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EFFECT OF NUTRIENT MANAGEMENT ON YIELD AND QUALITY OF MANGO (*MANGIFERA INDICA* L.) CV. KESAR UNDER HIGH DENSITY PLANTING

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ABSTRACT

The present investigation entitled "Effect of nutrient management on yield and quality of mango (*Mangifera indica* L.) cv. Kesar under high density planting" was conducted at Instructional cum Research farm, Department of Horticulture, MPKV., Rahuri Dist., Ahmednagar during the year 2019-20 and 2020-21. The application of nutrients in split doses as treatments [F_1–F_5] in RBD (Randomized Block Design) with four replications and three plants per replication serves as a treatment unit. The growth parameters in high density planting of mango cv. Kesar were significantly influenced by nutrient application in different split doses. The minimum days required from flowering to fruit set (28.17 days) recorded at F_1, whereas maximum fruit weight (241.28 g), pulp (70.33 %), minimum peel (14.02 %), minimum stone (15.65%) and maximum pulp: peel ratio (5.24), pulp: stone ratio (4.73) were recorded in F_4. While in biochemical parameters *viz*., maximum TSS (19.50 ^{O}Brix), minimum acidity (0.31 %), maximum total sugars (14.04%), reducing sugars (4.35%), non-reducing sugars (8.81%) were these are influenced by the nutrient application in split doses.

Key words : Nutrient management, Biochemical characters, Split doses, High density planting, Mango.

Introduction

Mango (*Mangifera indica* L.), a member of the Anacardiaceae family, is the world's oldest and most valuable fruit. Mango is said to have originated in South East Asia, in the Indo Burma area, in the Himalayan foothills (Bose, 1985 and Mukherjee, 1951). Mangifera is a genus with 69 species (Kosterman and Bompard, 1993). India produces 40.4 percent of all mangoes in the globe. Mango is grown on 2.32 million hectares, with a production of 20.90 million tonnes and a productivity of 9.7 MT/ha; in Maharashtra, mango is grown on 1.67 lakh hectares, with a production of 7.91 lakh tonnes and a productivity of 9.7 MT/ha (Anonymous, 2021). During the previous ten years, mango production and area have expanded by 45-50%.

Kesar is the most popular mango variety in Maharashtra and has good export potential., Because of its better output, excellent fruit quality, rich flavour and pleasant scent with a red flush on the shoulders, this variety's area has risen not only in Maharashtra, but also in surrounding states like Gujarat, Madhya Pradesh and Rajasthan (Kulkarni *et al*., 2017). The high-density mango planting strategy has gained popularity in recent years. To boost production, the use of a High-Density Planting (HDP) system combined with good canopy management methods and a drip-fertigation system is essential (Kumar, 2013). It produces good yields early in the orchard's life cycle and is easy to manage (Choudhary *et al*., 2020). The fruit plant consumes a significant quantity of the soil's vital nutrient reserves. Continued nutrient depletion reduces fruit output and soil fertility over time, resulting in soil deterioration. Mango quality and production might be increased by applying a balanced amount of nutrients at the correct growing stage using the right approach. One of the most significant methods for increasing mango output and quality is nutrient management. Within the root zone, fertilisers must feed and maintain an optimal quantity of nutrients. As a result, it is critical to emphasise modern irrigation and fertilising approaches. For this purpose, combined irrigation and fertilisation is excellent, with irrigation water functioning as a vehicle for the nutrients that crops require. Fertilizers are becoming a more expensive input by the day. As a result, it is deemed important to investigate the most effective utilisation of these inputs. This may be accomplished by implementing an effective drip watering system. In certain mango-growing locations, fertilizer application is uneven or insufficient, resulting in nutritional shortages, particularly potassium. The different stages of plant growth show varying nutrient demand levels, thus an effective fertilisation strategy for mango trees should take that into account. Furthermore, mango trees are biennial, meaning they produce a large yield one year and a poor yield the next, which makes it difficult to develop an effective fertilisation strategy (Avilan, 1971). Appropriate measures to achieve optimum soil nutrient status will go a long way toward keeping mango trees at various phases, ensuring maximum yield in a sustainable manner. As a result, applying nutrients at the correct time and in the right amount, while keeping in mind the importance of phenological phases, might be a valuable strategy for achieving good output on such soils.

Materials and Methods

An investigation on “Effect of nutrient management on yield and quality of mango (*Mangifera indica* L.) cv. Kesar under high density planting” was undertaken at Instructional cum Research farm, Department of Horticulture, MPKV, Rahuri, Dist. Ahmednagar during the year 2019-2021. The experiment was conducted in Randomised Block Design (RBD) with five treatments of split nutrient application, four replication and three plant served as a treatment unit (plant/replication). The nutrients was applied in split doses (F_1 – 50% NPK at initial stage and 50% NPK at one month before flowering, F_2 – 50% NPK at initial stage, 50% P and 25% K at one month before flowering, 25% N at Peanut stage and 25% N at Marble stage, F_3 – 50% NPK at initial stage, 50% P at one month before flowering, 50% N and 25% K at Peanut stage and 25% K at Marble stage, F_4 – 50% NPK at initial stage, 50% P at one month before flowering, 20% N and K at Peanutstage, 20% N and K at Marble stage, 10% N and K at Egg stage, F_5 – (control) Recommended dose of fertilizers 50% N and 100% P and K at initial stage and 50% N at one month before flowering.

The number of fruit born on the tree at the commencement of first harvest was counted and expressed as number of fruit per tree, individual fruit was weighed on electronic balance and the average weight was expressed in grams, pulp weight was calculated by subtracting the sum of peel and stone weight from the fruit weight and the average pulp weight per fruit in percent was calculated and expressed in pulp (%), fruit were peeled off using a knife and weight of the peel was recorded using electronic weighing balance and the average peel weight per fruit in percent was calculated and expressed in peel (%). The stone weight was determined by extracting stone and taking their weight on electronic weighing balance and expressed as stone (%). The pulp: peel ratio was calculated by dividing the pulp weight by peel weight, pulp: stone ratio was calculated by dividing the pulp weight by stone weight, TSS were measured with the help of Hand Refractometer, total sugars and reducing sugars were determined by the method of Lane and Eynon (1923) as described by Ranganna (1977), non-reducing sugar (%) was estimated by deducting reducing sugar from total sugar.

Results and Discussion

Days from flowering to fruit set

The effect of nutrient application was found significant on days from flowering to fruit set (Table 1). The result shows significant differences in respect to days required from flowering to fruit set. Minimum days required from flowering to fruit set were recorded at treatment F_1 (27.77, 28.56 and 28.17 days) and it was at par with treatment F_5 (29.10, 30.72 and 29.91 days) in first year, second year and pooled, respectively. The maximum days was taken from flowering to fruit set (33.32, 34.20 and 33.76 days) in treatment F_3 during first year, second year and in pooled, respectively. The minimum time required for flowering to fruit set were recorded in treatment F_1 and it might have caused high C:N ratio which would have promoted early flowering (Katyal and Dutta, 1971). Madhumathi *et al*. (2004) and Ogendo *et al*. (2008) also showed an increase in photosynthetic production as a result of a greater phosphorus dose, which aids in breaking bud dormancy and increasing flowering sites.

Weight of fruit (g)

The effect of nutrient application was found significant on fruit weight in both the years and in pooled (Table 1). The maximum fruit weight was recorded in first year, second year and pooled were 238.85, 243.70 and 241.28 g in F_4 and it was at par with F_3 (233.00 g) in first year, F_2 (237.80 g) F_3 and F_5 (234.60 g) in second year and F_2 (233.96 g) and F_3 (235.60 g) in pooled, respectively. The

Table 1 : Effect of nutrient management on days from flowering to fruit set and weight of fruit (g) underhigh density planting of mango (*Mangifera indica* L.) cv. Kesar.

Treatment	Days from flowering to fruit set			Weight of fruit (g)		
	2019-20	2020-21	Pooled	2019-20	2020-21	Pooled
F_1	27.77	28.56	28.17	230.00	226.30	228.15
F_2	31.52	32.34	31.93	230.13	237.80	233.96
F_3	33.32	34.20	33.76	233.00	238.20	235.60
F_4	31.39	32.03	31.71	238.85	243.70	241.28
F_5	29.10	30.72	29.91	227.13	234.60	230.86
SE(m) ±	1.12	0.98	1.03	2.44	3.19	2.88
CD @ 5%	3.46	3.02	3.03	7.51	9.83	8.42

Table 2 : Effect of nutrient management on pulp (%), peel (%) and stone (%) under high density planting of mango (*Mangifera indica* L.) cv. Kesar.

Treatment	Pulp (%)			Peel (%)			Stone (%)		
	2019-20	2020-21	Pooled	2019-20	2020-21	Pooled	2019-20	2020-21	Pooled
F_1	66.44	67.52	66.98	16.45	15.45	15.95	17.13	17.09	17.11
F_2	66.88	67.55	67.21	15.62	15.57	15.59	17.53	16.90	17.21
F_3	69.32	69.50	69.41	14.76	14.62	14.69	15.93	15.88	15.90
F_4	70.41	70.26	70.33	13.05	14.98	14.02	16.55	14.76	15.65
F_5	65.72	65.45	65.58	15.78	16.88	16.33	18.50	17.68	18.09
SE(m)±	0.28	0.55	0.46	0.25	0.32	0.43	0.22	0.33	0.28
CD @5%	0.87	1.69	1.36	0.79	1.00	1.27	0.68	1.03	0.83

minimum fruit weight 227.13 at F_5, 226.30 and 228.15 g was recorded at F_1 in first year, second year and pooled, respectively. This increase in weight was might be due to increased synthesis of metabolism to fruit and due to accumulation of sugars and high pulp percentage in plants treated with continuous dose of N, P and K. Another probable cause could be greater mobility of these major nutrients to the developing fruit which acted as strong metabolic sink and it stimulates the synthesis of chlorophyll and increased photosynthetic activity which results in increased stored food material in the tissue (Singh and Rajput, 1977).

Pulp (%)

The effect of nutrient application was found significant on pulp (%) in both the years as well as in pooled (Table 2).

During first year, maximum pulp was recorded in treatment F_4 (70.41 %) and it was found significantly superior among all the treatments. During second year, maximum pulp was recorded in treatment F_4 (70.26%) and it was at par with treatment F_3 (69.50%). Whereas, in pooled, maximum pulp was recorded in treatment F_4 (70.33%) and it was at par with treatment F_3 (69.41%). The minimum pulp was recorded in treatment F_5 i.e., control (65.72, 65.45 and 65.58%) during both the years of experiment as well as in pooled, respectively.

The increased pulp percent in treatment F_4 might be due to faster metabolite production, notably carbohydrate, and their translocation to fruit, resulting in higher pulp content (Dutta, 2004). Makhmale *et al*. (2016) found that applying fertilizers in split dosages boosts mango pulp percent.

Peel (%)

The effect of nutrient application was found significant on peel (%) in both the years and in pooled (Table 2). The minimum peel percent was recorded in treatment F_4 (13.05%) during first year and it was found significantly superior to rest of the treatments. During second year, minimum peel percent was noticed in treatment F_3 (14.62%) and it was at par with treatment F_4 (14.98%) and treatment F_2 (15.57%) whereas, in pooled, minimum peel percent was recorded in treatment F_4 (14.02%) and it was at par with treatment F_3 (14.69%). The maximum peel percentage was recorded in treatment F_5 (15.78, 16.88 and 16.33%) during first year, second year and in pooled, respectively. This might be attributed to an increase in either the flesh or the peel, or both. This is mostly due to the increase of flesh development. Durrani *et al*. (1982) in sapota and Lal *et al*. (2003) in ber also reported similar findings.

Stone (%)

The effect of nutrient application was found significant on stone (%) in both the years and in pooled (Table 2). The minimum stone (%) was noticed in treatment F_3 (15.93%) during first year and it was at par with treatment F_4 (16.55%). During second year of the experiment, minimum stone (%) was recorded in treatment F_4

Table 3 : Effect of nutrient management on pulp: peel ratio and pulp: stone ratiounder high density planting of mango (*Mangifera indica* L.) cv. Kesar.

Treatment	Pulp: Peel			Pulp: Stone		
	2019-20	2020-21	Pooled	2019-20	2020-21	Pooled
F_1	4.26	4.90	4.58	4.13	4.18	4.15
F_2	4.38	4.61	4.49	3.96	4.19	4.07
F_3	4.85	4.97	4.91	4.57	4.55	4.56
F_4	5.54	4.94	5.24	4.43	5.03	4.73
F_5	4.22	3.95	4.09	3.59	3.79	3.69
SE(m) ±	0.11	0.14	0.19	0.07	0.12	0.10
CD @ 5%	0.34	0.45	0.56	0.22	0.38	0.30

Table 4 : Effect of nutrient management on total soluble solids (^{O}Brix) and acidity (%) under high density planting of mango (*Mangifera indica* L.) cv. Kesar.

Treatment	Total soluble solids (^{O} Brix)			Acidity (%)		
	2019-20	2020-21	Pooled	2019-20	2020-21	Pooled
F_1	17.80	17.93	17.87	0.29	0.29	0.29
F_2	18.25	18.37	18.31	0.29	0.29	0.29
F_3	18.51	18.81	18.66	0.28	0.27	0.28
F_4	19.47	19.54	19.50	0.26	0.26	0.26
F_5	17.56	17.66	17.61	0.32	0.30	0.31
SE(m) ±	0.18	0.10	0.15	0.004	0.005	0.004
CD @ 5%	0.56	0.31	0.43	0.013	0.014	0.013

(14.76%) and it was significantly superior among all the treatments. In pooled, minimum stone (%) was recorded in treatment F_4 (15.65%) and it was at par with treatment F_3 (15.90%). The maximum stone (%) was recorded in treatment F_5 (18.50, 17.68 and 18.09%) during first year, second year and in pooled, respectively. This might be due to an increase in flesh, stone or both. This is primarily due to the increase of flesh development. Durrani *et al*. (1982) reported similar results in sapota, Lal *et al*. (2003) in ber and Makhmale *et al*. (2016) in mango.

Pulp: peel ratio

The effect of nutrient application was found significant on pulp: peel ratio in both the years and in pooled (Table 3). The maximum pulp: peel ratio during first year was recorded in treatment F_4 (5.54) and it was significantly superior among all the treatments. During second year, the maximum pulp: peel ratio was recorded in treatment F_3 (4.97) and it was at par with treatment F_1 (4.90) and treatment F_4 (4.94). In pooled, highest pulp: peel ratio was noticed in treatment F_4 (5.24) and it was at par with treatment F_3 (4.91). Minimum pulp: peel ratio was recorded in treatment F_5 (4.22, 3.95 and 4.09) during both the year as well as in pooled, respectively. This increase in the pulp: peel ratio might be due to an increase in either the flesh or the peel or both. This is mostly due to the stimulation of flesh growth. Durrani *et al*. (1982) reported similar results in sapota, Lal *et al*. (2003) in ber and Makhmale *et al*. (2016) in mango. Higher potassium levels were mainly attributable to a rise in pulp weight. Shinde *et al*. (2009) found similar results in mango, while Kumar and Kumar (2008) found similar results in banana.

Pulp: stone ratio

The effect of nutrient application was found significant on pulp: stone ratio in both the years and in pooled (Table 3). The maximum pulp: stone ratio was recorded in treatment F_3 (4.57) during first year and it was at par with treatment F_4 (4.43). During second year, maximum pulp: stone ratio was recorded in treatment F_4 (5.03) and it was significantly superior among all the treatments. In pooled, highest pulp: stone ratio was recorded in treatment F_4 (4.73) and it was at par with treatment F_3 (4.56). The data showed minimum pulp: stone ratio in treatment F_5 (3.59, 3.79 and 3.69) during both the years as well as in pooled, respectively. This increase in the pulp-to-stone ratio in treatment F_4 might be attributable to an increase in either flesh or stone or both. The increase of flesh growth is principally responsible for this. Durrani *et al*. (1982) reported similar results in sapota, Lal *et al*. (2003) in ber and Makhmale *et al*. (2016) in mango.

Biochemical Parameters

Total soluble solids (^{O} Brix)

The effect of nutrient application was found significant effect on TSS in both the years and in pooled (Table 4). The maximum TSS was recorded in treatment F_4 (19.47 ^{O} B) during first year and it was found significantly superior among all the treatment. During second year, maximum TSS was recorded in treatment F_4 (19.54 ^{O} B) and it was significantly superior among all the treatments. However, in pooled, maximum TSS was recorded in treatment F_4 (19.50OB) and it was found significantly superior among rest of the treatments. The minimum TSS was recorded in F_5 (17.56, 17.66 and 17.61^O B) during both the years as well as in pooled, respectively. The increase in TSS in treatment F_4 might be attributed to the plant's enhanced metabolic process, or the conversion of complex chemicals into simple sugar, which boosts metabolic activity in fruit and results in higher TSS. According to Ghosh *et al*. (2004), the highest levels of N and P resulted in the greatest rise in TSS in custard apple.

Table 5 : Effect of nutrient management on total sugars (%) reducing sugars (%) and non - reducing sugars (%) under high density planting of mango (*Mangifera indica* L.) cv. Kesar.

Treatment	Total sugars (%)			Reducing sugars (%)			Non-reducing sugars (%)		
	2019-20	2020-21	Pooled	2019-20	2020-21	Pooled	2019-20	2020-21	Pooled
F_1	12.47	13.30	12.88	4.34	4.90	4.62	7.72	7.04	7.38
F_2	12.80	13.34	13.07	4.58	5.08	4.83	7.81	7.38	7.59
F_3	13.46	13.60	13.53	4.93	5.22	5.07	8.10	8.08	8.09
F_4	14.16	13.93	14.04	5.36	5.28	5.32	8.36	8.46	8.41
F_5	11.62	12.52	12.07	4.11	4.59	4.35	7.14	7.54	7.34
SE(m) ±	0.09	0.17	0.13	0.12	0.08	0.06	0.13	0.10	0.17
CD @ 5%	0.28	0.51	0.39	0.37	0.25	0.18	0.41	0.30	0.50

Acidity (%)

The effect of nutrient application was found significant on acidity (%) in both the years and in pooled (Table 4). The minimum acidity was recorded in treatment F_4 (0.26, 0.26 and 0.26 %) during both the years as well as in pooled and it was found significantly superior among rest of the treatments in first year, second year and in pooled, respectively. The maximum acidity was recorded in treatment F_5 (0.32, 0.30 and 0.31%) during both the years as well as in pooled, respectively. Acidity may be depleted in treatment F_4 as a result of quick conversion of acids into sugars and their derivatives or as a result of their use in respiration or both (Gupata and Bramachari, 2004). In mango, Sinto *et al*. (2011) obtained a similar finding.

Total sugars (%)

The effect of nutrient application was found significant on total sugars (%) in first year, second year and in pooled (Table 5). The maximum total sugars were recorded in treatment F_4 (14.16%) during first year and it was significantly superior among rest of the treatments. During second year, maximum total sugars was observed in treatment F_4 (13.93%) and it was at par with treatment F_3 (13.60 %). In pooled, maximum total sugars were found in treatment F_4 (14.04%) and it was significantly superior among rest of the treatments. The minimum total sugars were recorded in treatment F_5 (11.62, 12.52 and 12.07%) during both the years as well as in pooled, respectively. It is might be due to the action of important nutrients on converting complex substances to simple ones, resulting in enhanced metabolic activity in the fruit and hence higher total sugars (Salisbury and Rose, 1992). Sadarunnisa *et al*. (2010) found similar findings in papaya.

Reducing sugars (%)

The effect of nutrient application was found significant on reducing sugars (%) in first year, second year as well as in pooled (Table 5). The maximum reducing sugars was recorded in treatment F_4 (5.36%) in first year and it was found significantly superior to rest of the treatments. During second year, maximum reducing sugars was recorded in treatment F_4 (5.28%) and it was at par with treatment F_3 (5.22%) and F_2 (5.08%), whereas, in pooled, maximum reducing sugars was recorded in treatment F_4 (5.32%**)** and it was significantly superior over rest of the treatments. The minimum reducing sugars was recorded in treatment F_5 (4.11, 4.59 and 4.35%) during both the years as well as in pooled, respectively. According to Ghosh *et al*. (2004), the highest levels of N and K resulted in the greatest increase in total sugar in the custard apple. Boora and Singh (2000) observed similar results in Sapota, as well.

Non-reducing sugars (%)

The effect of nutrient application was found significant on non-reducing sugars (%) in first year, second year as well as in pooled (Table 5). The maximum non reducing sugars during first year was recorded in treatment F_4 (8.36%) and it was at par with treatment F_3 (8.10%). During second year, maximum non-reducing sugars was recorded in treatment F_4 (8.46%) and it was significantly superior among the rest of treatments. In pooled, the maximum non-reducing sugars recorded in treatment F_4 (8.41%) and it was found at par with treatment F_3 (8.09%). The minimum non-reducing sugars was recorded in treatment F_5 (7.14%) during first year. During second year, the minimum non-reducing sugars was recorded in treatment F_1 (7.04%) whereas, the minimum non-reducing sugars in pooled was recorded in treatment F_5 (7.34%). This increase in non-reducing sugars might be attributed to either a faster conversion of sugar into its derivatives via reverse glycolytic pathways or because they were utilized in respiration. Singh (1975), Singh and Rajput (1977) found similar results in mango and guava, respectively.

Conclusion

From the above findings, it could be concluded that nutrient application F_4 (50% NPK at initial stage, 50% P at one month before flowering, 20% N and K at Peanutstage, 20% N and K at Marble stage, 10% N and K at Egg stage) was found to be the best time and dose of application for yield and quality characters *viz.* days from flowering to fruit set, weight of fruit (g), pulp (%), peel (%), stone (%), pulp to peel ratio, pulp to stone ratio, total soluble solids (^{O}Brix), acidity (%), total sugars, reducing sugars and non-reducing sugars.

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