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Influence of Bio-Stimulants on the Yield Attributes, Peel and Pulp Color of Mango (*Mangifera indica* L.) cv Mallika under Central Dry Zone of Karnataka

Arpitha S., Sridhar R., Sudharani N., Madaiah D., M. Dinesh Kumar

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ABSTRACT

The mango (*Mangifera indica* L.) is considered the 'King of fruits' and found to be economically important due to its excellent fruit quality, despite having good fruit quality characteristics, it is associated with production constraints such as low initial fruit set, heavy fruit drops, undersized fruit and improper fruit color development. On the other hand, bio-stimulants play an important role in improving the productivity and quality of fruits. In the present study, four biostimulants viz., jasmonic acid, salicylic acid, brassinosteroids and triacontanol, were sprayed at intervals of 70 and 90 days after anthesis at two different concentrations with four replications. Among the treatments, triacontanol @ 10 ppm (T_9) showed a significant difference in yield parameters and recorded maximum average fruit weight (571.98 g), fruit length (17.53 cm), fruit diameter (92.38 cm), fruit volume (723.75 cc), pulp weight (435.91 g), pulp percentage (76.24), number of fruits (75.25), yield per tree (41.31 kg) in comparison to control. However, salicylic acid @ 150 ppm (T_5) showed the highest colorimeter coordinates L^*, a^*, b^*, C^* and h^o for both pulp and peel color. The study concludes the use of phytohormones enhances the fruit development and quality parameters of mango cv Mallika under the central dry zone of Karnataka.

Keywords Mango, Mallika, Bio-stimulants, Fruit color, Yield attributes.

Arpitha S.[1], Sridhar R.[2]*, Sudharani N.[3], Madaiah D.[4], M. Dinesh Kumar[5]

[1]Department of Fruit Science, College of Horticulture, Mudigere 577132, Karnataka, India

[2]Assistant Professor
Department of Fruit Science, College of Horticulture, Hiriyur 577598, Karnataka, India

[3]Assistant Professor
Department of Food Science & Nutrition, College of Horticulture, Mudigere 577132, Karnataka, India

[4]Professor and Head
Department of Post-Harvest Technology, College of Horticulture, Mudigere 577132, Karnataka, India

[5]Professor of Agronomy & Dean (PGS), KSN UAHS, Iruvakki, Shivamogga 577412, Karnataka, India

Email: sridharr@uahs.edu.in
*Corresponding author

INTRODUCTION

Mango (*Mangifera indica* L.) belongs to the family Anacardiaceae and is the choicest, most demanding fruit crop of India, which holds a great cultural, socio-economic and religious significance with a long history of cultivation. Mango being considered 'King of fruits' found to be economically important due to its excellent qualities (attractive color, sweet taste and

mouth watering flavor) and nutritional composition like vitamins, minerals, edible fiber, and phytochemicals (Srivastav *et al.* 2021). India is the largest producer of Mango, accounting for almost 40% of world production (Ramachandra *et al.* 2021). The total cultivated area in India is 2.32 million ha with a total production of 20.90 million MT (Anon 2020-21). Andhra Pradesh, Uttar Pradesh, Odisha, Karnataka, Maharashtra, Gujarat, Tamil Nadu, and Bihar are major mango growing states. The area and production of Mango in Karnataka was 0.192 million ha and 1.829 million MT respectively (Anon 2016-17).

Mango variety Mallika was developed by Indian Agricultural Research Institute, New Delhi. This hybrid was developed by crossing Neelam and Dashehari. The tree is medium in size, semi-vigorous and has a strong tendency to bear fruit on a regular basis. Mallika produces big sized, high-quality fiberless fruits with good keeping quality. Fruits are ovate to oblong in shape with slightly prominent ventral shoulder with good fruit keeping quality. Despite good characters, many problems are associated in mango production such as low initial fruit set, heavy fruit drops, under sized fruit and improper fruit color development (Singh and Singh 1995). The foliar application of bio-stimulants during flowering and fruit development stages could be useful for reducing the problem of fruit drop thereby increasing yield of mango. They play an important role in indigenous hormone production to keep the auxin-ABA balance and have a great influence over the up and down regulation of several genes involved in plant growth and development. It also appears to have prominent effect on productivity and quality of fruit crop by influencing various metabolic processes and also increases fruit yield through an accelerated fruit development resulting from increased availability of metabolites and assimilates. Further, foliar application will also helps in uniform fruit color. Hence, the main objective of this study was to evaluate the effect of the preharvest application of bio-stimulants on the yield and color of peel and pulp of mango cv Mallika.

MATERIALS AND METHODS

The experiment was carried out during 2021-22 in the Zonal Agricultural and Horticultural Research Station (ZAHRS), Babbur farm, Hiriyur taluk of Chitradurga district. The experiment was laid out in Randomized Complete Block Design (RCBD) comprising of nine treatments viz., T_1 – control, T_2 - jasmonic acid (100 µM), T_3 - jasmonic acid (150 µM), T_4 - salicylic acid (100 ppm), T_5 - salicylic acid (150 ppm), T_6 - brassinosteroid (0.40 ppm), T_7 - brassinosteroid (0.60 ppm), T_8- triacontanol (7.5 ppm) and T_9 - triacontanol (10.0 ppm) with four replications, sprayed at an interval of 70 and 90 days after anthesis.

Fruits harvested at full matured stage from each tree were weighed in kilogram during the harvest and summed up and expressed in kg per tree. Treatment wise number of fruits were counted at each harvesting and then summed up which was expressed as number of fruits per tree. Five fully matured fruits were randomly selected and each fruit was weighed on electric balance and average weight of the fruit per treatment was computed in grams. Fruit length was measured from the basal end of the fruit to the tip by using a vernier caliper and expressed in centimeter. The diameter of fruit was recorded at the widest point across the shoulder of the fruit using vernier caliper and expressed in centimeter. The fruit volume was measured by water displacement method. The fruits were dipped in a full filled jar of water and the water displaced by the fruits was collected and measured by volumetric cylinder and the average reading was expressed in cubic centimeter.

Harvested fruits were wrapped with the newspaper and kept in the corrugated boxes for uniform ripening. Peel and pulp color of ripened fruits were recorded using colorimeter (Konica, Minolta CR10, Japan) and represented in *L**, *a**, *b**, C* (chroma) and h^0 (hue angle) values. The *L** value represents brightness and its value ranges between 0 (black) to 100 (white). Green color of peel is indicated by negative or smaller value of *a** whereas red color is denoted by positive or higher *a** value. The b value represents variations from blue (-b) to yellow (+b). C* (chroma) is the degree of strength in a color and h^0 (hue angle) describes relative amount of redness and yellowness where 90^0 for yellow. For each parameter, three values were recorded and their average was taken as final value. Redness and whiteness index was calculated using *L**, *a** and *b** values.

RESULTS AND DISCUSSION

In the present study as presented in Table 1 observed the maximum fruit length and diameter were recorded in T_9 - triacontanol @ 10 ppm (17.53 cm and 92.38 cm, respectively) and the minimum was noticed in T_1 - control (12.65 cm and 75.49 cm, respectively). Increased level of auxin and cytokinin was observed with the application of triacontanol. These phytohormones resulted in cell division and cell elongation by enlargement of vacuoles and loosening of the cell wall after increasing its plasticity ultimately increasing length and diameter of the fruit. The results are in conformity with Patel *et al*. (2021) in mango, Abubakar *et al*. (2013) in pomegranate cv Kandhari, Choudhary *et al.* (2013) in mandarin, Thakur (2014) in apricot and Zubair *et al*. (2017) in apple. The maximum fruit volume was recorded in T_9 - triacontanol @ 10 ppm (723.75 cc), however minimum fruit volume was found in T_1 - control (417.63 cc). The increase in fruit volume was attributed to the role of triacontanol in stimulating cell division and enhancing the biosynthesis of natural hormones and carbohydrates. These results are in agreement with Abubakar *et al.* (2013) in pomegranate cv Kandhari, Choudhary *et al.* (2013) in mandarin and Zubair *et al.* (2017) in apple.

The maximum number of fruits was obtained in T_9 - triacontanol @ 10 ppm (75.25), whereas the minimum number of fruits (63.50) was obtained in T_1 – control (Table 1). This might be due to the reason that the application of triacontanol attributed to more efficient utilization of food for reproductive growth, flowering and fruit set, higher photosynthetic efficiency and increase in fruit retention ultimately increases the number of fruits (Patil *et al.* 2005). These results follow the findings of Kasambhai (2015), Momin *et al.* (2016) and Patel *et al.* (2021) in mango and Choudhary *et al.* (2013) in mandarin.

The maximum average fruit weight was found in T_9 - triacontanol @ 10 ppm (571.98 g). The minimum average fruit weight (457.18 g) was found in T_1 – control (Table 1). Photosynthesis has been implicated as an important response to triacontanol and the increased growth and dry weight of plants, as well as fruit weight, was due to the accumulation of photosynthates. It also increases the net assimilation rate in plants. The findings of Patel *et al.* (2021) in mango, Abubakar *et al.* (2013) in pomegranate cv Kandhari, Thakur (2014) in apricot and Zubair *et al.* (2017) in apple reported that with the application of triacontanol, there was an increase in average fruit weight.

The maximum yield was obtained in T_9 - triacontanol @ 10 ppm (41.31 kg). However, the minimum yield (26.32 kg) was recorded in T_1 – control (Table 1). According to Verma *et al.* (2009) foliar spray of triacontanol at different growth stages enhances the translocation of assimilates resulting in increased yield. The yield of mango is the cumulative effect of number of fruits, fruit length, diameter and average weight of fruits. Similar findings were reported by Kasambhai (2015), Patel *et al.* (2021) in mango, Choudhary *et al.* (2013) in mandarin and Thakur (2014) in apricot.

Table 1. Effect of bio-stimulants on yield parameters of mango cv Mallika.

Treatments	Fruit length (cm)	Fruit diameter (cm)	Fruit volume (cc)	Number of fruits	Average fruit weight (g)	Yield tree^{-1} (kg)	Pulp weight (g)	Pulp percentage
T_1 – Control	12.65	75.49	417.63	63.50	457.18	26.32	274.11	59.97
T_2 - Jasmonic acid (100 µM)	13.36	80.15	436.28	66.50	462.35	27.20	313.72	67.88
T_3 - Jasmonic acid (150 µM)	13.40	83.93	453.25	69.75	481.65	30.35	327.30	67.96
T_4 - Salicylic acid (100 ppm)	13.85	87.37	659.26	64.00	513.78	29.00	352.01	68.53
T_5 - Salicylic acid (150 ppm)	16.85	90.18	675.26	66.25	532.28	30.74	379.04	71.22
T_6 - Brassinosteroid (0.40 ppm)	14.48	81.85	512.88	67.75	498.53	31.17	328.71	65.98
T_7 - Brassinosteroid (0.60 ppm)	15.46	90.71	692.50	68.25	529.60	33.74	356.72	67.38
T_8 - Triacontanol (7.5 ppm)	17.05	91.20	711.27	70.25	547.68	35.01	409.80	75.04
T_9 - Triacontanol (10.0 ppm)	17.53	92.38	723.75	75.25	571.98	41.31	435.91	76.24
SEm ±	**0.23**	**0.61**	**3.85**	**1.49**	**7.98**	**0.63**	**2.71**	**0.01**
CD @ 5%	**0.67**	**1.78**	**11.44**	**4.34**	**23.31**	**1.84**	**7.92**	**0.03**

Table 2. Effect of bio-stimulants on peel and pulp color of mango cv Mallika.

Treatment	Peel color					Pulp color				
	*L**	*a**	*b**	C*	h^0	*L**	*a**	*b**	C*	h^0
T_1 – Control	54.22	16.34	52.11	59.48	61.87	55.59	15.49	55.91	57.51	55.06
T_2 - Jasmonic acid (100 µM)	59.52	19.61	56.64	67.10	70.80	62.71	22.68	58.43	65.64	67.70
T_3 - Jasmonic acid (150 µM)	63.13	20.66	67.47	67.86	71.40	63.19	22.91	61.77	65.83	68.49
T_4 - Salicylic acid (100 ppm)	58.85	20.38	58.19	67.07	71.14	60.64	21.17	60.99	63.04	68.05
T_5 - Salicylic acid (150 ppm)	63.41	22.25	67.82	68.92	73.17	63.38	23.39	62.29	66.20	69.11
T_6 - Brassinosteroid (0.40 ppm)	56.81	18.52	53.45	60.77	63.26	57.81	16.46	57.90	58.19	59.87
T_7 - Brassinosteroid (0.60 ppm)	57.90	19.91	59.84	64.20	71.04	59.14	17.36	58.07	63.28	61.24
T_8 - Triacontanol (7.5 ppm)	57.75	17.73	58.82	64.38	66.24	56.14	16.61	56.17	58.98	63.13
T_9 - Triacontanol (10.0 ppm)	60.89	19.80	60.95	65.08	71.32	57.14	20.77	58.79	64.87	64.95
SEm ±	**0.75**	**0.36**	**1.31**	**1.13**	**0.62**	**1.28**	**0.72**	**1.08**	**1.81**	**1.02**
CD @ 5%	**2.18**	**1.05**	**3.83**	**3.28**	**1.81**	**3.74**	**2.10**	**3.15**	**5.29**	**2.96**

The results presented in Table 1 concerning pulp weight and pulp percentage showed significant differences among the different treatments. The maximum pulp weight and pulp percentage were found in T_9 - triacontanol @ 10 ppm (435.91 g and 76.24, respectively) and the minimum were recorded in T_1 – control (274.11 g and 59.97, respectively). According to Patel *et al.* (2021), the higher pulp content may be due to higher accumulation and translocation of metabolite from other parts of the tree towards developing fruits. Similar findings were noticed by Mulagund *et al.* (2015) in banana.

Significant difference was found among the treatments for peel color and as for the data presented in Table 2. Treatment T_5 - salicylic acid @ 150 ppm increased *L**, *a**, *b**, C* and hº values (63.41, 22.25, 67.82, 68.92 & 73.17, respectively) which was on par with T_3 - jasmonic acid @ 150 µM (63.13, 20.66, 67.47, 67.86 and 71.40, respectively). While, the lowest values for *L**, *a**, *b**, C* and hº was recorded in T_1 - control (54.22, 16.34, 52.11, 59.48 and 61.87, respectively). Significant difference was found among the treatments for pulp color and presented in Table 2. The treatment T_5 - salicylic acid @ 150 ppm increased *L**, *a**, *b**, C* and hº values (63.38, 23.39, 62.29, 66.20 and 69.11, respectively) which was on par with T_3 - jasmonic acid @ 150 µM (63.19, 22.91, 61.77, 65.83 and 68.49, respectively). While, the lowest values for *L**, *a**, *b**, C* and hº was recorded in T_1 - control (55.59, 15.49, 55.91, 57.51 and 55.06, respectively). Higher fruit color i.e., high *L**, *b** and C* values are probably due to higher carotenoid synthesis in fruits with increased maturity and hastening of chlorophyll breakdown, which increases carotenoid accumulation. Similar results were reported by El-Monem *et al.* (2013), Faissal *et al.* (2014) and Reddy *et al.* (2016) in mango and Zubair *et al.* (2017) in apple.

Based on the above results, it can be concluded that triacontanol @ 10 ppm recorded maximum number of fruits, yield, pulp weight, fruit length, fruit diameter and fruit volume and salicylic acid @ 150 ppm shown the highest colorimeter coordinates *L**, *a**, *b**, C* and hº for both peel and pulp of mango cv Mallika under central dry zone of Karnataka sprayed.

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