Original Research Article

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

Abstract

The current study was conducted by Krishi Vigyan Kendra, 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 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 (75% RDF + 20 kg Vermicompost + 250 ml Azotobacter + 250 ml PSB) produced the highest 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, 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, 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 dSm-1), Organic Carbon (0.52%), available N (305.21 kg/ha), available P (32.56 kg/ha), and available K (201.33 kg/ha). Also, the maximum soil microbial count of 6.5×10^9 and 7.8×10^9, was recorded. From an economical view point, treatment T3 resulted in the maximum benefit cost ratio (3.01) and the highest net realization (₹ .497800) based on fruit yield per hectare.

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.

Numerous studies demonstrate a decrease in the amount of minerals and vitamins in fresh fruit, combined with low quality, low yield, and tree deterioration that appears to be related to inadequate nutrition availability. Reducing the reliance on chemical fertilizers is necessary due to sustainability concerns.

The physical, chemical, and microbiological characteristics of soil are at risk when chemical fertilizers are used on a regular basis. The soil will deteriorate and production per unit area will decline if integrated nutrient management is not implemented (Singh and Banik, 2011). Thus, maintaining soil fertility, economic productivity, and applying potential plant nutrients in a balanced proportion are imperative (Singh *et al.*, 2016). Nutrient management is a crucial component of intensive farming (Boora R.S., 2016). The concept of integrated nutrient management is dynamic and takes into account both the economic and qualitative fruit yield as well as the physio-chemical and microbiological health of the soil. It also acts as a resistance marker against nutrient mining, which occurs when there is an imbalance between the amount of nutrients applied and the annual nutrient demand (Srivastava and Singh, 2008). It is a holistic approach in which the tree's nutritional needs for maximum production are first determined, and then various nutrient forms are applied at the ideal times using the best available techniques in an environmentally friendly way to achieve the highest productive efficiency (Singh *et al.*, 2016). Therefore, integrated nutrient management is the best strategy for controlling the input of nutrients since it will lessen the pressure from the careless application of inorganic fertilizers while maintaining soil productivity and crop yield (Boora R.S., 2016). Applying manures improves the texture of the soil, lessens soil erosion caused by wind and water, encourages the growth of beneficial soil microorganisms such as earthworms, increases the amount of organic matter in the soil, and increases its ability to hold water. Vermicompost, a crucial part of integrated nutrition management (INM), is enhanced with organic carbon and is referred to as complete and balanced plant food because it has all the nutrients needed by plants in the right amounts. It also helps to maintain soil fertility by enhancing the soil's characteristics and encouraging the growth of beneficial microflora. Vermicompost has the ability to suppress harmful bacteria. Other components, such as Azotobacter, a non-symbiotic nitrogen fixing bacteria, directly influences plant growth by synthesizing various plant growth hormones such as gibberellins, cytokinins, IAA, and so on (Aasfar *et al.*, 2021), in addition to reducing dependency on nitrogen-containing fertilizers such as urea (Bageshwar *et al.*, 2017; Wani *et al.*, 2016).

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. In two split doses, organic, inorganic, and biofertilizers were applied. A first dose at the end of August and a second split dose in February following fruit set as a basal application in the soil after thoroughly mixing 30 cm away from the trunk under the spread of trees in the ring method, and then appropriately covered by soil. A digital hand refractometer with a range of 0 to 32 °Brix was used to record the TSS.

Six fruits were chosen at random for each treatment and replication in order to measure the physical parameters, and observations were made. Using an electronic balance, the weight of the collected fruits was recorded at the time of harvest. A computerized vernier calliper was used to measure the fruits' diameter and length. Water displacement method was used to measure the volume of fruit. When harvesting each experimental tree, the amount of fruits on each tree was tallied according to treatment for the yield parameters. The total crop per tree was weighed and expressed in kilograms in order to record the yield. The average yield of each tree was multiplied by the total number of trees per hectare to determine the fruit production per hectare. After the fruits were harvested, soil samples were taken using a screw auger from four pits located in each of the four directions surrounding the tree at depths of 0–30, 30–60, and 60–100 cm. blending the dirt thoroughly and removing half of the sample to prepare the final one. After that, the sample was crushed using a wooden pestle, sieved through a 2 mm sieve, and its N, P2O5, and K2O contents were examined. Subbiah and Asija (1956) described the alkaline potassium permanganate method for estimating soil nitrogen availability. The available phosphorus in soil was determined using Olsen's technique, as described by Olsen *et al.* (1954). The available potash in soil was evaluated using a flame photometer, as described by Jackson (1973). The data collected on physical characteristics, yield parameters, and soil nutrient status were statistically analyzed (Panse and Sukhatme, 1985).

Results and Discussion

Effect on Growth Parameters of Mango Fruits

The application of 75% RDF + 20 kg Vermicompost + 250ml Azotobacter + 250ml PSB per 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 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. 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 in Guava (Binepal *et al*. 2013).

Effect on yield parameters of Mango

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/tree and 265.32 q/ha) was also 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 tree led to its realization. Improved nutrient availability and uptake by 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 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 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), 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 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.

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 tree) came to the next. 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 Vermicompost + 250 ml Azotobacter	140900	532100	391200	1:2.77
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, T3 (75% RDF + 20 kg Vermicompost + 250 ml Azotobacter + 250 ml PSB per plant) 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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