**Effect of organic manure and inorganic fertilizers on growth, yield attributes and yield of maize (*Zea mays* L.) in eastern plain zone of Uttar Pradesh, India**

**Abstract**

The present study aims to determine the effect of integrated nutrient management on the growth and yield of maize (Zea mays L.). The field experiment was conducted at the Students' Instructional Farm, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, during the Kharif season of 2022–23. The experiment was laid out in a **randomized block design (RBD) with 12 treatments,** including different combinations of inorganic fertilizers (RDF) and organic amendments (FYM and vermicompost), replicated three times. Results revealed that the **application of 100% RDF + Vermicompost @ 5 t/ha (T9) significantly improved growth, yield attributes, and yield** compared to other treatments. The highest **plant height (220 cm), dry matter accumulation (227 g/plant), cob length (17.7 cm), cob weight (165.3 g), number of grains per cob (420), and grain weight per cob (106.2 g)** were recorded under **T9,** followed by **100% RDF + FYM @ 10 t/ha (T5).** Similarly, the **highest grain yield (65.30 q/ha) and straw yield (119.11 q/ha)** were obtained in **T9,** showing a substantial increase over the control **(33.00 q/ha and 73 q/ha, respectively).** The study concludes that the **combined application of 100% RDF with Vermicompost @ 5 t/ha is the most effective strategy for improving maize productivity** while ensuring soil health sustainability.

**Keywords: Farm Yard Manure(FYM), Maize, Vermicompost, Yield**

**Introduction**

Maize (***Zea mays L***.) also known as corn, is one of the topmost necessary cereal crops around the globe for agricultural economy as food, feed and industrial production. Maize ***(Zea mays L.)*** is the most versatile crop with a wide range of adaptability in different agroecologies. It is an important C4 crop in the world that has high-yielding ability (**Adiaha*et al.,* 2016)**. According to several field study reports, combining the use of organic manure and mineral fertilizers is the only way to achieve high and sustained crop yields. By transforming inorganic nitrogen into organic forms, the complementary application of organic and inorganic fertilizers improves nutrient synchronicity and decreases losses. Additionally, it is crucial for boosting fertilizer effectiveness and minimizing any potential environmental issues brought on by its use. This study was done to evaluate how well maize performed after receiving complementary organic and inorganic fertilizers**(Gao *et al.,* 2020).** Inorganic fertilizers play a crucial role in modern agriculture, to increase maize growth and production, but it is also known that dependence on inorganic fertilizers results in a decrease in soil organic matter, acidity, soil degradation through soil nutrient imbalance, nutrient uptake, acidity, or increasing environmental pollution. To overcome this problem, nutrient management by applying inorganic and organic fertilizer ( biochar + manure + EM-4, fermented for 4 weeks) was needed. The use of inorganic fertilizer is to fulfill the nutrient requirement by maize plant growth and yield (Baharuddin & Tejowulan, 2021; Shah et al., 2023).

Maize grain contains starch (72%), vitamins A and B (3-5%), proteins (10%), oil (4.8%), fibre (5.8%), sugar (3.0%), and ash (1.7%) are all abundant in maize. Fresh corn grain comprises 100 grams, which is equivalent to 361 calories,9.4 grams of protein, 4.3 grams of fat, 74.4 grams of carbohydrates, 1.8 grams of fibre, 1.3 grams of ash, 10.6% water, 140 mg of vitamins, 9 mg of calcium, 290mg of phosphorus, and 2.5 mg of iron**(Mir *et al.,* 2019).**

In India, it is being grown on 9.57 million hectares, producing 28.77million tons with average productivity of 30.06 q/ha, and in Uttar Pradesh, it is being grown on 0.73 million ha, producing 1.69 million tons with an average productivity of 23.31 q/ha **(latest final data, 2019–20). (Agri. Stat. at a glance2021).**

Since nitrogen is a component of protoplasm and chlorophyll and is linked to every live cell's function, it is essential for improving crop yield. In a similar vein, phosphorus is crucial for the storage and transfer of energy in plant systems. Additionally, phosphorus plays a crucial structural role in the formation of phytin, enzymes, phospholipids, and nucleic acids **(Susmita et al. 2024; Daroga*et al.,* 2017).**

These nutrients are heavily removed from soil by maize, together with nitrogen lost by volatilization and leaching, and phosphorus fixed into an inaccessible form. This will lessen the amount of nutrients that are recovered from chemical fertilizer. To solve this issue, an integrated nutritional environment in the soil is implemented through the use of organic manure, biofertilizers, and chemical fertilizers. Even though using chemical fertilizers more frequently can enhance production, there is a risk that this will worsen soil fertility and characteristics and cause pollution. Only the application of organic manure or microbial inoculation can keep it at a sustainable level**(Osman and Osman, 2013).** In recent years, intensive farming practices using high-yielding cultivars with imbalanced fertilization have resulted in the over-mining of native soil nutrients that adversely affect crop production and soil fertility status (Santhoshkumar et al. 2023).

The organic manure is mixed in. After microbial decomposition, FYM is a well-known source that releases nutrients in a simpler and usable form. However, organic manure cannot completely replace the crop's nutritional needs. Because the demand for nutrients is very higher than the supply. As a result, sensible evaluation of the use of both organic and inorganic sources is required to obtain a level of output that is sustainable (**Parama and Munawery, 2012).**

Azotobacter and phosphate solubilizers, two eco-friendly, low-cost agricultural inputs, have demonstrated significant potential in recent years for microbial fertilization. For the purpose of energy conservation, research into biological nitrogen fixation and phosphorus solubilization is desperately needed**(Riaz*et al.,* 2020).** The objective of the present experiment is to study the effect of integrated nutrient management on the growth and yield of maize.

**Method and Materials**

**Experimental Site**:

The study was carried out on the Students' Instructional Farm (SIF) at Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, and weather data for the maize crop during the Kharif season of 2022–2023 were generated by the Department of Agronomy's agro-meteorological observatory. The experiment farm is located in Uttar Pradesh's Indo-Gangetic Alluvial Tract.

**Crop husbandry**

Field preparation involved tractor-driven ploughing with a disc plough, followed by cross-harrowing and levelling. After the land was prepared, the experiment was set up according to the treatment plan across 36 plots. Each plot measured 6 ×5 m2 with a plant-to-plant distance of 60cm × 20cm. Farmyard manure (FYM) was applied as a basal dose at a rate of 10 q ha⁻¹. Fertilizers weighed according to treatment recommendations, were evenly applied and mixed into the soil of each plot. Using Urea (46 %), DAP (46 % P2O5 and 18 % N), and murate of potash (60 % K2O), respectively, the crop was uniformly fertilized at a rate of 120 kg N, 60 kg P2O5, and 60 kg K2O ha-1. A full dose of phosphorus, potassium, and one-third of nitrogen were applied as basal at the time of sowing. The remaining 2/3 of the nitrogen was added in two equal portions, 1/3 after the first irrigation and 1/3 after the second. On June 22, 2022, certified seeds of the maize DKC-7074 were seeded. A uniform seed rate of 18 to 22 kg per hectare was sown by hand behind the country plough at the right moisture level, and the planking was done correctly to cover the seeds in the furrow. When the cob head reached a golden yellow hue and the leaves and stem started to turn dry, the crop was harvested.

**Detail of treatments and design**

The experiment was conducted in randomized block design, with 12 treatments combined in 3 replications.

**Table -1: detail of the treatment combinations**

|  |  |
| --- | --- |
| **Symbol** | **Treatment details** |
| T1 | Control |
| T2 | 75%RDF+FYM@5tonnes per hectare |
| T3 | 100%RDF+FYM@5tonnes per hectare |
| T4 | 75%RDF+FYM@10tonnes per hectare |
| T5 | 100%RDF+FYM@10tonnes per hectare |
| T6 | 75%RDF+VERMICOMPOST@2.5tonnes per hectare |
| T7 | 100%RDF+VERMICOMPOST@2.5tonnes per hectare |
| T8 | 75%RDF+VERMICOMPOST@5tonnesper hectare |
| T9 | 100%RDF+VERMICOMPOST@5tonnes per hectare |
| T10 | 75%RDF |
| T11 | 100%RDF |
| T12 | 125%RDF |

**Statistical analysis**: The growth parameters and yields were recorded and analyzed as per Gomez (1984) the tested at a 5% level of significance to interpret the significant differences.

**Result and Discussion**

**Growth parameters**

The study revealed that the plant population was highest in **T9 (7.0 plants/meter),** followed by **T5 and T7 (6.9 plants/meter),** while the lowest was in **T1 (Control) with 6.0 plants/meter.** Plant height was significantly influenced by treatments, with the tallest plants recorded in **T9 (220 cm),** followed by **T5 (218.9 cm)** and **T7 (218 cm),** whereas the shortest plants were in **T1 (190 cm).** Similarly, dry matter accumulation was highest in **T9 (227 g/plant),** followed by **T5 (226.2 g/plant)** and **T7 (225.5 g/plant),** while the lowest was in **T1 (195.1 g/plant).** Treatments with **100% RDF combined with organic amendments (FYM or vermicompost)** resulted in better growth and biomass production. These results are in accordance with the findings of**Raskar*et al*. (2013), Baradhan and Kumar (2018**) and **Mahato*et al.* (2020)**

**Table 2: Effect of different treatment combinations of growth parameters.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Symbol** | **Treatment details** | **Plant population**  **(Running meter)** | **Plant height**  **(cm)** | **Dry matter (g/plant)** |
| **At maturity stage** | | |
| T1 | Control | 6 | 190 | 195.1 |
| T2 | 75 % RDF + FYM@5tonnes per hectare | 6.5 | 209 | 220.3 |
| T3 | 100 % RDF + FYM@5tonnes per hectare | 6.8 | 216.6 | 224.4 |
| T4 | 75 % RDF + FYM@10tonnes per hectare | 6.6 | 214 | 222.3 |
| T5 | 100 % RDF + FYM@10tonnes per hectare | 6.9 | 218.9 | 226.2 |
| T6 | 75 % RDF + VERMICOMPOST@2.5tonnes per hectare | 6.6 | 210 | 221 |
| T7 | 100 % RDF + VERMICOMPOST@2.5tonnes per hectare | 6.8 | 218 | 225.5 |
| T8 | 75 % RDF + VERMICOMPOST@5tonnesper hectare | 6.8 | 215.1 | 223 |
| T9 | 100 % RDF + VERMICOMPOST@5tonnes per hectare | 7 | 220 | 227 |
| T10 | 75 % RDF | 6.4 | 207 | 218 |
| T11 | 100 % RDF | 6.5 | 212.5 | 221.6 |
| T12 | 125 % RDF | 6.7 | 216 | 223.8 |
| **SEd ±** | | **0.05** | **4.710** | **4.850** |
| **C.D. (P=0.05)** | | **NS** | **9.831** | **10.124** |

**Yield attributing characters**

The study showed that cob length, cob weight, number of rows per cob, and grain characteristics were significantly influenced by different treatments. The longest cob was recorded in **T9 (17.7 cm),** followed by **T5 (17.2 cm)** and **T12 (17.0 cm),** while the shortest was in **T1 (Control, 12 cm).** The highest cob weight was observed in **T9 (165.3 g),** followed by **T5 (164.8 g)** and **T7 (163 g),** whereas the lowest was in **T1 (135 g).** The maximum number of rows per cob was recorded in **T9 (14 rows),** followed by **T5 (13.2 rows)** and **T3 (12.4 rows),** while the control had the lowest **(5.5 rows).** The number of grains per cob was highest in **T9 (420 grains),** followed by **T5 (419 grains)** and **T7 (417 grains),** while the lowest was in **T1 (205 grains).** Similarly, the maximum grain weight per cob was observed in **T9 (106.2 g),** followed by **T5 (105.4 g)** and **T7 (104 g),** while the lowest was in **T1 (91 g).** These results are in conformity with the finding of **Gupta *et al.* (2018), Raman and Suganya (2018) and Coulibaly*et al.* (2019)**

**Table 3 Effect of different treatment combinations on yield attributing character**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Symbol** | **Treatment details** | **Length of the cob (cm)** | **Weight of Cob (g)** | **No. of rows per cob** | **Number of grains cob-1** | **Number of grains weight cob-1** |
| T1 | Control | 12 | 135 | 5.5 | 205 | 91 |
| T2 | 75%RDF+FYM@5tonnes per hectare | 14.8 | 151 | 6.5 | 408 | 97.9 |
| T3 | 100%RDF+FYM@5tonnes per hectare | 16.4 | 162.3 | 12.4 | 416 | 102 |
| T4 | 75%RDF+FYM@10tonnes per hectare | 15.7 | 157 | 8.6 | 412.7 | 99.5 |
| T5 | 100%RDF+FYM@10tonnes per hectare | 17.2 | 164.8 | 13.2 | 419 | 105.4 |
| T6 | 75%RDF+VERMICOMPOST@2.5 tonnes per hectare | 15 | 155.5 | 6.9 | 409.1 | 98.3 |
| T7 | 100%RDF+VERMICOMPOST@2.5tonnes per hectare | 16.9 | 163 | 12 | 417 | 104 |
| T8 | 75%RDF+VERMICOMPOST@5tonnesper hectare | 16 | 159 | 9.5 | 414.2 | 101.1 |
| T9 | 100%RDF+VERMICOMPOST@5tonnes per hectare | 17.7 | 165.3 | 14 | 420 | 106.2 |
| T10 | 75%RDF | 14.4 | 148.5 | 6.2 | 406.5 | 97.2 |
| T11 | 100%RDF | 15.3 | 157 | 8 | 410.3 | 99 |
| T12 | 125%RDF | 17 | 161.1 | 10.4 | 414.2 | 101.7 |
| **SE(d)** | | **0.408** | **3.421** | **0.137** | **8.798** | **2.462** |
| **CD (P=0.05)** | | **0.851** | **7.142** | **0.286** | **18.364** | **5.138** |

**Yield**

The study revealed significant effects of different treatments on straw and grain yield. The highest **straw yield** was recorded in **T12 (119.15 q/ha)** and **T9 (119.11 q/ha),** followed by **T8 (117.91 q/ha)** and **T7 (117.53 q/ha),** whereas the lowest was in **T1 (Control) with 73 q/ha.** Similarly, the highest **grain yield** was observed in **T9 (65.30 q/ha),** followed by **T5 (63.80 q/ha)** and **T7 (62.10 q/ha),** while the lowest was in **T1 (33.00 q/ha).** Treatments with **100% RDF combined with FYM or vermicompost significantly increased both straw and grain yield** compared to the control. Similar results were found by **Shah and Wani (2017), Singh *et al.* (2017) and Kumar *et al.,* (2022)**

**Table 4: Effect of different treatment combinations on yield (q ha-1)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Symbol** | **Treatment details** | **Straw yield (q/ha)** | **Grain Yield (q/ha)** |
| T1 | Control | 73 | 33.00 |
| T2 | 75 % RDF + FYM@5tonnes per hectare | 110.97 | 52.20 |
| T3 | 100 % RDF + FYM@5tonnes per hectare | 117.75 | 60.50 |
| T4 | 75 % RDF + FYM@10tonnes per hectare | 115.32 | 57.60 |
| T5 | 100 % RDF + FYM@10tonnes per hectare | 117.39 | 63.80 |
| T6 | 75 % RDF + VERMICOMPOST@2.5tonnes per hectare | 112.00 | 54.00 |
| T7 | 100 % RDF + VERMICOMPOST@2.5tonnes per hectare | 117.53 | 62.10 |
| T8 | 75 % RDF + VERMICOMPOST@5tonnesper hectare | 117.91 | 59.40 |
| T9 | 100 % RDF + VERMICOMPOST@5tonnes per hectare | 119.11 | 65.30 |
| T10 | 75 % RDF | 106.83 | 50.00 |
| T11 | 100 % RDF | 114.01 | 55.50 |
| T12 | 125 % RDF | 119.15 | 61.00 |
| **SEd ±** | | **2.23** | **1.26** |
| **C.D. (P=0.05)** | | **4.66** | **2.64** |

**Conclusion**

The study revealed that **100% RDF + Vermicompost @ 5 t/ha (T9)was the most effective treatment,** significantly enhancing maize growth, yield attributes, and yield. **T9 recorded the highest plant height (220 cm), dry matter (227 g/plant), grain yield (65.30 q/ha), and straw yield (119.11 q/ha),** showing a substantial increase over the control. Integrating **organic amendments (FYM or vermicompost) with RDF improved crop performance** compared to sole RDF applications.

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