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Effect of Organic and Synthetic Fertilizer Management on the Yield and Growth Components of Basmati Rice in Western U.P., India

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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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ABSTRACT

The present investigation was conducted during kharif 2022 at the CRC of Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut (U.P.) to studies the Effect of organic and Synthetic Fertilizer management on the yield and growth components of Basmati Rice in Western U.P. (India). The soil of experimental site was clay- loamy in texture, slightly alkaline, non-saline,

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low in organic carbon, N, P, and high in available K. DTPA extractable micronutrient were in high amount. Eleven treatments, viz., T1 (Absolutely Control), T2 (100:75:0 kg NPK ha-1), T3 (100:75:60 kg NPK ha-1), T4 (Only FYM @ 20 t ha-1), T5 (Only VC @ 20 t ha-1), T6 (50:37.5:30 kg NPK ha-1 + FYM @ 20 t ha-1), T7 (50:37.5:30 kg NPK ha-1 +VC @ 20 t ha-1), T8 (100:75:60 kg NPK ha-1 + FYM @ 10 t ha-1), T9 (100:75:60 kg NPK ha-1 + VC@ 10 t ha-1), T10 (50:37.5:30 kg NPK ha-1 + FYM @ 10 t ha-1) and T11 (50:37.5:30 kg NPK ha-1 + VC @ 10 t ha-1) were tested in RBD with three replication. The study revealed that application of T9 significantly improved the growth and yield attributes thus increasing the yield of rice over control with a corresponding increase of 61.2 and 34.5 percent in grain and straw yield of rice, respectively, although this treatment was found to be on par with T7 and T11. Thus, the inclusion of inorganic with organic sources of plant nutrients together helps to maintain yield stability, increasing the effectiveness of supplied nutrients, and creating favorable soil physical conditions.

Keywords: Basmati rice; nutrient management; VC; FYM; micronutrients.

1. INTRODUCTION

After wheat, rice is a popular staple food among people in many parts of the world. For more than 65% of people, rice is a staple food, and for 70% of Indians, it is a source of work and security of livelihood [1].

"The global population is currently growing at an alarming rate. There is no way to increase net arable land for grain production when the world's population is expanding at an alarming rate. Due to a growing population and food consumption, limited arable land, and other sources of supply, the current farming system is under tremendous pressure to meet rising food demand" [2]. The inefficient use of inputs (fertilizer, water, and labour), growing labor shortages, particularly for rice cultivation, new emerging challenges from climate change, rising fuel prices, increasing cost of cultivation, and socio-economic changes such as labour migration, urbanization, youth disinterest in agricultural work, and worries about environmental pollution are the main obstacles to the productivity and sustainability of rice-based systems in the country. The only option to maintain rice output and fulfil the rising demand from the population is to raise productivity per unit of rice and improve resource utilization. To address this issue and boost yields, crop growers are moving to high-yielding cultivars that respond to fertilizer.

It was discovered that using inorganic fertilizer to maintain cropping increased production only temporarily and had negative long-term effects on soil quality [3]. Unnecessary nutrient application could result in a loss in nutrient-use efficiency, making fertilizer application unprofitable, harming the ecosystem and groundwater quality, posing health risks, and having a negative impact on the climate [4]. "On the other hand, continuous application of organic fertilizer alone on rice fields results in low yield and low N and K content at the mid-tillering stage of rice plants" [5]. "Because of this, using organic manures and inorganic fertilizers together helps to maintain yield stability by correcting minor secondary and micronutrient deficiencies, increasing the effectiveness of supplied nutrients, and creating Favorable soil physical conditions" [6].

2. MATERIALS AND METHODS

Field experiment was conducted during kharif 2022 at the CRC of Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, U.P to studies the effect of organic and Synthetic Fertilizer management on the yield and growth components of Basmati Rice in in Western U.P. (India). Meerut lies in the heart of Western Uttar Pradesh and has semi-arid to sub-tropical climate. Field experiment is located at latitude of 290 40′ N and longitude of 770 42′ E and at an altitude of 237 meters above mean the sea level (MSL). The soil of experimental site was clay- loamy in texture, slightly alkaline, non-saline, low in organic carbon, N, P, and high in available K. DTPA extractable micronutrient were in high amount. Eleven treatments, viz., T_1 (Absolutely Control), T_2 (100:75:0 kg NPK ha^{-1}), T_3 (100:75:60 kg NPK ha^{-1}), T_4 (Only FYM @ 20 t ha^{-1}), T_5 (Only VC @ 20 t ha^{-1}), T_6 (50:37.5:30 kg NPK ha^{-1} + FYM @ 20 t ha^{-1}), T_7 (50:37.5:30 kg NPK ha^{-1} +VC @ 20 t ha^{-1}), T_8 (100:75:60 kg NPK ha^{-1} + FYM @ 10 t ha^{-1}), T_9 (100:75:60 kg NPK ha^{-1} +VC@ 10 t ha^{-1}), T_{10} (50:37.5:30 kg NPK ha^{-1} + FYM @ 10 t ha^{-1}) and T_{11} (50:37.5:30 kg NPK ha^{-1} + VC @ 10 t ha^{-1}) were tested in RBD with three replication. Recommended dose according to treatments were applied at the time of sowing while 50 percent nitrogen was applied as basal and rest 50 percent in two equal splits at 30 and 60 DAS stage through urea. Required quantity of vermicompost and FYM as per treatments was also applied before sowing. Certified treated seed of PUSA Basmati-1 was used for experiment.

3. RESULTS AND DISCUSSION

3.1 Growth and Developmental Studies

Different nutrients treatments had significant effect on various growth parameters *viz.* plant height, number of tillers, leaf area index and dry matter accumulation recorded at different stages of crop growth. Crop fertilized with 100: 75: 60 Kg NPK ha^{-1}+ Vermicompost 10 t ha^{-1} remained at par with that receiving 50: 37.5: 30 Kg NPK ha^{-1}+ Vermicompost 20 t ha^{-1} but proved significantly better than 100: 75: 0 Kg NPK ha^{-1}.

3.1.1 Plant height (cm)

Plant height tended to increase with advancement in crop age, irrespective of the treatments. The rate of growth was higher rate during 30 to 90 days period than slow rate during 90 days to harvest**.** The data regarding the effect of different nutrients treatments on plant height are presented in Fig. 1. Increase in plant height with supplementation of NPK with Zn by Manzoor [7] and Fe by Diwakar [8] have been reported under different agro-climatic conditions. Further, such an increase in plant height might have been attributed to increased supply of essential elements mainly N, P, K, Zn and Fe. All these essential elements are known to have specific metabolic functions in various physiological processes like photosynthesis, respiration and transpiration etc., by being constituent of various metabolites or as co-factor or catalyst in enzymatic processes.

3.1.2 Number of tillers (m^{-2})

“Number of tillers differed significantly under the influence of nutrients at all the crop growth stages in rice. Number of tillers tended to increase with advancement in crop age up to 60 days irrespective of the treatments and then started declining. The data regarding the effect of different treatments on number of tillers m^{-2} are presented in in Fig. 2”. Malla Reddy et al., [9]. Number of tillers m^{-2} increased with successive increase in growth stages up to 60 DAT and then decrease subsequently. The reduction in number of tillers after 60 days resulted from the senescence phase where secondary and tertiary tillers die.

3.1.3 Dry matter accumulation (g m^{-2})

The dry matter accumulation (g m^{-2}) in rice increased with advancement in crop age and reached to a maximum at maturity. The rate of increase was however, slow up to 30 days and reached its peak between 60 days to harvesting. The data regarding the effect of different nutrients treatments on dry matter accumulation are presented in in Fig. 3. Favorable effect of Nitrogen, Phosphorus and Potassium application on dry matter accumulation in rice has also been reported by Haefele et al. [10] and Pal et al. [11].

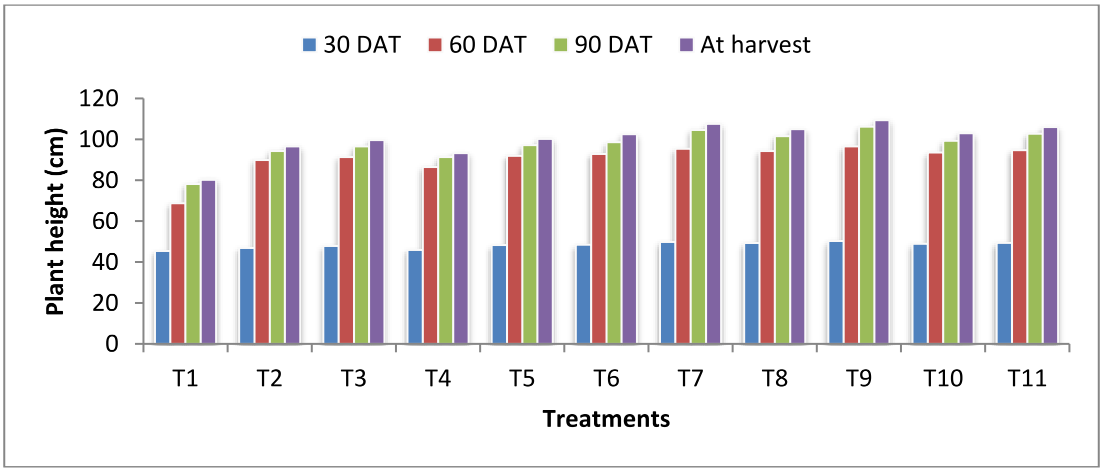

Fig. 1. Effect of organic and synthetic fertilizer management treatments on plant height (cm) in rice at different stages of rice

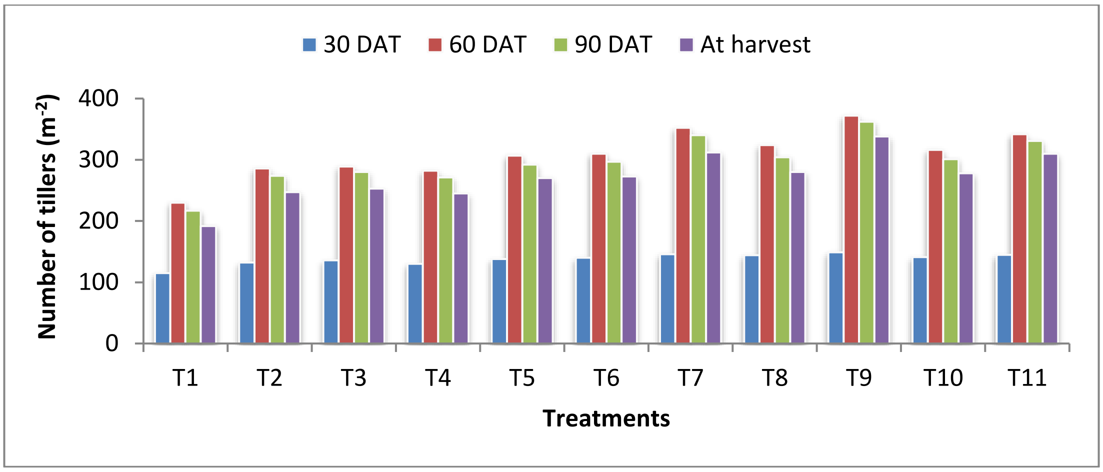

Fig. 2. Effect of organic and synthetic fertilizer management treatments on number of tillers (m^{-2}) at different stages of rice

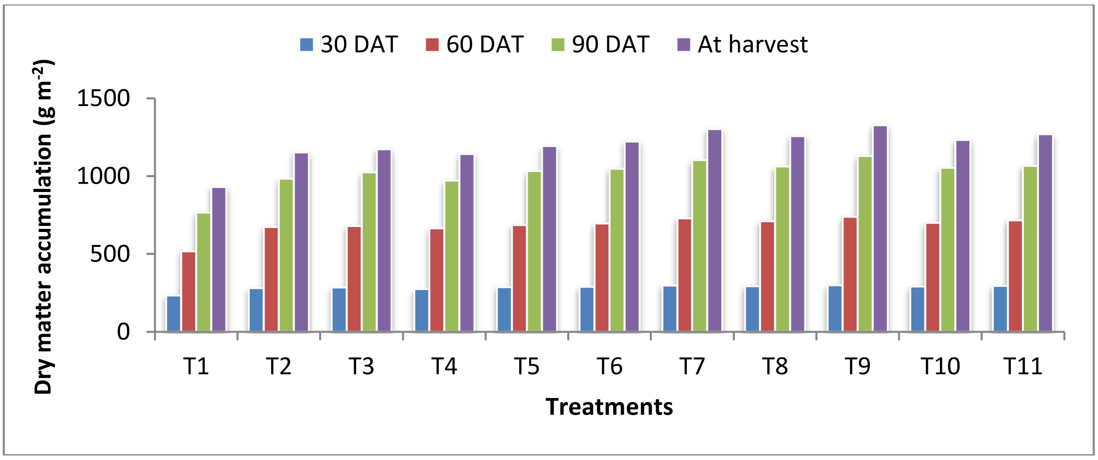

Fig. 3. Effect of organic and synthetic fertilizer management treatments on dry matter accumulation (g m^{-2}) at different stages of rice

3.1.4 Leaf area index

The data pertaining to LAI in rice crop at 30, 60 and 90 DAT is presented in Fig. 4.

3.2 Yield Attributes and Yield

3.2.1 Panicle length and Filled grain per panicle

The panicle length and filled grains per panicle increased with application of nutrients and the increase was significant. Highest panicle length and filled grains per panicle was observed in crops given 100: 75: 60 Kg NPK ha^{-1}+ Vermicompost 10 t ha^{-1} remained at par with 50: 37.5: 30 Kg NPK ha^{-1}+ Vermicompost 20 t ha^{-1} proved significantly better than 100 % NPK. Such an improvement in panicle length and filled grains per panicle has also been reported by Kumar and Singh *et al.,* [12]. with NPK. The data regarding the effect of different nutrients treatments on length of panicle, filled grain panicle and 1000 grains weight are shown in Fig. 5.

3.2.2 1000-grains weight

"Alike other yield attributes, 1000 grains -weight also increased with application of nutrients irrespective of the dose and sources although it was not significant and it ranged from 23.8 g with no nutrient application to 25.95 g with 100: 75: 60 Kg NPK ha^{-1}+ Vermicompost 10 t ha^{-1}. Further perusal of the data vis-à-vis 100 % NPK suggested increase in 1000 grains -weight with all short of manipulation and the highest was with 100: 75: 60 Kg NPK ha^{-1}+ Vermicompost 10 t ha-

^{1} followed by 50: 37.5: 30 Kg NPK ha^{-1}+ Vermicompost 20 t ha^{-1}. Favorable effect of NPK on 1000 grains-weight has been observed" by Qadir *et al*., [13]. This might be due to higher leaf area index, higher photosynthesis and intense formation and filling of the grains. Favorable effect of nitrogen, phosphorus and potassium application on yield attributes of rice has also been reported by Gupta and Sharma [14].

3.2.3 Grain and straw yield

Rice fertilized with various nutrients and their sources gave significantly higher yield over control, irrespective of the combinations. The increase in yield ranged from 31.7 % with 100 % NPK (35.3 q ha^{-1}) to 61.2 % with 100: 75: 60 Kg NPK ha^{-1}+ Vermicompost 10 t ha^{-1} (43.2 q ha^{-1}) over control treatment. Crop grown by 50: 37.5: 30 Kg NPK ha^{-1}+ Vermicompost 20 t ha^{-1} (41.7 q ha^{-1}) gave significantly higher yield than those given 100 % NPK and remained at par with 50: 37.5: 30 Kg NPK ha^{-1} + Vermicompost 10 t ha^{-1}. A similar trend was noted in respect of straw yield. The increase in yield ranged from 25.9 % with 100 % NPK (59.7 q ha^{-1}) to 34.5 % with 100: 75: 60 Kg NPK ha^{-1}+ Vermicompost 10 t ha^{-1} (63.8 q ha^{-1}) over control treatment. Further, an increase in test weight might have cumulatively resulted in significant improvement in grain weight which finally decided the grain yield. The data regarding the effect of different nutrients treatments on grain yield, Straw yield, biological yield and harvest index are shown in Fig. 6. Similar effect on grain and straw yield of rice has also been reported by Rout and Sahoo *et al*., [15]. They ensuring that the essential nutrients required for both vegetative and reproductive growth are available in optimal quantities. This balanced nutrient supply supports both grain development and the overall biomass production, including straw.

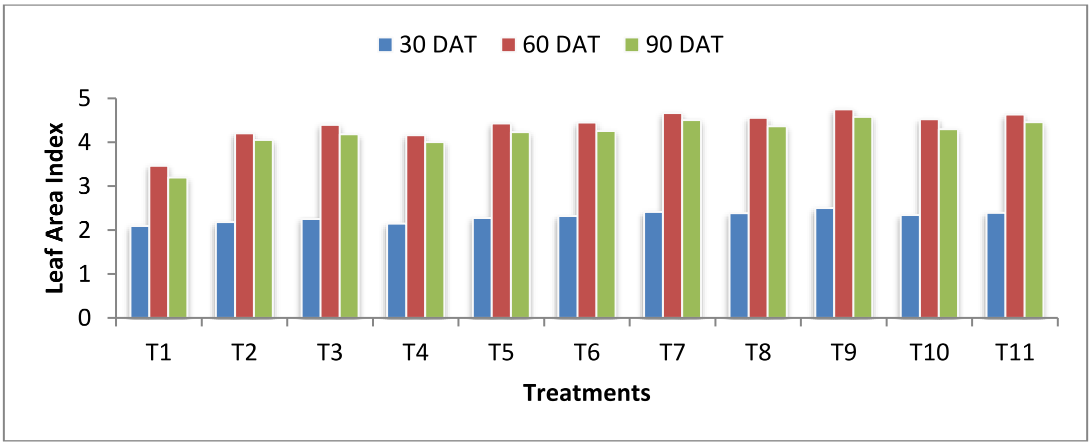

Fig. 4. Effect of organic and synthetic fertilizer management treatments on leaf area index (LAI) at different stages of rice

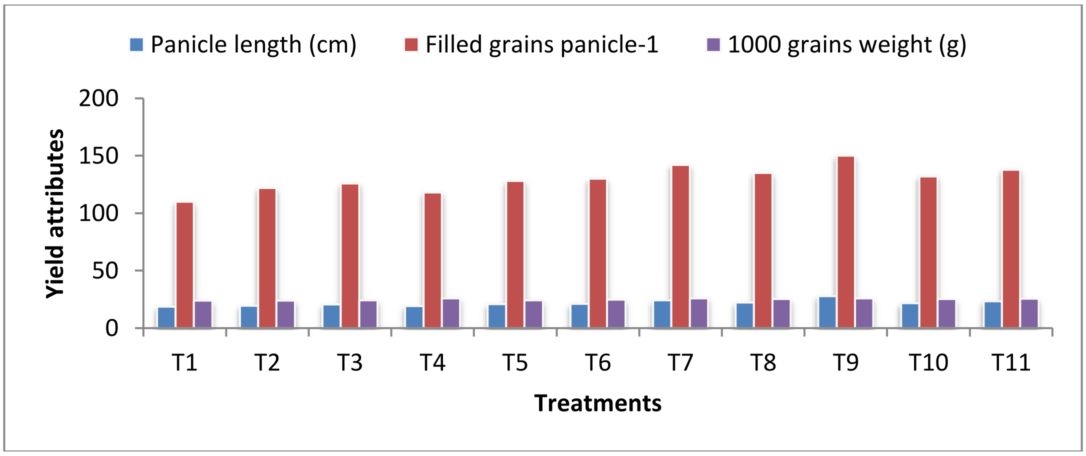

Fig. 5. Effect of organic and synthetic fertilizer management treatments on yield attributes of rice

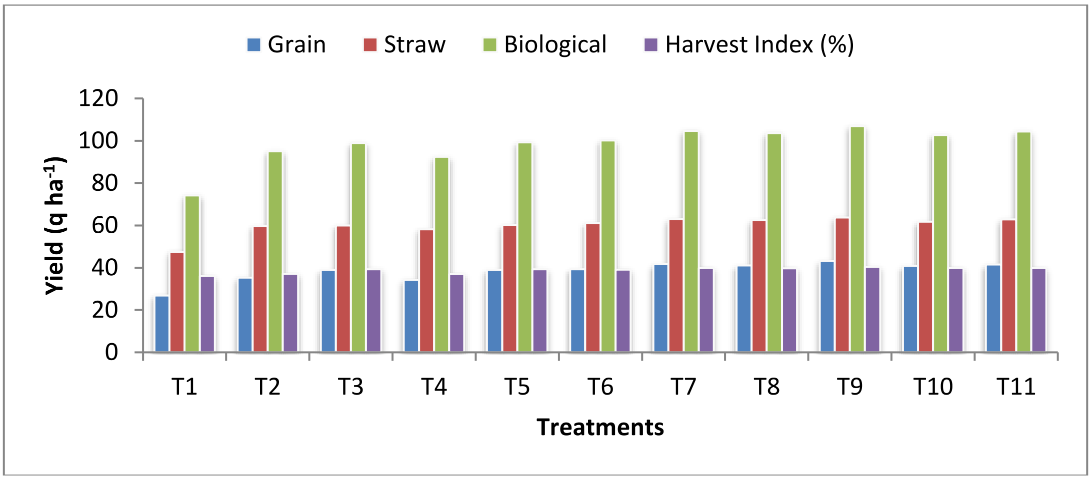

Fig. 6. Effect of organic and synthetic fertilizer management treatments on grain, straw, biological yield and harvest index of rice

3.2.4 Biological yield (q ha^{-1})

The highest biological yield (107.0 q ha^{-1}) found in 100: 75: 60 Kg NPK ha^{-1} + Vermicompost 10 t ha^{-1} was significantly higher than 100: 75: 0 Kg NPK ha^{-1} (95.0 q ha^{-1}) and the control treatment (74.2 q ha^{-1}) while at par with the remaining treatments.

3.2.5 Harvest index (%)

Among the different nutrient's treatments, the lowest harvest index (36.1 %) was found in control treatment, while the highest harvest index (40.4 %) was recorded in 100: 75: 60 Kg NPK ha^{-1} + Vermicompost 10 t ha^{-1}. An improvement in source sink relationship with application of NPK by Silveira *et al.,* [16] has been observed in rice. The maximum harvest index was estimated as INM as compared to all other treatment. "It might be due to better portioning of photosynthetic substance to economic yield. Appreciably high harvest index shows the efficiency of converting biological yield to economic yield". Arif *et al.,* [17].

4. CONCLUSION

The study revealed that application of T_9 significantly improved the growth and yield attributes, thus increasing the yield of rice over control with a corresponding increase of 61.2 and 34.5 percent in grain and straw yield of rice, respectively, although this treatment was found to be on par with T_7 and T_{11}. Thus, the inclusion of inorganic with organic sources of plant nutrients together helps to maintain yield stability, increasing the effectiveness of supplied nutrients, and creating Favourable soil physical conditions.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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