Original Research Article

Evaluation of INM Practices on Fruit Yield and Quality of Established Mango Orchard

Impact of Integrated Nutrient Management on Fruit Yield and Quality of Mango Orchard under Farmer's Field Conditions.

Abstract

The current study was conducted by KVK, Saharsa, under the supervision of Bihar Agricultural University, Sabour, Bhagalpur, Bihar, and ICAR-ATARI (Zone-IV) in fifteen farmers' fields in Bihar's Saharsa district between 2020-21 and 2021-22. Each farmer's field was handled as a single replication. The experimental treatments were distributed in ~~The trial used~~ a Randomized Block Design with 15 replications (=15 farmers) and three treatments containing recommended agronomic techniques. According to two years' worth of pooled data, treatment T3~~, which included~~ (75% RDF + 20 kg Vermicompost + 250 ml Azotobacter + 250 ml PSB) produced the highest ~~physical parameters, including~~ fruit length (9.35 cm), fruit width (6.52 cm), fruit volume (213.21 cm3), and fruit weight (225.35 g), as well as yield parameters, such as the highest number of fruits per plant (365.33), fruit yield per plant (91.33 kg), and TSS (18.10°Brix). in this respect, ~~The next more effective treatment was~~ T2 (75% RDF + 20 kg Vermicompost + 250 ml Azotobacter) came to the next. Considering the effect of agronomic practices on some chemical properties of soil under trees, ~~The treatment~~ T3 (75% RDF + 20 kg Vermicompost + 250 ml Azotobacter + 250 ml PSB per tree) had the highest recorded values of pH (7.4), EC (0.51), Organic Carbon (0.52), available N (305.21 kg/ha), available P (32.56 kg/ha), and available K (201.33 kg/ha) ~~in the soil nutrient analysis~~. Also, the ~~With treatment T3,~~ the maximum soil microbial count, ~~or~~ of 6.5 × 10^9 and 7.8 × 10^9, was recorded. From an economical view point ~~perspective~~, treatment T3 ~~produced~~ resulted in the maximum benefit cost ratio (3.01) and the highest net realization (₹ .497800) based on fruit yield per hectare.

Comment [A1]: Identify every abbreviation included here for the first time only

Comment [A2]: Please, insert the measure i.e. %, mg kg^{-1}, g kg^{-1}, dS m^{-1}

Keywords: Mango, Vermicompost, PSB, Azotobacter and nutrient management, INM

Introduction

Mangos are members of the Anacardiaceae family. Mangos are referred to as the "King of fruits." It is the national fruit of India and one of the most significant tropical fruits in the world. With 23.22 lakh hectares under cultivation, 20.34 million tons of mangoes produced, and a productivity of 8.83 tons/ha, India has historically been the world's greatest mango producer (NHB, 2022-23). India is the world's top producer of mangoes, accounting for 41% of global production. Fruits are medium-sized, green, and have a usual color and scent. The control of nutrients has a significant impact on crop quality, yield, and growth. When growing horticultural crops like mangos, this is crucial. A balanced diet is essential to achieving a higher-quality output without compromising the health of the soil. Only by selecting easy-to-apply, diverse organic, inorganic, and biological nutrient sources would this be achievable. Plants need a balanced diet to finish their life cycle and yield more, which we may offer when we apply the necessary amount of fertilizer. Therefore, selecting and supplying the right nutrients to meet crop needs while preserving or enhancing the fertility and productivity of native soil is crucial. This trial was conducted with these points of view in mind for research purposes.

Comment [A3]: This section has no enough literature about the effects of selected INM treatments on Mango growth and yield parameters ! Also, it should be include the obvious and clear objective.

Materials and Methods

The experiment was carried out in fifteen farmer's farms in the Saharsa district of Bihar between 2020-21 and 2021–2022. The data for the several characters examined in this research were statistically analysed using a completely randomized design for pooled analysis and computation of analysis of variance. There were fifteen repetitions of each of the three treatments. T1-RDF (1000:500:1000g NPK + 100kg FYM), T2-75% RDF + 20kg Vermicompost + 250ml Azotobacter, and T3-75% RDF + 20kg Vermicompost + 250ml Azotobacter + 250ml PSB are the treatment details. ~~While~~ Nitrogen and vermicompost were splitted into ~~given in~~ two equal portions, the first half was applied in June and the second half in February, while the whole dosage of FYM, phosphorus, and potassium ~~was~~ were applied in June. In February, 250 ml/tree of ~~biofertilizer per tree~~ Azotobacter and/or phosphorus-solubilizing bacteria were given. A digital hand refractometer with a range of 0 to 32 °Brix was used to record the TSS.

Comment [A4]: Materials and methods: There is a severe lack of information about the quality of the soil in the different experimental areas, as well as the methods used in estimations, in addition to the details of the experimental measurement and related determination methods. This part needs to be completely reformulated

Results and Discussion

Effect on physical parameters of Mango fruits

~~Integrated nutrition management had a considerable effect on physical parameters.~~ The application of 75% RDF + 20 kg Vermicompost + 250ml Azotobacter + 250ml PSB per ~~plant~~ tree resulted in the largest fruit length (9.35 cm), breadth (6.52 cm), volume (213.21 cm^3), and weight (225.35 g) (Table 1). This was closely followed by 75% RDF + 20 kg Vermicompost + 250mL Azotobacter. The increased number of leaves may have improved photosynthetic activity, resulting in a higher buildup of carbohydrates. Higher carbohydrate levels may have accelerated development and increased fruit weight (Kuttimani *et al.* 2013).

This was on line with the findings of Singh *et al.* (2011) for mango and Pattar *et al.* (2018) and Patil and Shinde (2013) for bananas. A higher level of photosynthetic activity, which results in larger cells and more intercellular space, may be the cause of the fruit's increased length and diameter. Bhalerao *et al.* (2009), Vishwakarma *et al.* (2017) in bael and Kumar *et al.* (2017) in sweet orange have reported similar results. The fact that the fruit volume and weight ~~in~~ as affected by treatment T3 were significantly larger suggests that the mobility of photosynthates from source to sink, or increased translocation, was made feasible by a better sink capacity. ~~The findings of Bhalerao *et al.* (2009), Vishwakarma *et al.* (2017) in bael, and Kumar *et al.* (2017) in sweet orange are closely similar to the results.~~ Due to more balanced nutrient intake, which may have improved metabolic activities in the plant and ultimately resulted in high protein and carbohydrate synthesis and fruit weight, biofertilizers may also be linked to better fruit filling. Cheena *et al.* (2018) in sapota, Kundu *et al.* (2011) in mango, and Kumar *et al.* (2019) in pomegranate have all observed similar results. It is regarded as a noteworthy source of certain micronutrients that, by boosting metabolic processes in plant cells, regulate the length and width of fruit (Sharma *et al.*, 2013). This result is on line with Binepal *et al*. 2013 in guava. Biofertilizers helps to continuous supply of nutrients and induction of growth promoting substances which stimulate cell division, cell elongation in fruits during the growth period at rapid rate and ultimately enhance the fruit volume (Binepal *et al*. 2013 ~~in guava~~).

Effect on yield parameters

The treatments had a substantial impact on yield characteristics, such as the number of fruits per tree and the yield (kg/ha and q/ha) (Table 2). But in the pooled data, T3 had the most fruits per tree (365.33). This was comparable to treatment T2 may have resulted from an increase in the amount of nutrients in the crop's assimilation area, which accelerated the creation of dry matter. Similar to this, as a result of dry matter's sensible partitioning to an economic sink. Another possibility is that the addition of FYM has a solubilization impact on plant nutrients, improving the plant's uptake of N, P, K, Ca, and Mg during different stages of growth. The results above are consistent with the findings of Gajbhiye *et al.* (2020) in pomegranates, Dalal *et al.* (2004) in citrus, and Cheena *et al.* (2018) in sapota. For both years' pooled data, the maximum fruit produce (91.33 kg/~~plant~~tree and 265.32 q/ha) was also ~~discovered with~~ achieved by the application of 75% RDF + 20 kg Vermicompost + 250 ml Azotobacter + 250 ml PSB per plant (T3). The rise in the number and weight of fruits produced per ~~plant~~ tree led to its realization. Improved nutrient availability and uptake by ~~plant~~ roots, as well as improved source-sink interaction through greater transport of carbohydrates from leaves to fruits, resulted in higher fruit yield. It is commonly known that potassium and nitrogen are essential to chlorophyll's ability to function. The effectiveness of photosynthesis, the process by which solar energy is transformed into chemical energy, may be shown by an increase in the amount of chlorophyll in leaves. The plant produced maximum photosynthetic yield in terms of high biomass and translocation of the absorbed materials nutrients to the growing sink as a result of its efficient utilization of N, P, and K. This is consistent with research conducted on sapota by Cheena *et al.* (2018), sweet orange by Kumar *et al*. (2017), and pomegranate by Gajbhiye *et al.* (2020).

Effect on soil nutrient status

There was a notable difference in available N, available P, and available K between the treatments. Table 3 makes it evident that, for both years' pooled data, the treatment T3 (75% RDF + 20 kg Vermicompost + 250 ml Azotobacter + 250 ml PSB per plant) also recorded the largest available N (305.21 kg/ha), P (32.56 kg/ha), and K (201.33 kg/ha) in comparison with which was comparable to the T2 treatment. The enhanced nitrogen status of the soil attributed to FYM's gradual decomposition, which produces humic acid and amino acids that promote nitrogen availability, may have contributed to the increase in available nitrogen. These results are consistent with those of Meena *et al.* (2018) for pomegranates and Sharma *et al.* (2017) for custard apples. The production of organic acids from organic manures during the microbial decomposition of organic matter may have contributed to the solubility of native phosphorus and, as a result, increased the phosphorus availability in treatment T3. This could explain the higher phosphorus availability in T 3 (Patel, 2008). Furthermore, phosphate ions and organic anions battle it out for binding sites on soil particles. By chelating Al^{3+}, Fe^{3+}, and Ca^{2+}, the complex organic anions raise the availability of phosphorus by reducing the cations' ability to precipitate phosphate. Similar results were also observed for papaya by Tandel *et al.* (2017), custard apple by Sharma *et al*. (2017), and banana by Ganapathi and Dharmatti (2018). The increased K_2O content in treatment T3 may have resulted from decreased potassium fixation as well as the organic and inorganic acids created during the breakdown of organic manures, which helped to release potassium that was insoluble in minerals. The favourable effects of organic manures in releasing potassium through the interaction of organic matter with clay and direct addition of potassium to the available pool of soil were responsible for the build-up of available potassium in the soil (Shivakumar, 2010). The findings are consistent with those of Tandel *et al*. (2017).

Effect on microbial count

The data definitely showed that the largest microbial count (6.5×10^9 and 7.8×10^9) in the soil was recorded by treatment T3 (75% RDF + 20 kg Vermicompost + 250 ml Azotobacter + 250 ml PSB per plant), which was followed by T2 and T1 (Table 4). Greater numbers of soil bacteria were found in the soil treated with biofertilizers and INM treatment.

Increased biological activity from INM treatment and biofertilizers encourages mycorrhiza symbiosis, which progressively improves the beneficial microorganism. Aonla, Kour *et al*. (2019), Meena *et al*. (2019), and Dutta *et al*. (2016) in mango and sapota all corroborated this conclusion.

Comment [A5]: What is the relation between your work and AMF? This is not suitable interpretation! Please, you have to cite the most related References and search for the most advanced or recent ones

Effect on economics

The treatment T3, which consists of 75% RDF + 20 kg Vermicompost + 250 ml Azotobacter + 250 ml PSB per plant, had the greatest net realization of all the treatments Rs. 4,97,800. T2 (which consists of 75% RDF + 20 kg Vermicompost + 250 ml Azotobacter per ~~plant~~tree) came to the next ~~was closely behind T3~~. Nonetheless, treatment T3 had the highest benefit-to-cost ratio (3.01), followed by treatment T2 (Table 5).

Table-1: Effect of INM on physical parameter of mango fruit

Treatments	Fruit length (cm)	Fruit width (cm)	Fruit volume (cm^3)	Fruit weight (g)
T1- RDF (1000:500:1000g NPK + 100 kg FYM)	9.25	6.45	204.23	203.35
T2- 75 % RDF + 20 kg Vermicompost + 250ml Azotobacter	9.32	6.48	206.56	212.85
T3- 75% RDF + 20 kg Vermicompost+ 250ml Azotobacter + 250ml PSB	9.35	6.52	213.21	225.35
SEm±	0.17	3.76	4.03	7.36
CD at 5%	0.43	10.71	12.21	21.35

Table-2: Effect of INM on Yield attributing traits and quality parameter of mango fruit

Treatments	No. of fruits/plant	Yield (kg/plant)	Fruit yield (q/ha)	TSS (°Brix)
T1- RDF (1000:500:1000g NPK + 100 kg FYM)	283.35	70.75	183.00	17.20
T2- 75 % RDF + 20 kg Vermicompost + 250ml Azotobacter	312.85	78.21	212.84	17.55
T3- 75% RDF + 20 kg Vermicompost + 250ml Azotobacter + 250ml PSB	365.33	91.33	265.32	18.10

SEm±	7.91	2.84	3.74	0.29
CD at 5%	23.36	8.12	12.56	0.84

Table-3: Effect of INM on Soil properties

Treatments	pH	EC (dSm-1)	OC (%)	Available N (kg/ha)	Available P (kg/ha)	Available K (kg/ha)
T1- RDF (1000:500: 1000g NPK + 100 kg FYM)	6.9	0.37	0.29	183.16	20.56	165.43
T2- 75 % RDF + 20 kg Vermicompost + 250 ml Azotobacter	7.1	0.46	0.49	290.22	30.12	180.12
T3- 75% RDF + 20 kg Vermicompost+ 250 ml Azotobacter + 250 ml PSB	7.4	0.51	0.52	305.21	32.56	201.33
SEm±	0.04	0.01	0.05	7.30	1.36	6.90
CD at 5%	0.07	0.03	0.08	22.83	4.17	21.43

Table-4: Effect of integrated nutrient management on microbial count of soil

Treatments	Season 1	Season 2
Initial	4.3×10^8	5.2×10^8
T1- RDF (1000:500:1000g NPK + 100 kg FYM)	5.2×10^8	6.2×10^8
T2- 75 % RDF + 20 kg Vermicompost + 250 ml Azotobacter	6.3×10^9	7.6×10^9
T3- 75% RDF + 20 kg Vermicompost+ 250 ml Azotobacter + 250 ml PSB	6.5×10^9	7.8×10^9

Table-5: Effect of INM on economics of Mango

Treatments	Cost of production (Rs./ha)	Gross income (Rs./ha)	Net return (Rs./ha)	Cost : Benefit Ratio
T1- RDF (1000:500:1000g NPK + 100 kg FYM)	130500	457500	327000	1:2.50
T2- 75 % RDF + 20 kg	140900	532100	391200	1:2.77

Vermicompost + 250 ml Azotobacter				
T3- 75% RDF + 20 kg Vermicompost+ 250 ml Azotobacter + 250 ml PSB	165500	663300	497800	1:3.01

Conclusion

After two years of field research, it was determined that increasing the physical parameters and yield-contributing parameters of mangos could be achieved by applying 75% RDF + 20 kg Vermicompost + 250 ml Azotobacter + 250 ml PSB per plant. Together with the soil's enhanced microbial count, this treatment has also improved the soil's nutritional condition. From an economical view point ~~perspective~~, T3 (75% RDF + 20 kg Vermicompost + 250 ml Azotobacter + 250 ml PSB per plant) ~~produced~~ gained the highest net realization. But T2 [75% RDF + 20 kg Vermicompost + 250 ml Azotobacter per plant] likewise achieved the maximum benefit-cost ratio and was statistically equal to T3 in the majority of the criteria.

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