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## INTEGRATED NUTRIENT STRATEGIES FOR SUSTAINABLE CULTIVATION OF MANGO CV. BANGANPALLI

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### ABSTRACT

Mango (*Mangifera indica* L.), a major fruit crop in India, is cultivated over 2.21 million hectares with an annual production of 20.8 million tonnes, accounting for 43% of global output. Traditional reliance on chemical fertilizers, though effective for yield, has led to adverse effects such as rising input costs, nutrient imbalances, and declining soil health. An investigation was carried out to evaluate the effect of Integrated Nutrient Management (INM) on yield attributes, fruit quality, and economics in the mango cultivar 'Banganpalli' using pooled data over four consecutive years from 2011-12 to 2014-15 at the Fruit Research Station, Sangareddy, Telangana, under AICRP (Fruits). The experiment included ten treatments involving various combinations of recommended dose of fertilizers (RDF), organic manures, bio-fertilizers, mulching, and micronutrient foliar sprays. Results revealed that INM treatments significantly influenced yield-contributing characters, quality parameters, and benefit–cost ratio compared to sole application of chemical fertilizers. Among the treatments, T4 (RDF with micronutrients and organic mulching) recorded the highest number of fruits per plant and maximum yield per tree (51.39 kg/tree), owing to improved soil moisture conservation, enhanced nutrient availability, and better root activity. The highest average fruit weight (356.01 g), total soluble solids (18.32 °Brix), and shelf life (13.58 days) were observed under T7 (½ RDF + FYM + Azotobacter), indicating the beneficial role of biofertilizers in improving nutrient uptake, biological nitrogen fixation, and fruit development. Quality attributes such as pulp–stone ratio and acidity were significantly influenced by INM, with integrated application of organic and biological inputs resulting in superior edible portion and acceptable acidity levels. Economic analysis showed that T7 registered the highest benefit–cost ratio (6.65), reflecting reduced input costs and improved profitability, whereas treatments involving intensive micronutrient application and mulching incurred higher costs despite higher yields. Overall, the study demonstrates that integrated use of inorganic fertilizers, organic manures, and biofertilizers enhances mango productivity, fruit quality, and economic returns, and offers a sustainable alternative to exclusive reliance on chemical fertilizers.

**Keywords:** Integrated Nutrient Management, Biofertilizers, Micronutrients, Organic Mulchin.

### Introduction

Mango (*Mangifera indica* L.) is a key fruit crop in India, celebrated for its adaptability, exquisite flavor, and rich nutritional content. According to recent data, India leads the world in mango production, cultivating approximately 2.21 million hectares and yielding around 20.8 million tonnes annually constituting about 43% of global production.

Traditionally, chemical fertilizers have been the primary nutrient source for optimal growth and yield in mango orchards. However, several constraints like high input costs, declining soil health due to continuous use, reduced microbial activity, and nutrient imbalances are being faced. Moreover, long-term dependency on chemical fertilizers diminishes organic matter and affects the sustainability of mango orchards. In this context, integrating chemical

fertilizers with organic manures and bio-fertilizers offers a viable strategy to enhance nutrient efficiency and sustainability.

Indiscriminate use of inorganic chemical fertilizers resulted in high amount of chemical residues in field as well as in the crop produces leading to various environmental and heat hazards along with socio-economic problem (Kundu *et al.*, 2011). In order to maintain soil health and to obtain yield of better quality fruits, it is essential to adopt integrated nutrient management (INM) approach. Biofertilizers are the living organism which add, conserve and mobilize the plant nutrients in the soil. The beneficial effect of biofertilizers is now well established in fruit crops like mango (Kundu *et al.*, 2011), Papaya (Sukhade *et al.*, 1995) and banana (Gogoi *et al.*, 2004).

To address this, a recent investigation evaluated combined nutrient regimes including full-dose chemical fertilizers, integrated fertilizer, organic, bio-fertilizer treatments, and organic amendments assessing their effects on plant growth, fruit yield, and quality attributes. The study found that integrated nutrient management (INM) not only surpasses the full chemical treatment in productivity but also improves soil health and fruit quality.

### Material and Methods

An experiment was conducted during 2011–12 and 2014-15 at Fruit Research Station, Sangareddy, Telangana under AICRP (Fruits) on mango cultivar ‘Banganpalli’ which was uniform in vigor and size, planted at a spacing of 10 × 10 m and maintained under uniform cultural practices. The experiment comprised

ten (10) treatments, each replicated thrice. The treatment details are T<sub>1</sub> – 1000:1000:1000g N, P<sub>2</sub>O<sub>5</sub>, K<sub>2</sub>O/tree (control), T<sub>2</sub> – T<sub>1</sub> + Zn (0.5%) + B (0.2%) + Mn (1%) + Ca (0.6%) as 2 foliar application (August & October), T<sub>3</sub> – T<sub>1</sub> + Organic mulching 10cm thick, T<sub>4</sub> – T<sub>2</sub> + Organic mulching 10cm thick, T<sub>5</sub> – ½ RDF + 50kg FYM + 250g *Trichoderma*, T<sub>6</sub> – ½ RDF + 50kg FYM + 250g *Azospirillum*, T<sub>7</sub> – ½ RDF + 50kg FYM + 250g *Azotobacter*, T<sub>8</sub> – ½ RDF + 50kg FYM + 5 kg Vermicompost, T<sub>9</sub> – ½ RDF + 50kg FYM + 250g *Pseudomonas fluorescence*, T<sub>10</sub> – ½ RDF + 50kg FYM + 250g *Trichoderma* + 250g *Pseudomonas fluorescence*.

### Yield Parameters and Quality Assessment Methodology

The yield parameters recorded were the average number of fruits per tree, average yield per tree (kg), and average fruit weight (g). Yield was measured by weighing the fruits during each picking. For assessing various fruit quality parameters, fifty uniform and mature fruits were collected from each tree.

The total soluble solids (TSS) content of the fruit pulp was measured using a ERMA hand refractometer. Acidity was analyzed according to the standard methods outlined by A.O.A.C. (1990). The shelf-life of the fruits at room temperature was evaluated by placing ten mature fruits per treatment in three replicates, allowing them to ripen at room temperature. The shelf-life was recorded as the number of days the fruits remained consumable without deterioration. The data was statistically analysed by method of analysis of variance using R.B.D as described by Panse and Sukhatme (1985).

### Results and Discussion

**Table 1 :** Effect on Integrated Nutrient Management on Yield of mango and Economics of Mango (pooled data from 2011-12 to 2014-15)

Treatments	No. of fruits / plant	Average fruit weight (g)	Yield (Kg/tree)	B:C
T <sub>1</sub>	97.32	326.46	31.07	3.63
T <sub>2</sub>	126.53	323.34	39.45	1.41
T <sub>3</sub>	110.72	332.26	36.47	2.52
T <sub>4</sub>	152.30	345.74	51.39	1.24
T <sub>5</sub>	126.91	339.60	42.31	3.39
T <sub>6</sub>	131.24	340.93	43.91	4.68
T <sub>7</sub>	131.88	356.01	46.99	6.65
T <sub>8</sub>	137.97	342.33	45.49	4.00
T <sub>9</sub>	96.37	327.80	31.37	3.55
T <sub>10</sub>	97.57	321.85	29.99	2.98
SE+m	10.06	14.03	2.64	-
CD at 5%	28.45	39.68	7.46	-
CV	16.64	8.36	13.23	-

T<sub>1</sub> – 1000:1000:1000g N, P<sub>2</sub>O<sub>5</sub>, K<sub>2</sub>O/tree (control), T<sub>2</sub> – T<sub>1</sub> + Zn (0.5%) + B (0.2%) + Mn (1%) + Ca (0.6%) as 2 foliar application (August & October), T<sub>3</sub> – T<sub>1</sub> + Organic mulching 10cm thick, T<sub>4</sub> – T<sub>2</sub> + Organic mulching 10cm thick, T<sub>5</sub> – ½ RDF + 50kg FYM + 250g *Trichoderma*, T<sub>6</sub> – ½ RDF + 50kg FYM + 250g *Azospirillum*, T<sub>7</sub> – ½ RDF + 50kg FYM + 250g *Azotobacter*, T<sub>8</sub> – ½ RDF + 50kg FYM + 5 kg Vermicompost, T<sub>9</sub> – ½ RDF + 50kg FYM + 250g *Pseudomonas fluorescence*, T<sub>10</sub> – ½ RDF + 50kg FYM + 250g *Trichoderma* + 250g *Pseudomonas fluorescence*.

**Table 2:** Effect on Integrated Nutrient Management on quality attributes of Mango (pooled data from 2011-12 to 2014-15)

Treatments	TSS ( <sup>o</sup> Brix)	Acidity (%)	Pulp stone ratio	Shelf life (days)
T <sub>1</sub>	17.12	0.28	5.37	10.67
T <sub>2</sub>	17.36	0.30	5.15	12.08
T <sub>3</sub>	18.13	0.31	5.68	9.91
T <sub>4</sub>	17.43	0.30	6.21	10.83
T <sub>5</sub>	17.13	0.29	4.67	10.50
T <sub>6</sub>	17.66	0.33	6.17	11.91
T <sub>7</sub>	18.32	0.29	6.07	13.58
T <sub>8</sub>	17.24	0.27	5.27	11.08
T <sub>9</sub>	17.46	0.32	4.34	9.91
T <sub>10</sub>	17.16	0.33	5.68	8.88
SE+m	0.34	0.02	0.37	0.53
CD at 5%	0.95	0.06	1.04	1.49
CV	3.83	13.47	13.50	9.62

T<sub>1</sub> – 1000:1000:1000g N, P<sub>2</sub>O<sub>5</sub>, K<sub>2</sub>O/tree (control), T<sub>2</sub> – T<sub>1</sub> + Zn (0.5%) + B (0.2%) + Mn (1%) + Ca (0.6%) as 2 foliar application (August & October), T<sub>3</sub> – T<sub>1</sub> + Organic mulching 10cm thick, T<sub>4</sub> – T<sub>2</sub> + Organic mulching 10cm thick, T<sub>5</sub> – ½ RDF + 50kg FYM + 250g *Trichoderma*, T<sub>6</sub> – ½ RDF + 50kg FYM + 250g *Azospirillum*, T<sub>7</sub> – ½ RDF + 50kg FYM + 250g *Azotobacter*, T<sub>8</sub> – ½ RDF + 50kg FYM + 5 kg Vermicompost, T<sub>9</sub> – ½ RDF + 50kg FYM + 250g *Pseudomonas florescence*, T<sub>10</sub> – ½ RDF + 50kg FYM + 250g *Trichoderma* + 250g *Pseudomonas florescence*.

The pooled results over four years (2011–12 to 2014-15) clearly highlight the significant impact of various integrated nutrient management (INM) treatments on mango yield parameters, quality parameters and benefit-cost (B:C) ratio.

#### Effect of Integrated Nutrient Management on Yield Attributes of Mango

The treatments under Integrated nutrient management (INM) significantly influenced yield and yield contributing parameters of mango, as evidenced by pooled data over four years (Table 1). The number of fruits per plant, average fruit weight, and total yield per tree varied markedly among treatments, indicating differential responses to nutrient sources and combinations.

Among the treatments, T<sub>4</sub> (T<sub>2</sub> + organic mulching) recorded the highest number of fruits per plant (152.30) and maximum yield per tree (51.39 kg), which was significantly superior to the control (T<sub>1</sub>) and most other treatments, as reflected by CD values at 5% level. This improvement can be attributed to the combined effect of balanced macro and micronutrient supply through soil and foliar application, along with organic mulching that improved soil moisture conservation, nutrient availability, and root activity.

The highest average fruit weight (356.01 g) was observed under T<sub>7</sub> (½ RDF + FYM + *Azotobacter*), followed closely by T<sub>4</sub> and T<sub>6</sub>. Biofertilizer application, particularly *Azotobacter*, might have

enhanced nitrogen availability through biological nitrogen fixation and improved phytohormone production, leading to better fruit development and increased fruit size. The results are in line with the findings of Kumar, M., *et al.* (2014), Sharma, R. (2015) who reported maximum fruit weight (170 g) with an application of Vermicompost (25 kg / plant) + Oil cake (2.5 kg / plant) + *Azotobacter* + VAM + *Trichoderma viridi* + PSB @ 100g per plant each, Patel *et al.* (2010) in sapota. This might also be attributed due to improvement in fertilizer use efficiency while applied along with the organic manures as per Ranjan and Ghosh (2006).

Control treatment (T<sub>1</sub>) recorded relatively lower fruit number (97.32) and yield (31.07 kg/tree), highlighting the limitation of sole application of chemical fertilizers without organic or biological supplementation. The results are in accordance with Chandra, K. K., *et al.* (2012) who quoted the higher fruit yield of 140.5 % in trees treated with IPNM and VAM over the yield of control.

#### Economics of Mango Production (B:C Ratio)

Economic analysis revealed substantial variation in benefit–cost (B:C) ratio among treatments. Interestingly, T<sub>7</sub> recorded the highest B:C ratio (6.65), despite not producing the maximum yield. This indicates that treatments involving ½ RDF + FYM + biofertilizers substantially reduced input costs while

maintaining reasonably high yields, thereby enhancing net returns.

Treatments T6 (Azospirillum) and T8 (vermicompost) also recorded higher B:C ratios (4.68 and 4.00, respectively), suggesting that partial substitution of chemical fertilizers with organic and biological inputs is economically advantageous. In contrast, T4, though superior in yield, recorded a lower B:C ratio (1.24) due to higher cost of micronutrient sprays and mulching operations.

### Effect of INM on Quality Attributes of Mango

Quality parameters such as total soluble solids (TSS), acidity, pulp–stone ratio, and shelf life were significantly influenced by INM treatments (Table 2). Inoculation of Azotobacter along with organics might have performed regulatory role on absorption of nutrients and translocation of metabolites especially carbohydrates which positively increase the quality of fruits.

The highest TSS (18.32 °Brix) was recorded under T7, followed by T3 and T6. Enhanced microbial activity and improved nutrient uptake under biofertilizer treatments might have favored carbohydrate synthesis and accumulation, resulting in higher sweetness levels. Results are in accordance with the findings of Sharma, R. (2015) who reported improved fruit quality with an addition of organic sources of nutrients with maximum TSS of 21.80 °B recorded with an application of Vermicompost 25 kg/plant + Oil cake 2.5 kg/plant + Azotobacter + VAM + Trichoderma + PSB (100g each plant), Ram *et al.* (2007), Madhavi *et al.* (2008) and Baviskar *et al.* (2011)

Acidity ranged from 0.27 to 0.33%, with lower acidity observed under T8 and T1, while higher acidity was noted in treatments involving biofertilizers. However, all values were within acceptable limits for table mango quality.

The highest pulp–stone ratio (6.21) was observed under T4, followed by T6 and T7, indicating superior edible portion under integrated nutrient supply combined with mulching or biofertilizers. Improved nutrient translocation and better fruit filling under INM treatments might have contributed to this improvement.

Shelf life was significantly extended under INM treatments, with T7 recording the maximum shelf life (13.58 days), followed by T2 and T6. The presence of calcium in foliar sprays (T2, T4) and balanced nutrient supply under biofertilizers might have strengthened cell wall integrity and delayed senescence.

### Summary

The pooled data (2011–12 to 2014–15) revealed that integrated nutrient management significantly improved yield, quality, and economic returns in mango. The treatment T4 (RDF + micronutrients + organic mulching) produced the highest yield (51.39 kg/tree), whereas T7 (½ RDF + FYM + Azotobacter) recorded the highest B:C ratio (6.65), maximum TSS (18.32 °Brix), and longest shelf life (13.58 days). Sole application of chemical fertilizers resulted in inferior yield and quality compared to integrated approaches. Overall, the study confirms that partial substitution of chemical fertilizers with organic manures and biofertilizers not only sustains productivity but also improves fruit quality and profitability, making INM a viable and sustainable nutrient management strategy for mango cultivation.

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