foliar spray @ 2% at 20 and 45 DAS, T_{11} -T_3 + polyfeed foliar spray @ 1% at 20 and 45 DAS, T_{12} -T_4 + polyfeed foliar spray @ 1% at 20 and 45 DAS, $T_1$3 - T_5 + polyfeed foliar spray @ 1% at 20 and 45 DAS, $T_1$4 - T_6 + polyfeed foliar spray @ 1% at 20 and 45 DAS data were gathered on five plants chosen from each plot.

Results and Discussion

Growth Parameters

The plant height varied from 30 DAS to 34.59 cm, 60 DAS to 110.89 cm, and harvest to 182.64 cm to 125.68 cm, in that order. The application of RDF 125% + vermicompost @ 5 t ha^{-1} (T_9) was the treatment that significantly recorded the highest plant height at 30, 60 DAS, and harvest, respectively, measuring 69.34 cm, 158.50 cm, and 182.64 cm. The same results were reported by Kripa Adhikari *et al*. (2021) and Arthy *et al*. (2020 a) [15, 16]. After that, 2.5 t ha^{-1} (T_{10}) of RDF 125% + poultry manure was applied, which is equivalent to 66.58 cm, 154.65 cm, and 177.88 cm at 30, 60 DAS, and harvest, respectively. Similar outcomes were found to be responsible for encouraging plant growth (Prabhvathi *et al*., 2021; Hammad *et al*., 2022) [17, 18]. The control group (T_1) recorded the lowest plant heights of 34.59 cm, 110.89 cm, and 125.68 cm at 30, 60 DAS, and harvest, respectively. The results of Verma *et al*. (2018) and Mahato *et al*. (2020) [19, 20] in the current study supported this.

Haribhushan *et al*. (2017) and Kaur *et al*. (2018) [21, 22] both found similar results. Of the treatments, application of RDF 125% + vermicompost @ 5 t ha^{-1} (T_9) significantly recorded the highest leaf area index of 3.74 and 6.34 at 30 and 60 DAS, respectively. After that, 2.5 t ha^{-1} (T_{10}) of RDF 125% + poultry manure were applied, or 3.64 and 6.09 at 30 and 60 DAS, respectively. The control group (T_1) had the lowest leaf area index, measuring 2.48 and 3.32 at 30 and 60, respectively.

At 30 DAS, the DMP was 2541–1253 kg ha–1, at 60 DAS, it was 6190–3601 kg ha–1, and at harvest, it was 13339–6384 kg ha–1. The application of RDF 125% + vermicompost @ 5 t ha^{-1} (T_9) was the treatment that produced the highest DMP at 30, 60 DAS, and harvest, respectively, with measurements of 2541 kg ha^{-1}, 6190 kg ha^{-1}, and 13339 kg ha^{-1}. This could be explained by the plant growing in time with its environment. Vijay Kumar and Lalita Verma (2018) [23-24]. Subsequently, 2.5 t ha^{-1} (T_{10}) of RDF 125% + poultry manure were applied, meaning that 2457 kg ha^{-1}, 6040 kg ha^{-1}, and 13049 kg ha^{-1} were applied at 30, 60 DAS, and harvest, respectively. The control group (T_1) recorded the lowest DMP of 1253 kg ha^{-1}, 3601 kg ha^{-1}, and 6384 kg ha^{-1} at 30, 60 DAS, and harvest, respectively.

Table 1: Effect of graded levels of NPK and organic manures on plant height (cm) at 30, 60 DAS and at harvest

Treatment	30 DAS	60 DAS	At harvest
T_1 – Control	34.59	110.89	125.68
T_2 – RDF 100%	44.07	123.73	139.72
T_3 – RDF 75% + vermicompost @ 5 t ha^{-1}	52.48	135.12	153.78
T_4 – RDF 75% + poultry manure @ 2.5 t ha^{-1}	49.76	131.44	149.24
T_5 – RDF 75% + pressmud @ 12.5 t ha^{-1}	46.89	127.55	144.43
T_6 – RDF 100% + vermicompost @ 5 t ha^{-1}	60.91	146.76	168.14
T_7 – RDF 100% + poultry manure @ 2.5 t ha^{-1}	58.12	142.76	163.21
T_8 – RDF 100% + pressmud @ 12.5 t ha^{-1}	55.25	138.87	158.40
T_9 – RDF 125% + vermicompost @ 5 t ha^{-1}	69.34	158.50	182.64
T_{10} – RDF 125% + poultry manure @ 2.5 t ha^{-1}	66.58	154.65	177.88
T_{11} – RDF 125% + pressmud @ 12.5 t ha^{-1}	63.76	150.72	173.04
SEd	1.26	1.71	2.11
CD (P=0.05)	2.71	3.67	4.53

Table 2: Effect of graded levels of NPK and organic manures on LAI at 30 and 60 DAS

Treatment	30 DAS	60 DAS
T_1 – Control	2.48	3.32
T_2 – RDF 100%	2.79	4.07
T_3 – RDF 75% + vermicompost @ 5 t ha^{-1}	3.10	4.81
T_4 – RDF 75% + poultry manure @ 2.5 t ha^{-1}	3.00	4.57
T_5 – RDF 75% + pressmud @ 12.5 t ha^{-1}	2.90	4.32
T_6 – RDF 100% + vermicompost @ 5 t ha^{-1}	3.42	5.57
T_7 – RDF 100% + poultry manure @ 2.5 t ha^{-1}	3.31	5.31
T_8 – RDF 100% + pressmud @ 12.5 t ha^{-1}	3.21	5.06
T_9 – RDF 125% + vermicompost @ 5 t ha^{-1}	3.74	6.34
T_{10} – RDF 125% + poultry manure @ 2.5 t ha^{-1}	3.64	6.09
T_{11} – RDF 125% + pressmud @ 12.5 t ha^{-1}	3.53	5.83
S.Ed	0.05	0.11
CD (P=0.05)	0.10	0.24

Table 3: Effect of graded levels of NPK and organic manures on DMP (kg ha^{-1}) at 30, 60 DAS and at harvest

Treatment	30 DAS	60 DAS	At harvest
T_1 – Control	1253	3601	6384
T_2 – RDF 100%	1776	4833	10702
T_3 – RDF 75% + vermicompost @ 5 t ha^{-1}	2028	5277	11573
T_4 – RDF 75% + poultry manure @ 2.5 t ha^{-1}	1945	5134	11286
T_5 – RDF 75% + pressmud @ 12.5 t ha^{-1}	1859	4982	10992
T_6 – RDF 100% + vermicompost @ 5 t ha^{-1}	2283	5732	12456
T_7 – RDF 100% + poultry manure @ 2.5 t ha^{-1}	2196	5575	12155
T_8 – RDF 100% + pressmud @ 12.5 t ha^{-1}	2110	5424	11862
T_9 – RDF 125% + vermicompost @ 5 t ha^{-1}	2541	6190	13339
T_{10} – RDF 125% + poultry manure @ 2.5 t ha^{-1}	2457	6040	13049
T_{11} – RDF 125% + pressmud @ 12.5 t ha^{-1}	2370	5886	12754
SEd	37.43	66.63	130.35
CD (P=0.05)	80.47	143.25	280.25

Conclusion

Plant height, LAI, and DMP increased as a result of applying RDF 125% + vermicompost @ 5 t ha^{-1} (T_9), one of the treatments examined in the field experiment. The application of RDF 125% + poultry manure @ 2.5 t ha^{-1} (T_{10}) came next. Under control (T_1), the lowest values of the growth attributes—plant height, LAI, and DMP—were noted. For hybrid maize, this treatment is thought to be an economically feasible nutrient management strategy.

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