Effect of Nutrient Combination on Growth and Yield of Maize

**ABSTRACT**

Maize production in Uttarakhand faces several interrelated constraints that hinder its productivity and profitability. The region's diverse topography, particularly in hilly areas, leads to fragmented and terraced land holdings, making mechanization difficult and limiting large-scale cultivation. A comprehensive field experiment was meticulously planned and executed during the *kharif* season of 2021 at the esteemed Doon Valley College of Education, nestled in the serene locale of Thakurpur, Selaquai, Dehradun, Uttarakhand. The primary objective was to assess the effect of integrated nutrient management, combining organic and inorganic nutrients, in optimizing the growth and yield of irrigated maize. The experiment was carried out using randomized block design with three replications. The treatments consists of nutrient combinations, namely T1 - Control, T2 - 100% Recommended Dose of Fertilizers (RDF), T3 - 75% RDF, T4 - 50% RDF, T5 - 75% RDF + 25% Organic Manure (OM), T6 - 50% RDF + 50% OM, T7 - 75% RDF + 25% OM + Zinc Sulphate, T8 - 100% RDF + Zinc Sulphate,
T9 - 50% RDF + 50% OM + Zinc Sulphate. The maize variety utilized in this research was Kanchan-25, chosen for its excellent adaptability and productive capacity. During the growing season, thorough observations were conducted on various growth indicators including plant height, plant density, dry matter accumulation, and leaf area index (LAI). Moreover, significant yield-related characteristics such as the count of leaves per plant, grains per cob, weight of the cob, grain yield, and stover yield were likewise noted. Of all the nutrient treatments evaluated, the combination of 50% recommended chemical fertilizers (RDF), 50% organic manure, and zinc sulphate (T9) was particularly notable. This treatment greatly enhanced plant growth, leading to increased dry matter production and a larger leaf area. It also produced the highest yield results increased grain and stover outputs. These findings clearly highlight the advantages of combined nutrient management. This method combines the rapid nutrient release of chemical fertilizers with the enduring soil-enhancing benefits of organic manure, promoting robust crop development and optimizing yield Moreover, it offers a sustainable and eco-friendly way to boost maize productivity, showing that it's possible to achieve high yields without compromising on responsible farming practices.

*Keywords: Organic manure, Zinc Sulphate, RDF, Growth and Yield parameter*

**INTRODUCTION**

Maize (*Zea mays L.),* often referred to as the "Queen of Cereals," plays a vital role in global agriculture due to its exceptional capacity for high productivity. In India, it ranks third in total cereal production just after wheat and rice underscoring its importance in the country's food and economic systems. Globally, maize is cultivated on approximately 202 million hectares across 166 countries, producing an impressive 1,162 million metric tons during the 2019–2020 season, with an average yield of 5.75 metric tons per hectare (FAO & IIASA, 2021). China stands at the forefront of this production, contributing nearly 288.84 million metric tons. In India, maize occupies about 9.569 million hectares, yielding 28.766 million metric tons with an average productivity of 3.01 tons per hectare (Anonymous, 2020). The leading maize-growing states include Karnataka, Madhya Pradesh, Bihar, Tamil Nadu, Telangana, Maharashtra, and Andhra Pradesh.

Belonging to the Poaceae family, maize is highly adaptable and can thrive across a range of climatic zones from cool temperate hills to dry desert margins because of its photoperiod-insensitive nature. This flexibility allows it to be cultivated in all three seasons, further justifying its regal nickname ‘‘Queen of Cereals’’(Zhang *et al.,*2023)*.* However, one of the challenges with maize is its high nutrient demand. It grows rapidly and depletes vital soil nutrients particularly nitrogen (N) and phosphorus (P) at nearly every stage of its growth (Coetzee *et al*., 2017).Maintaining soil fertility is therefore critical for sustaining high yields. Although chemical fertilizers have become a standard tool for boosting crop output, their escalating costs are cutting into farmers' profits. More concerning is the long-term damage that can result from their unbalanced or excessive use. When fertilizers are not applied judiciously, they can disrupt the soil's natural nutrient balance, degrade its structure, and ultimately reduce its fertility making it increasingly difficult to sustain healthy crop growth. Prashar *et al*.(2025).In many regions, intensive farming practices, the cultivation of nutrient-exhaustive crops like maize, and a lack of organic manure use have led to a significant decline in soil health. Over time, this has reduced the effectiveness of even recommended doses of nitrogen fertilizer. Given this situation, there is a growing emphasis on integrated nutrient management systems. These systems combine both organic and inorganic nutrient sources to enhance productivity while maintaining soil health over the long term. (Das *et al*.,2019).In India, an imbalance in fertilizer pricing has further complicated nutrient management. Nitrogen-rich fertilizers like urea are heavily subsidized, making them cheaper than phosphorus and potassium-based alternatives. This has led to overuse of nitrogen and under-application of other essential nutrients, reducing the efficiency of nutrient uptake and harming both crop yields and soil condition (Gulat *et al.,* 2017).

Maize production in Uttarakhand faces several interrelated constraints that hinder its productivity and profitability. The region's diverse topography, particularly in hilly areas, leads to fragmented and terraced land holdings, making mechanization difficult and limiting large-scale cultivation. Soil fertility is often poor, with low nitrogen levels being a significant limitation, especially in the Tarai region’s Mollisols, requiring precise nutrient management through split applications. Inadequate and irregular irrigation, particularly in rainfed areas, further compounds stress on crops. Weed infestation and diseases such as bacterial stalk rot, downy mildew, and leaf blight are prevalent and often unmanaged due to limited awareness and access to crop protection measures (Chinyo *et al*.,2024)

To overcome these issues, integrating organic manures such as farmyard manure or compost with chemical fertilizers is proving to be an effective strategy. This approach not only boosts maize productivity but also improves the physical, chemical, and biological properties of the soil. Research has shown that combining organic and inorganic sources of nutrients can lead to better crop performance.

**MATERIALS AND METHODS**

The experiment was carried out during rabi season of 2020-2021 at the Agriculture Farm of Doon Valley College of Education, situated in the locale of Thakurpur, Selaquai, Dehradun. The Doon Valley region experiences a sub-tropical to temperate climate owing to its varying elevations. The experimental site was situated at the North latitude of 30.3336o and 77.9374o East latitude with average rainfall of 630mm.The soil of experimental field is sandy loam to silty clay loam texture with alluvial and loamy soil dominating. These soils are moderate to well drained and light to medium textured with the pH of 6.2 to 7.0 and moderate organic matter.The field was ploughed and given pre sowing irrigation. After preparatory tillage, the field was divided into 27 blocks using Randomized block design with three replications and nine treatments. These treatments included: T1 - control, T2 - 100% Recommended Dose of Fertilizers (RDF), T3 - 75% RDF, T4 - 50% RDF, T5 - 75% RDF + 25% Organic Manure (OM), T6 - 50% RDF + 50% OM, T7 - 75% RDF + 25% OM + Zinc Sulphate, T8 - 100% RDF + Zinc Sulphate, and T9 - 50% RDF + 50% OM + Zinc Sulphate. The crop variety utilized was Kanchan-25, sown on July 4, 2021 and harvested on October 18, 2021.Sowing was conducted with a spacing of 15x15 cm at a depth of 4 to 5 cm through seed dibbling, ensuring optimal seed germination, with a seed rate of 20 kg/ha.

Basal doses of Farm Yard Manure (FYM), Diammonium phosphate (DAP) and muriate of potash (MOP) were evenly distributed across the field, while urea was administered in two equal split doses (at 30 and 45 days after sowing. The herbicides are applied based on the treatment. For precise and representative data gathering, essential growth parameters like plant height, the count of leaves per plant, leaf area index (LAI), and dry matter production (DMP) were methodically documented from randomly chosen and marked plants in each experimental plot. This approach was used to remove sampling bias and to accurately represent the actual variability in each treatment. Measurements were recorded at suitable growth phases, adhering to established agronomic practices, to observe the physiological progress of the maize plants across different nutrient conditions. The maize cobs were gathered at harvest only after verifying that the moisture content of the grain had fallen below 10%, an essential threshold signifying physiological maturity. This method not only guaranteed precise yield measurements but also reduced post-harvest losses linked to elevated moisture levels, including fungal infection and deterioration during storage. The integration of random sampling throughout growth and accurate timing of harvest enhanced the dependability and repeatability of the experimental results

**RESULT AND DISCUSSION**

**Growth characters**

The application of various organic and inorganic fertilizers to maize significantly influenced its growth parameters. Plant height differed significantly due to different treatments at all stages of crop growth. The plant height was found to increase progressively with advancement in growth of the crop upto harvest. Among the treatments the height plant height (195.64 cm) was found in T950% RDF + 50% organic manure + zinc sulphate which was significant over other treatments this was followed by 75% RDF + 25% OM + Zinc Sulphate T7(189.82).This might be due to immediate availability of essential macronutrients like nitrogen(N), Phosphorus(P) and Potassium(K) which are essential for cell division and elongation.50% organic manure improves soil structure, water holding capacity and gradually releases nutrients over time, ensuring longer nutrient supply throughout the growth stages. Organic manure promotes microbial activity , increases humus content and improves soil aeration , which enhances root proliferation. A stronger root system supports greater nutrient and water absorption, directly influencing plant height. Zinc is crucial for auxin synthesis, enzyme activation and protein synthesis all of which are essential for elongation and development. These finding are in comparison with *Chen et al*.(2024). The least plant height was found in T1 (Control) followed by T4 50% RDF (181.42cm) where inorganic fertilizers alone are used due to which there is a possibility of leaching or volatization.

 Highest leaf area index (1.42) was recorded with the application of (T9)50% RDF + 50% organic manure + zinc sulphate which was followed by 1.26 in (T7) 75% RDF + 25% OM + Zinc Sulphate. This might be due to the immediate supply of nutrient availability and long term supply of nutrients from both organic and inorganic fertilizers. Zinc promotes chlorophyll synthesis, photosynthetic activity and hormonal regulation which are important for leaf expansion and increasing leaf surface area. These findings are similar to Singh *et al.*(2022).In contrast to this lower leaf area index was found in (T1) control(1.02) followed by (T4) 50% RDF (1.04) this might be due to insufficient nutrient supply by only RDF this in comparison with Kaur *et al.(*2024)

 Highest No. of leaves per plant (1.42) were found in the treatment T9 (50% RDF + 50% organic manure + zinc sulphate) followed by (T7) 75% RDF + 25% OM + Zinc Sulphate (20.24). This superior leaf production can be attributed due to the combined application of organic and chemical fertilizers improve soil nutrient uptake by increasing root proliferation which causes better nutrient synchronization with crop demand. In addition to this it increases the availability of certain micronutrients like zinc and iron which are essential for leaf formation, this synergy led to greater vegetative vigour these findings are similar with Ahmed *et al.*(2021). Where as the least no.of leaves are found in the treatment (T7) control 15.22 followed by (T4) 50% RDF16.22 because reduced availability of fertilizer doses led to nutrient imbalance which affected cell division, auxin production and enzyme function resulting in fewer leaves per plant compared to other treatments. These findings are similar to Ram *et al*.(2023)

Dry matter accumulation is a key indicator of crop growth and is closely linked to yield potential .It reflects the plants overall biosynthesis activity during various development stages. In the present study, total biosynthetic activity during various development stages. The total DMP varied significantly among other treatments. The maximum total dry matter accumulation (75.82g)was observed with application of (T9) 50 % RDF + 50% organic manure + zinc sulphate which was followed by (T7) 75% RDF + 25% OM + Zinc Sulphate (73.24g). Significantly higher dry matter accumulation in fertilizer treated plots might be due to the availability of quick acting nutrients from inorganic fertilizers and slow release nutrients from organic manure which provides continues supply of nutrients, in the same time organic matter supplies good amount of organic carbon and increases plant growth over time. Zinc is increases cell division , cell elongation which there by increases bio mass accumulation. These findings are similar with Ramesh and Chhabra 2023. Where as the minimum dry matter accumulation is found in (T1) control 45.82 followed by (T4) 50% RDF56.48 due to the in availability of organic input and zinc which causes reduced nutrient availability and decreased physiological efficiency which is in comparison with Kaur *et al.*2023

**Grain yield**

The grain yield was significantly affected by integrated nutrient management treatments in maize. The highest grain yield was obtained in (T9) 50 % RDF + 50% organic manure + zinc sulphate (33.81) q ha-1 which was followed by (T7) 75% RDF + 25% OM + Zinc Sulphate (31.77) q ha-1.The increase in the yield under these treatments might be because of enhanced nutrient turnover and availability of nutrient from both the fertilizers along with this zinc plays a vital role in pollen development, grain setting and grain filling which supports the formation of strong grain sink resulting in larger and heavier grains. These findings are in comparison with Mahato and Dutta 2020. The least value of grain yield was found in (T1) 17.65 which was followed (T4) by 50% RDF 20.65 as there is lower soil quality due to the absence of organic manure and zinc which is important for grain development which are in comparison with Liu *et al*.(2020)

**stover yield**

The stover yield of maize was observed to follow the same trend as that of grain yield where the highest stover yield was obtained in the treatment (T9) 50 % RDF + 50% organic manure + zinc sulphate (33.81) q ha-1 which was followed by (T7) 75% RDF + 25% OM + Zinc Sulphate (31.77) q ha-1.The least stover yield was found in (T1) 17.65 which was followed (T4) by 50% RDF 20.65.

**Harvest Index**

In regarding to harvest index it was significantly influenced by different treatments. The height harvest index was found in the treatment (T9) 50 % RDF + 50% organic manure + zinc sulphate (45.82) which was followed by (T7) 75% RDF + 25% OM + Zinc Sulphate (44.77) due to the excellent development of maize plant under higher nutrient availability throughout the crop growth period especially during critical period. These results are in accordance with Abid et al.(2020), where as it is found to be least in (T1) 33.73which was followed (T4) 38.55

**Table1. Effect of Nutrient Combination on Growth and Yield of Maize**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Treatments** | **Plant Height (cm)** | **Dry weight** | **LAI** | **No. of leaves /plant** | **Grain yield****q/ha** | **Stover****Yield****q/ha** | **HI** |
| T1 | 172 | 45.8 | 1.02 | 15.2 | 17.6 | 28.1 | 33.7 |
| T2 | 188.8 | 63.8 | 1.06 | 16.4 | 25.5 | 37.6 | 39.8 |
| T3 | 183.3 | 61.2 | 1.05 | 16.3 | 25.0 | 34.6 | 39.4 |
| T4 | 181.4 | 56.4 | 1.04 | 16.0 | 20.2 | 31.4 | 38.5 |
| T5 | 187.2 | 64.4 | 1.11 | 17.0 | 25.6 | 38.7 | 43.3 |
| T6 | 188.1 | 64.8 | 1.16 | 18.0 | 29.2 | 39.2 | 44.3 |
| T7 | 189.8 | 73.2 | 1.26 | 20.2 | 31.7 | 41.4 | 44.7 |
| T8 | 189.2 | 68.2 | 1.22 | 18.2 | 30.5 | 40.5 | 44.6 |
| T9 | 195.6 | 75.8 | 1.42 | 21.2 | 33.8 | 42.0 | 45.8 |
| C.D | 9.69 | 3.36 | 0.06 | 0.91 | 1.43 | 1.928 | 2.20 |
| SE(d) | 4.53 | 1.57 | 0.028 | 0.42 | 0.66 | 0.90 | 1.03 |

**CONCLUSION**

The study found that combining 50% RDF , 50% organic manure along with zinc sulphate (T9) gave best results for maize growth and yield. This mix provided both quick and long lasting nutrients, the chemical fertilizers supported early growth, while organic manure improved soil health and ensured steady nutrient release. Zinc played a key role in boosting grain formation and overall plant development. As a result maize under (T9) showed taller plants, more leaf and higher biomass. This led to better grain and stover yield with an improved harvest index. Overall (T9) proved to be a productive , sustainable and farmer friendly option.

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