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Effect of Integrated Nutrient Management on Quality of Mango cv. Kesar

Z. K. Patel[1], R. V. Tank[2], N. B. Patel[3] and J. J. Patel[1]
[1]Ph.D. Scholar, Department of Fruit Science, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari, 390 45 (Gujarat), India.
[2]Associate Professor, Department of Fruit Science, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari, 390 45 (Gujarat), India.
[3]Professor, Department of Vegetable Science, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari, 390 45 (Gujarat), India.

*(Corresponding author: Z. K. Patel *)*
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ABSTRACT: The continuous and excessive use of inorganic fertilizers as source of nutrients in imbalanced proportion to increase the fruit production has created serious problems, causing economic inefficiency, damage to the environment and in certain situations. Poor purchasing capacity and negative effect of chemical fertilizers on soil health has led to intensified attempts for the use of bio-fertilizers and organic matter beside inorganic fertilizers. These all factors have increased the interest of farmers in adopting the Integrated Nutrient Management for production of fruit crops. Thus, field experiment on effect of integrated nutrient management on quality of mango cv. Kesar was conducted during the years 2020-21 and 2021-22 at Regional Horticultural Research Station, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari, (Gujarat). The experiment was laid out in Completely Randomized Design which comprising seven treatments namely, T_1: 100 % RDF (NPK+FYM), T_2: 100 % NPK soil analysis basis, T_3: T_2 +100 kg FYM tree^{-1}, T_4: 75 % RDF + 25 % RDN (Biocompost), T_5: 50 % RDF + 25 % RDN (Biocompost), T_6: 75 % RDF + 25 % RDN (Neemcake), T_7: 50 % RDF + 25 % RDN (Neemcake). All the seven treatments were repeated thrice. The results indicate that maximum TSS (18.53, 18.63 and 18.58 ºBrix), reducing sugars (6.53, 6.40 and 6.47 %), total sugar (15.20, 15.30 and 15.25 %), non-reducing sugars (7.66, 8.90, 8.80 %), ascorbic acid content (44.07, 45.13, 44.60 mg 100 g^{-1}), β-carotene content (599.27, 575.53, 587.40 µg 100 g^{-1}) and shelf-life (16.27, 18.47 and 17.37 days) as well as minimum acidity (0.256, 0.259, 0.258 %) with the application of 100 % NPK soil analysis basis + 100 kg FYM tree^{-1}. It was at par with treatment T_4 [75 % RDF + 25 % RDN (Biocompost)].

Keywords: Nutrient management, neemcake, biocompost, biofertilizers.

INTRODUCTION

Mango (*Mangifera indica* L.) belongs to family Anacardiaceae has been grown in India since long and is considered as "King of Fruits". It is native of Indo-Burma region. It is one of the choicest and most ancient fruits known to mankind. Mango fruit contains unique nutritional and medicinal qualities. Every 100 g mango pulp contains 0.8 g protein, 15 g carbohydrates, 0.4 g fat and 1.6 g dietary fibre. It is also good source of vitamin A and C. It is highly invigorative, laxative and diuretic (Bal, 2006).

In the present study, inorganic sources like N, P, K fertilizers and organic manures like FYM, bio-compost and neemcake are included as a component of INM. Organic manures act as a buffering agents and supplies food for beneficial living organisms. Farm Yard Manure refers to the decomposed mixture of dung and urine of farm animals along with litter and leftover material from roughages or fodder fed to the cattle. On an average well decomposed FYM contain 0.5 % N, 0.2 % P_2O_5 and 0.5 % K_2O. FYM increases the status of organic carbon, available nitrogen, phosphorus, potassium and trace elements in the soil, FYM also improves the physical properties of the soil. Bio-compost is a by-product of sugarcane industry. It is rich source of nutrients (C, Mn, S, N) along with bio inoculants. It contains N (0.75 %), P (0.20 %) and K (0.50 %). Neemcake is the by-product obtain in the process of cold pressing of neem tree fruits and kernels. It has an adequate quantity of N (2 - 5 %), P (0.5 - 1 %) and K (1 - 4 %) in organic form for plant growth. It makes soil more fertile due to an ingredient that blocks soil bacteria from converting nitrogenous compound into nitrogen gas. As a nitrification inhibitor, it prolongs the availability of nitrogen for longer time. It releases slowly in the soil ensuring the constant growth of the crop in the growing season. It reduces alkalinity in soil, as it produces organic acid on decomposition.

For higher production of quality fruits in a sustainable manner, application of nutrients at proper doses is very important. It is reality that proper dose of nutrients to be standardized for a set of agro-climatic conditions which in turn to be economically acceptable, viable and eco-friendly suitable. The INM have been recognized to influence fruit quality of mango. The balanced used of nutrients improved fertilizer use efficiency (Ranjan and Ghosh, 2006). Musmade *et al.* (2009) in acid lime recorded better quality fruit with the application of FYM and neemcake. As well as Korwar *et al.* (2006) also stated that quality of aonla were influenced by different sources of nutrients.

Biofertilizers are input containing microorganisms capable of mobilizing and solubilization of nutritive elements through biological processes. They are less expensive, ecofriendly , sustainable and do not require non-renewable source of energy during their production. They improve plant growth and fruit quality by producing plant hormones. The beneficial effect of biofertilizers are now well established in many fruit crops like mango (Ahmad *et al*., 2004). Biofertilizers provide strength against soil borne diseases and help in composting and effective recycling of solid waste which results in improved soil health. The combined use of bio-fertilizers and nitrogenous fertilizers improve the soil health and augments the fertilizer use efficiency (Vishwakarma *et al.,* 2017). Kumar *et al.* (2013) also reported that *azotobacter* influence the fruit quality of low-chilling pear. Therefore, an investigation was conducted to study the effect of integrated nutrient management on quality of mango cv. Kesar.

MATERIALS AND METHODS

The experiment was conducted during the years 2020-21 and 2021-22 at Regional Horticultural Research Station, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari, (Gujarat).

Statistical analysis of the data for various characters studied in present investigation was carried out through Completely Randomized Design for individual year and pooled analysis was carried out by taking the year effect in to the subgroup (split) and Analysis of variance was computed by split plot design. All the seven treatments were repeated thrice. Treatment details are, T_1: 100 % RDF (NPK+FYM), T_2: 100 % NPK soil analysis basis, T_3: T_2 +100 kg FYM tree^{-1}, T_4: 75 % RDF + 25 % RDN (Biocompost), T_5: 50 % RDF + 25 % RDN (Biocompost), T_6: 75 % RDF + 25 % RDN (Neemcake), T_7: 50 % RDF + 25 % RDN (Neemcake).

The recommended dose of NPK was 750:160:750 g tree^{-1} + 100 kg FYM. Full dose of FYM, phosphorus and potassium were applied in the month of June, whereas nitrogen, biocompost and neemcake were given in two equal splits, first half in the month of June and remaining half in the month of February. Biofertilizers (*Azotobacter*, phosphorus solubilizing bacteria and potassium mobilizing bacteria) were applied in the month of February @ 50 ml per tree each in all treatments except T_1.

For this study, three fruits were randomly taken at ripe stage and analyzed to determine the fruit chemical composition (TSS, reducing, non-reducing and total sugars, acidity, ascorbic acid and β carotene). TSS was recorded by using digital hand refractometer (Range of 0 to 32 °Brix). Reducing sugars, total sugars and non-reducing sugars were determined by method suggested by Lane and Eylon (1923) as described by Ranganna (1986). Titrable acidity was estimated by titrating known amount of pulp against 0.1 N NaOH using phenolphthalein as indicator Ranganna (1986). Ascorbic acid content of fruits was determined by Dye method given by Ranganna (1986). β-carotene content of mango fruits was estimated by spectrophotometric method as detailed by Raj *et al.* (2016).

Table 1: Initial quantity of nitrogen, phosphoras and potassium content based on soil analysis.

Sr. No.	2020-21			2021-22		
	N	P	K	N	P	K
	(kg ha^{-1})			(kg ha^{-1})		
T_2	195.67	30.46	300.26	202.60	34.40	326.73
T_3	254.72	41.82	348.38	261.95	48.33	367.87

Note: Based on the amount of available N, P and K, soil classified as follows:

For available N:

Class	Available N (kg ha^{-1})	Fertilizer dose to be applied
Low	<250	Increase RDN by 10 %
Medium	250-500	RDN only
High	>500	Decrease RDN by 10 %

For available P:

Class	Available P (kg ha^{-1})	Fertilizer dose to be applied
Low	<28	Increase RDP by 10 %
Medium	28-50	RDP only
High	>50	Decrease RDP by 10 %

For available K:

Class	Available K (kg ha^{-1})	Fertilizer dose to be applied
Low	<140	Increase RDK by 10 %
Medium	140-280	RDK only
High	>280	Decrease RDK by 10 %

The statistical analysis of data was carried out as per the method prescribed by Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

The data reported in Table 2 and Table 3 indicated that chemical composition of mango fruits was significantly affected by soil application of different fertilizers and manures.

TSS (ºBrix): Soil application of treatment T_3 (100 % NPK soil analysis basis + 100 kg FYM kg tree^{-1}) noted significantly higher value of TSS *i.e.* 18.53, 18.63 and 18.58 ºBrix for both the years *i.e.* 2020-21, 2021-22 and pooled data, respectively (Table 2). This treatment was statistically at par with the treatment T_4 and T_6 in pooled data. Increase in TSS was recorded by the application of FYM and NPK. This was because adequate dose of NPK stimulated the functioning of number of enzymes in the physiological process which might have increased the total soluble solid content of the fruits. Similar results were obtained by Kumar *et al.* (2017) in sweet orange, Kumar *et al.* (2019) in acid lime, Raut *et al.* (2020) in custard apple and Singh and Varu (2013) in papaya.

An increase in TSS contents with biofertilizers application may be attributed due to the quick metabolic transformation of starch and pectin into soluble compounds and rapid translocation of sugars from leaves to the developing fruits, conversion of complex polysaccharides into simple sugars. These results are close related with the findings of Kumar *et al.* (2019) in acid lime, Raut *et al.* (2020) in custard apple, Kundu *et al*. (2011) in mango, Meena *et al.* (2018) in pomegranate, Singh and Varu (2013) in papaya and Binepal *et al.* 2013 in guava.

Titrable Acidity (%): It was clearly seen from the data of Table 3 that significantly lower titrable acidity *i.e.* 0.256, 0.259, 0.258 per cent was observed with the treatment T_3 (100 % NPK soil analysis basis + 100 kg FYM kg tree^{-1}) and in pooled data, it was at par with T_4, T_5 and T_6.

Minimum acidity with the application of 100 % RDF soil analysis basis + 100 kg FYM kg tree^{-1} may be due to the utilization of acid under the respiratory process or conversion of acid into sugar by the reactions involving reversal of glycolytic pathway in the fruit. These findings are in agreement with Kumar *et al.* (2019) in acid lime, Raut *et al.* (2020) in custard apple. Same fact is possible in case of biofertilizers and it is in agreement with the result of Kumar *et al.* (2019) in acid lime, Bohane *et al.* (2016) in ber, Srivastava *et al.* (2014) in papaya, Kundu *et al.* (2011) in mango, Meena *et al.* (2018) in pomegranate and Binepal *et al.* (2013) in guava.

Reducing Sugars (%), Total sugars (%) and non-reducing sugars (%)

The maximum reducing sugars content (6.53, 6.40 and 6.47 %), total sugars (15.20, 15.30 and 15.25 %) and non-reducing sugars (8.66, 8.90 and 8.78) was noted in the fruits harvested from the trees received the treatment 100 % NPK soil analysis basis + 100 kg FYM kg tree^{-1} (T_3) during both the years and in pooled data, respectively (Table 2). In non-reducing sugars content treatment T_3 was statistically similar with the treatments T_4, T_5 and T_6 in pooled data. FYM with RDF increased reducing, total and non-reducing sugars due to gradual supply of nutrients and organic manures throughout the growth period which increased the metabolites in improvement in soil moisture availability, soil pH, organic carbon and nutrient status of the soil and decrease acidity of fruits may be attributed to their conversion of complex substance (starch) in to sugars and their derivatives by the reactions involving reversal of glycolytic pathway or might be used in respiration or both.

Table 2: Effect of integrated nutrient management on TSS, reducing sugars, total sugars and non- reducing sugars content of mango fruits.

Treat-ments	TSS (ºbrix)			Reducing sugars (%)			Total sugars (%)			Non-reducing sugars (%)		
	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled
T_1	16.67	17.07	16.87	4.53	3.93	4.23	11.87	11.76	11.84	7.34	7.83	7.60
T_2	16.73	17.20	16.97	4.73	4.20	4.47	12.38	12.55	12.47	7.65	8.35	8.00
T_3	18.53	18.63	18.58	6.53	6.40	6.47	15.20	15.30	15.25	8.66	8.90	8.80
T_4	18.13	18.47	18.30	6.13	6.10	6.12	14.69	14.70	14.71	8.56	8.60	8.60
T_5	17.60	17.53	17.57	5.27	5.23	5.25	13.70	13.62	13.66	8.43	8.39	8.42
T_6	18.07	18.13	18.10	5.60	5.57	5.58	14.09	14.04	14.08	8.49	8.48	8.50
T_7	17.00	17.47	17.23	5.33	4.93	5.13	13.08	13.28	13.18	7.75	8.35	8.05
SEm ±	0.37	0.31	0.28	0.13	0.16	0.09	0.22	0.22	0.13	0.25	0.17	0.15
CD at 5%	1.11	0.94	0.85	0.40	0.48	0.27	0.66	0.66	0.40	0.76	0.50	0.47
CV_1 %	3.62	3.03	3.90	4.16	5.26	4.11	2.79	2.79	2.40	5.32	4.01	4.57
Year (Y): SEm ±			0.10	Year (Y): SEm ±		0.06	Year (Y): SEm ±		0.09	Year (Y): SEm ±		0.10
Y: CD at 5 %			NS	Y: CD at 5 %		0.19	Y: CD at 5 %		NS	Y: CD at 5 %		NS
CV_2 (%)			2.65	CV_2 (%)		5.26	CV_2 (%)		3.10	CV_2 (%)		5.49
YT: SEm ±			0.34	YT: SEm ±		0.15	YT: SEm ±		0.22	YT: SEm ±		0.24
YT: CD at 5%			NS	YT: CD at 5%		NS	YT: CD at 5%		NS	YT: CD at 5%		NS

The highest mean values for sugars with the application of NPK could be attributed to the involvement of nitrogen in various energy sources like amino acids and amino sugars (Kumar *et al.*, 2017). Similar findings were also reported by Verma and Chauhan (2012) in apple, Katiyar *et al*., (2012) in ber, Dwivedi (2013) in guava, Raut *et al*. (2020) in custard apple and Singh and Varu (2013) in papaya.

Application of biofertilizers might have performed regulatory role on absorption of nutrients and translocation of metabolites especially carbohydrates reserve in roots and stem which hydrolysed into sugar during ripening which improve the total sugar content of fruits. Similar results were found in Kumar *et al.* (2019) in acid lime, Raut *et al.* (2020) in custard apple, Kundu *et al.* (2011) in mango, Meena *et al.* (2018) in pomegranate, Singh and Varu (2013) in papaya and Binepal *et al.* 2013 in guava.

Ascorbic Acid Content of Fruits (mg 100 g^{-1}). Significantly maximum ascorbic acid content *i.e.* 44.07, 45.13, 44.60 mg 100 g^{-1} was also recorded under the treatment T_3 (100 % NPK soil analysis basis + 100 kg FYM kg tree^{-1}) during both the years *i.e.* 2020-21, 2021-22 and in pooled data, respectively (Table 3). It was found similar with the treatment T_4.

The higher ascorbic acid content might be due to increased N application in form of organic (FYM) and inorganic nutrient sources might enhance the catalytic activity of several enzymes, which participate in biosynthesis of ascorbic acid and its precursor (Kumar *et al.* 2019). These results are in line with the findings of Ingle *et al*., (2001) in acid lime and Savreet and Bal (2014) in lemon.

Soil drenching of biofertilizers improve soil physical condition, enhanced root development by mycelial network of microorganisms, increased moisture retention and thus improved water absorption, steady flow of nitrogen and other essential minerals which augment photosynthesis of plant leading in more starch reserve in shoots and roots which is translocation from shoots to fruits during maturation and helps in formation of ascorbic acid. These results are similar with the findings of Kundu *et al.* (2011) in mango, Meena *et al.* (2018) in pomegranate and Binepal *et al.* (2013) in guava.

β-Carotene Content (µg 100 g^{-1}). The data (Table 3) shows that β-carotene content (599.27, 577.53, 587.40 µg 100 g^{-1}) was recorded significantly maximum under the treatment T_3 (100 % NPK soil analysis basis + 100 kg FYM kg tree^{-1}) during the years, 2020-21, 2021-22 and in pooled data, respectively. Which was found at par with T_4 [75 % RDF +25 % RDN (Bio-compost)]. It might be influenced by adequate availability of nutrients from biofertilizers treatments. Proper uptake may lead to increase in pigment synthesis, resulting higher carotenoids in mango fruits. These findings are in line with the findings of Dutta *et al*. (2016) in mango.

Shelf-life (Days). Significantly maximum shelf-life *i.e.* 16.27, 18.47 and 17.37 days was registered with the treatment T_3 (100 % NPK soil analysis basis + 100 kg FYM kg tree^{-1}) during the years, 2020-21, 2021-22 and in pooled data, respectively. The treatment T_3 was at par with the treatment T_4 pooled data (Table 3).

This extended shelf life in treatment T_3 (100 % RDF soil analysis basis + 100 kg FYM kg tree^{-1}) might be due to it slow down the ethylene synthesis and ultimately ripening process through minimum reduction in weight loss and other physiological parameters as well as bio-chemical changes in fruits. These results are in line with the findings of Patel and Naik (2010) and Patel *et al.* (2017) in sapota.

Table 3: Effect of integrated nutrient management on tritable acidity, ascorbic acid content, β-carotene content and shelf-life of mango fruits.

Treat-ments	Titrable acidity (%)			Ascorbic Acid (mg 100 g^{-1})			β-Carotene Content (µg 100 g^{-1})			Shelf-life (Days)		
	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled
T_1	0.293	0.299	0.296	34.93	37.40	36.17	445.80	422.87	434.33	13.80	14.93	14.37
T_2	0.279	0.293	0.286	36.13	37.07	36.60	474.33	455.20	464.77	14.20	15.07	14.63
T_3	0.256	0.259	0.258	44.07	45.13	44.60	599.27	575.53	587.40	16.27	18.47	17.37
T_4	0.259	0.267	0.263	41.56	44.20	42.88	568.07	547.53	557.80	15.80	17.47	16.63
T_5	0.264	0.272	0.268	38.80	40.33	39.57	509.40	484.53	496.97	14.87	16.60	15.73
T_6	0.264	0.272	0.268	39.47	41.80	40.63	525.00	498.07	511.53	15.33	16.80	16.07
T_7	0.265	0.279	0.272	37.67	38.60	38.13	498.00	462.40	480.20	14.60	16.20	15.40
SEm ±	0.006	0.007	0.006	0.87	1.00	0.61	12.66	15.61	11.68	0.51	0.50	0.28
CD at 5%	0.018	0.021	0.018	2.63	3.04	1.86	38.41	47.36	35.45	1.55	1.53	0.85
CV_1 %	3.85	4.36	4.77	3.86	4.27	3.77	4.24	5.49	5.67	5.91	5.29	4.37
Year (Y): SEm ±			0.002	Year (Y): SEm ±		0.35	Year (Y): SEm ±		4.33	Year (Y): SEm ±		0.23
Y: CD at 5 %			0.007	Y: CD at 5 %		1.06	Y: CD at 5 %		13.13	Y: CD at 5 %		0.68
CV_2 (%)			3.36	CV_2 (%)		4.03	CV_2 (%)		3.93	CV_2 (%)		6.57
YT: SEm ±			0.007	YT: SEm ±		0.90	YT: SEm ±		14.22	YT: SEm ±		0.51
YT: CD at 5%			NS	YT: CD at 5%		NS	YT: CD at 5%		NS	YT: CD at 5%		NS

Biofertilizers altered physiology and biochemistry of the fruit and reduced respiration and transpiration which in turn resulted in low cumulative physiological loss in weight and increased shelf life. Similar results are in agreement with Sau *et al.* (2017) in mango and Patel *et al.* (2017) in sapota.

CONCLUSION

From the two years of field study, it can be concluded that soil application of 100 % NPK soil analysis basis + 100 kg FYM kg tree^{-1} can improved quality of fruit in mango cv. Kesar. However, T_4 [75 % RDF + 25 % RDN (Biocompost)] also stood statistically equivalent with T_3 in most of the quality parameters.

FUTURE SCOPE

In order to improve the quality of mango, future studies have to be done further by employing the different sources of INM (inorganic, organic and biofertilizers) treatments along with soil analysis in different locality.

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