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Effect of Integrated Nutrient Management on Growth and Yield Parameters of Maize (*Zea mays*.) (Poaceae)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Original Research Article

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ABSTRACT

Aim: To study effect of integrated nutrient management on growth and yield of maize (*Zea mays* L.).
Study Design: A field experiment was conducted at Agronomy farm, school of agriculture, Lovely Professional University, Punjab, India during *kharif* season of 2022.
Methodology: The experiment trail was laid out in randomized block design. It consisted of three replications with ten treatment combinations *i.e.* T_1- 100% Recommended dose fertilizers (RDF) + Farmyard manure(FYM)15 t ha^{-1};, T_2- 100% RDF + Vermicompost7.5 t ha^{-1};, T_3-100% RDF + seed priming with Biofertilizers (*Azotobacter*), T_4- 75% RDF + FYM 11 t ha^{-1};, T_5- 75% RDF + Vermicompost 5.6 t ha^{-1};, T_6-75% RDF +seed priming with Biofertilizers (*Azotobacter*);,T_7- 50% RDF basal dose + Nano urea spray 0.15% (25 and 50 Days After Sowing);, T_8- 50% RDF basal dose + Nano urea spray0.30% (25 and 50 DAS);, T_9- Vermicompost 3.5 t ha^{-1} + seed priming with Biofertilizers (*Azotobacter*); T_{10}- control.

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Results: The results showed that application of T_2 100% RDF + Vermicompost 7.5 t ha^{-1} had significant effect on growth and yield of maize. The plant height, number of leaves per plant and dry matter accumulation were also significantly higher in T_2followed by $T_1$100% RDF + FYM 15 t ha^{-1}. The highest grain yield (64.36 q ha^{-1}) was obtained in T_2 followed by T_1 (63.6 q ha^{-1}), T_3 (57.92 q ha^{-1}) andT_8 (56.16 q ha^{-1}).
Conclusion: Overall, the results and the study suggest the use of integrated nutrient management can improve the growth and yield of maize and provide sustainable solution to meet the nutrient requirements of the crop.

Keywords: Biofertilizer; farmyard manure; Nano urea; recommended dose fertilizers; vermicompost.

1. INTRODUCTION

Maize (*Zea mays* L.) is one of the most important cereal, next to rice and wheat and is used as both human food and animal feed. The annual C4 plant belongs to the family Poaceae with its origin in Central America. Maize being one of the most important cereal or grain crop and plays a significant role in the world agriculture economy. It is cultivated throughout the world as it has higher genetic yield potential than any other cerealcrop and hence referred to as “Queen of cereals” [1]. Maize is one of the most versatile crops having wider adaptability under varied agroclimatic conditions. It is cultivated on nearly190 million ha in about 160 countries having wider diversity of soil, climate, biodiversity and management practices that contributes 40 percent in the global grain production [2]. The maize development path in India remains very impressive, with production rising almost 16 times from less than two million tons in the 1950s Currently 47% of the corn produced in India is utilized in the food industry and 13% as animal feed and starch industry consumes about 14% of the corn. However, there is agrowing trend to use maize as digested food, which contributes to about 7% of annual maize consumption inthecountry [3].

Developing new techniques and varied cropping practices around the world has led to massive production of the crop all over the world. The indigenous and native methods of cultivation have proven to be insufficient to fulfil the food requirement for the rapidly growing population and thus the world has paved the way to usethe chemical fertilizers for the immediate surge in the production and match the demand of the food [4,5]. Poor management of fertilizer is the key factor responsible for obtain in glow yield as well as it leads to various environmental hazards such as eutrophication, leaching of nutrients and soil pollution etc., so in order to achieve optimum supply of nutrients application of organic sources, bio-fertilizers and micro-nutrients is recommended [6].

Therefore, integrated nutrient management (INM) aims to maintain soil fertility by suppling plant nutrients to anoptimal level for sustaining crop productivity. Adoption of this method also helps farmers to alleviate many issues such as poverty by cutting cost of products and food insecurity and enhancing crop production and improving quality of produce. However, the lack of information about integrated nutrient management indifferent crops and its various practices, is posing restrictions for its adoption and expansion. Thus, keeping in view the INM as need has present research was structured. The information about the importance and need of INM needs to be properly addressed and simplified so that ordinary farmers can understand and use it as much as possible.

2. MATERIALS AND METHODS

The field experiment was conducted in Agri farm at School of Agriculture, lovely professional University, Phagwara, Punjab during *kharif* season 2022 to study effect of integrated nutrient management (INM)on growth and yield of *kharif*maize. The experiment was conducted in randomized block design with ten treatment and 3 replications the treatments were as follows.

The experimental area was 450 square meters with 30 plots (5m*3m) 15$m^2$and ‘PMH 13’ Maizevariety as sown in the field with spacing 60 cm(row to row)*20 cm (plant to plant) spacing. Throughout the experiment different growth and yield parameters were recorded.

Table 1. Treatment details

S.no	Treatments
T_1	100% RDF (N:P:K 120:60:30) + FYM @ 15 t ha^{-1}
T_2	100% RDF + Vermicompost @ 7.5 t ha^{-1}
T_3	100% RDF + Seed priming with Biofertilizers (*Azotobacter*)
T_4	75% RDF + FYM @ 11.5 t ha^{-1}
T_5	75% RDF + Vermicompost @ 5.6 t ha^{-1}
T_6	75% RDF + Seed priming with Biofertilizers (*Azotobacter*)
T_7	50% RDF basal dose + two Nano urea spray @ 0.15% (25 and 50 DAS)
T_8	50% RDF basal dose + two Nano urea spray @ 0.30% (25 and 50 DAS)
T_9	Vermicompost @ 4 t ha^{-1} + Seed priming with Biofertilizers (*Azotobacter*)
T_{10}	Control

3. RESULTS AND DISCUSSION

3.1 Growth Parameters

***Plant height*:** Plant height is the important growth parameter in maize which relates with crop growth and knows time to maturity andrelated with maize life span. In Fig. 1 data reveals that significantly highest heightat harvest (191.13cm) was recorded in T_2 100% RDF + vermicompost @7.5 t ha^{-1} followed by $T_1$100% RDF + FYM @ 15 t ha^{-1} (191.07 cm) and lowest plant highest (130.87 cm) was recorded in T_{10}control. T_3 (175.63 cm)and application of T_8 basal dose RDF + nano urea 2 sprays plant height (176.80 cm) is statistically at par with T_1 and T_2.Similar plant height were observed by [7].

***Stem girth*:** Stem girth is an important parameter to evaluate the growth and development of maize crop. Results (Fig. 2) showed that significantly similar stem girth was observed in T_1 and T_2(6.81 cm) followed by T_8 basal dose RDF (NPK) + Nano urea @ 0.30% two sprays (6.67 cm).The lowest stem girth was observed in T_{1O} control (4.69 cm).Similar results were finding with [8]. Singh and Misal [8] reported that the presence of growth hormones, and other earthworm secretions in vermicompost that promotes plant growth and development.

***Dry matter accumulation*:** Plant dry matter is an important parameter that reflects overall productivity of maize crop. In Fig. 3 is shown data on significantly higher dry matter accumulation for T_1 (313.33 g p^{-1})and T_2(315 g p^{-1}) followed by T_3 100% RDF + Seed priming with *Azotobacter* (290 g p^{-1}) and with the basal dose RDF(NPK) + nano urea 2 sprays at 0.15 (T_7) and 0.30%ppm (T_8) the data areT_7 (278.33 g p^{-1})and T_8 (283.33) are par with T_3.The lowest was found in control. The results suggest that applying of organic fertilizers such as FYM and Vermicompost along with inorganic fertilizers may have a positive impact on plant growth and development. Similar findings were observed by [9].

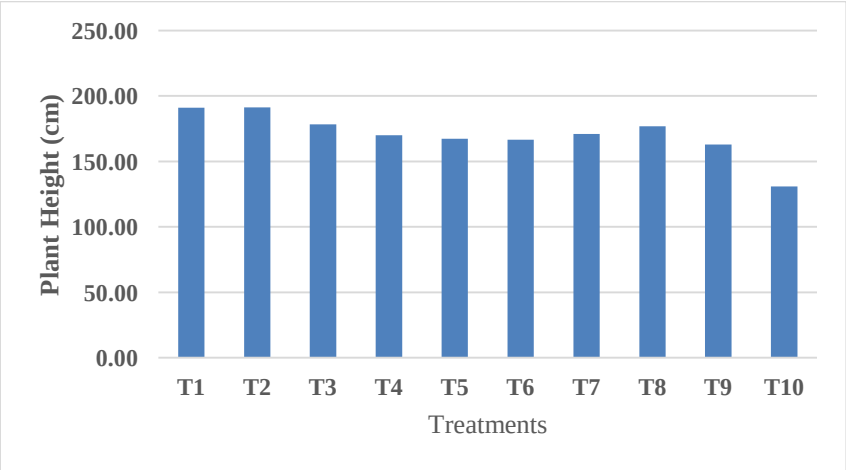

Fig. 1. Effect of plant height at different integrated nutrient management(INM) treatments in maize (*Zea mays*)

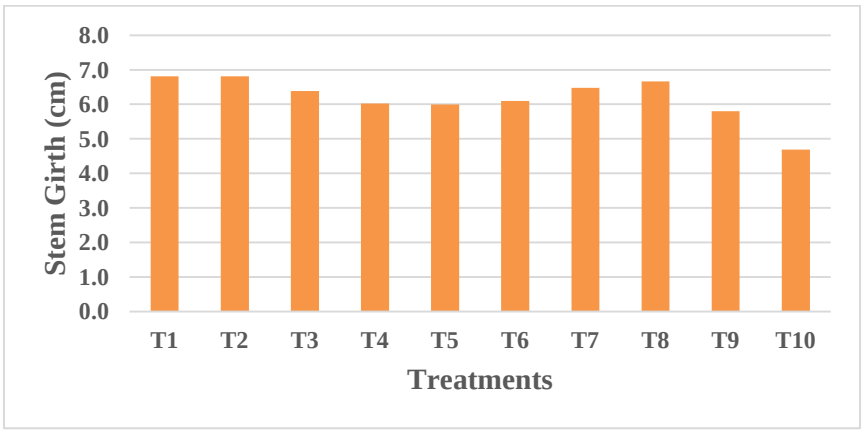

Fig. 2. Effect of stem girth at different INM treatments in maize (*Zea mays*)

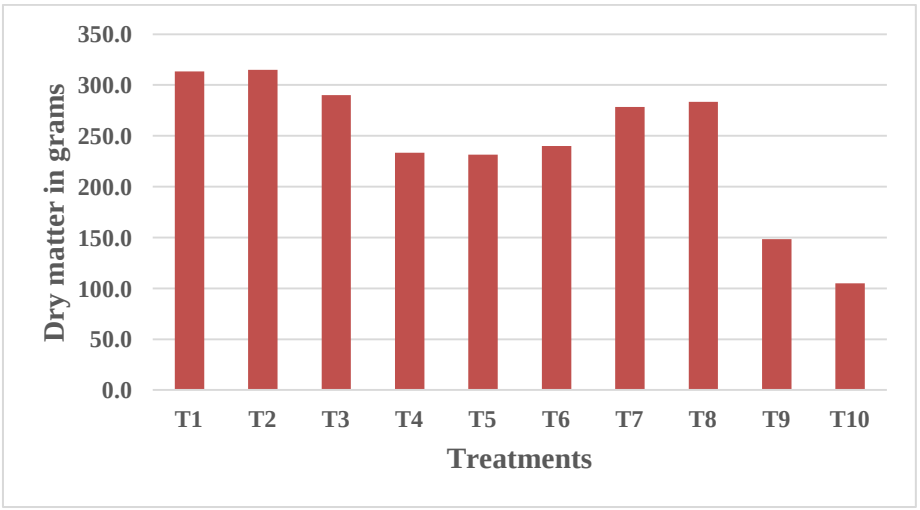

Fig. 3. Effect of dry matter accumulation at different INM treatments in maize (*Zea mays*)

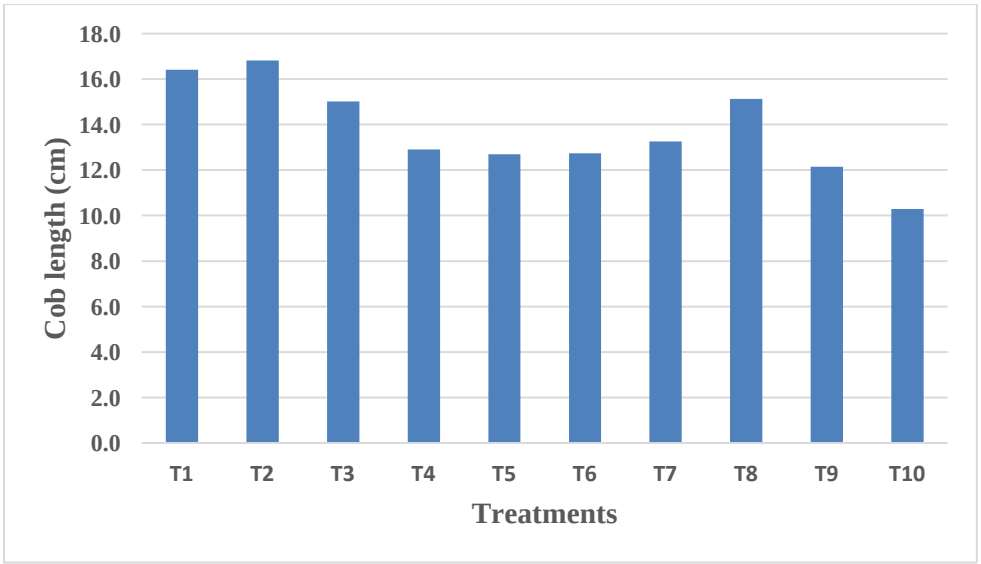

Fig. 4. Effect of cob length at different INM treatments in maize (*Zea mays*)

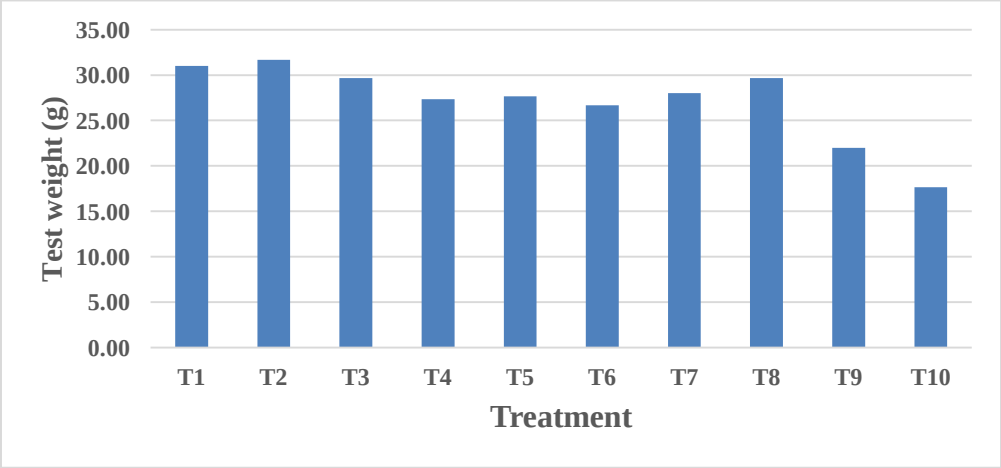

Fig. 5. Effect of Test weight on different INM treatments in maize (*Zea mays*)

3.2 Yield Attributes

Yield attributes are yield characters which directly influence the maize crop yield. Yield attributes like cob length (cm), cob girth (cm), number of grains per row, test weight (g), stover yield and biological yield. In Figs. 4 and 5 data revealed that maximum cob length (16.8 cm) and cob girth (13.05 cm), 100 grain weight (test weight) (31.67 g) was recorded in T_2 with application 100% RDF + Vermicompost @ 7.5 t ha^{-1}followed by T_1 (100% RDF + FYM @ 15 t ha^{-1}) (cob length of 16.4 cm) and (cob girth of 13.04 cm), test weight (31 g)and T_8 basal dose RDF(NPK) + Nano urea 0.30% two sprays (15.1 cm) and(12.90 cm) test weight (29.67 g). The lowest cob length (10.3 cm) and cob girth (9.45 cm)and test weight (17.67 g)was recorded in control (10.3 cm).Sujatha et al. [10] reported that maize yield attributes have positive impact by using organic sources like FYM, vermicompost combined with inorganic sources of nutrients. The use of integrated nutrient management produces nutrients are balanced in soil for plant growth, yield and sustainability. similar results were observed by [11,10].

Grain yield: In Fig. 6 the data showed the effect of integrated nutrient management of different treatments on maize grain yield. Maximum grain yield (64.36 q ha^{-1})was resulted in T_2 with application of 100% RDF + Vermicompost 7.5 t ha^{-1} followed by T_1(63.66 q ha^{-1}) with application of 100% RDF + FYM @ 15 t ha^{-1}.The lowest grain yield was recorded in control (21.28 q ha^{-1}). Similar findings were observed [12].

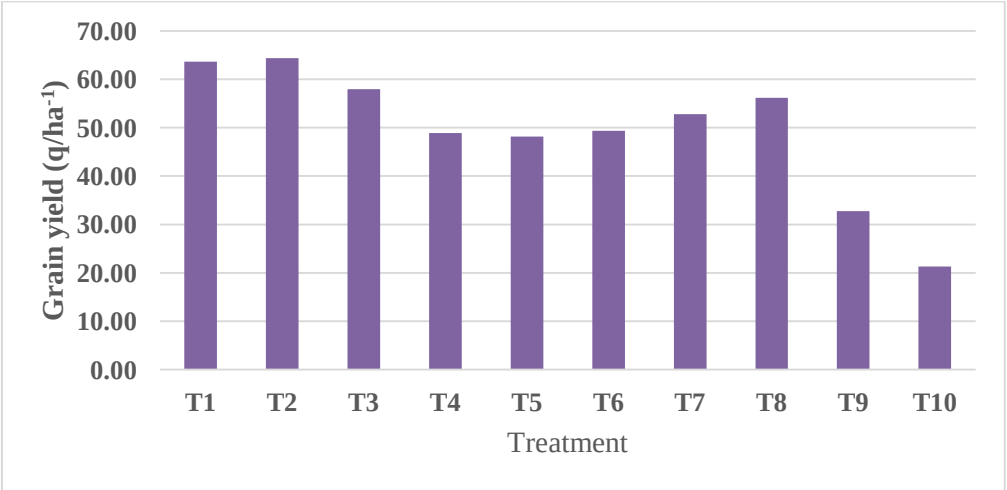

Fig. 6. Effect of grain yield on different INM treatments in maize (*Zea mays*)

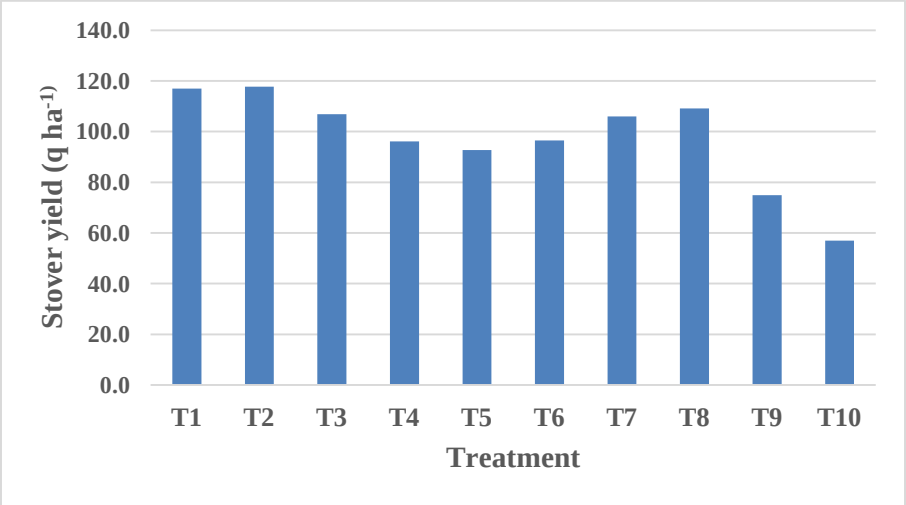

Fig. 7. Effect of stover yield on different INM treatments in maize (*Zea mays*)

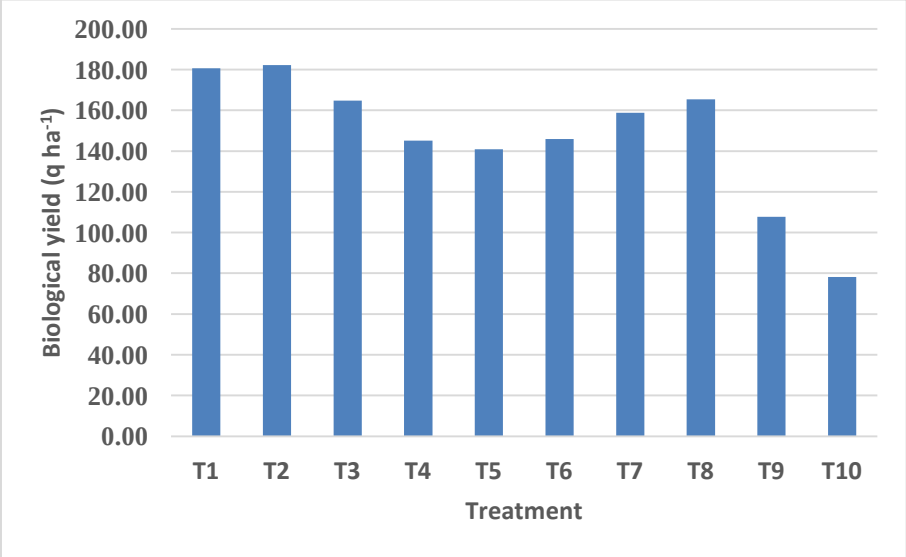

Fig. 8. Effect of Biological yield on different INM treatments in maize (*Zea mays*)

Stover yield: Stover yield is related with maize stalks and stem total dry matter which usually used as animal fodder after grain has been harvested. In Fig. 7 results showed that maximum stover yield (117.8 q ha^{-1}) was recorded $T_2$with application of 100% RDF + Vermicompost @ 7.5 t ha^{-1} followed by (116.9 q ha^{-1}) by applying 100% RDF + FYM @ 15 t ha^{-1}(T_1). The lowest stover yield (56.9 q ha^{-1}) in control (T_{10}).Similar results were observed by [13].

Biological yield: Biological yield is an important parameter in maize cultivation which refers the total amount of dry matter produced by the crop including grain and vegetative parts. Higher biological yield indicates higher plant productivity. In Fig. 8 results shown in maximum biological yield (182.13 q ha^{-1}) was resulted by applying 100% RDF + Vermicompost 7.5 t ha^{-1} followed by applying 100% RDF + FYM 15 t ha^{-1} (180.58 q ha^{-1})(T_1). The lowest biological yield was resulted in control (78.20 q ha^{-1}). Similar results were observed by [14].

4. CONCLUSION

Based on results of the experiment conducted at Agri farm lovely professional university, Punjab, it can be concluded that application 100% RDF + Vermicompost @ 7.5 t ha^{-1}had higher plant growth parameters and yield attributes and

higher grain yield of maize. The study shows that the application of organic manures in combination with chemical fertilizers had positive impact on maize yields and enhancing soil quality and promoting sustainable crop production. Hence, the adoption of integrated nutrient management can be a effective approach to improving maize productivity while maintain the soil health and reducing the use of chemical compounds.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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