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Influence of different chemicals on yield and quality of mango (*Mangifera indica* L.) cv. Kesar

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Abstract
An exogenous application of various chemicals like PAs (Putrescine 0.1mM and Spermine 0.01mM), Triacontanol 750 ppm, NAA 25 ppm, CPPU (Forchlorfenuron) 3 ppm, Salicylic acid (SA) 100 ppm, Zinc sulphate ($ZnSO_4$) 0.5% and Boron (B) 0.5% were sprayed at different stages on mango trees cv. Kesar to investigate their effect on yield and quality. The result revealed that significant highest number of fruits per tree (281.00), highest fruit weight (239.36 g), fruit yield per tree (69.21 kg), fruit firmness (14.67 kg/cm^2), pulp weight (164.71 g), TSS (19.66%), ascorbic acid (46.14 mg 100 g^{-1}), total sugars (13.13%), sugar: acid ratio (55.98) and similarly the lowest acidity (0.24%) was also recorded in treatment T_7 i.e. NAA 25 ppm + SA 100 ppm + $ZnSO_4$ 0.5%. The maximum pulp-stone ratio (4.04) was recorded in treatment T_{14} i.e. CPPU 3 ppm + SA 100 ppm + B0.5%.Whereas, lowest yield and quality was observed in treatment T_{19} (control).

Keywords: Mango, Kesar, yield, quality, chemicals

Introduction
Mango (*Mangifera indica* L.) is one of the most important fruit of India and got a unique position in India. It created Mango mania in its consumer choice due to its excellent fragrance, flavor, attractive blushes, delicious taste and high nutraceutical value. It is native to India (Indo Burma region). Numerous cultivars of mango are cultivated in India with diversity of flavor and taste among them, Kesar is high yield potential, almost regular bearer, mid-season variety, having good consumer acceptance, attractive shape, size, saffron colored pulp and very good keeping quality. It has been observed that, a large area is under cultivation of this variety in Maharashtra particularly in Marathwada region. In general, the productivity of mango is revealed to be decreasing annually in this region due to low yield of the trees. Fruit drop is one of the major problems contributing to low yield in mango trees. Heavy fruit drop is an important factor contributing to low fruit yield in mango orchards and sometime only 0.1% of set fruit reach maturity. Quality is influenced by several factors including nutritional and environmental. Several workers have also suggested that foliar feeding of nutrients directly to the site of metabolism noticeably improved fruit yield and quality attributes (Singh *et al*., 2017) [14]. Exogenous application of various plant growth regulators has been reported to have variable success in reducing fruit drop, possibly due tothe complex nature of the abscission phenomenon. Similarly, micronutrients play a key vital role in various enzymatic activities and synthesis of assimilating hormones.
In light of above, the present investigation entitled "Influence of different chemicals on yield and quality of mango (*Mangifera indica* L.) cv. Kesar" was undertaken with an objective to enhance yield and quality of mango.

Materials and Methods
The present investigation was carried outon eleven years old mango trees of uniform growth, which were spaced at 5×5 m at Central Nursery Farm, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani (MS) during the years 2019 and 2020. The experiment was laid out in Randomized Block Design (RBD)with two replications and nineteen treatments *viz.*,T_1-(TRIA 750 ppm + SA 100 ppm + $ZnSO_4$ 0.5%), T_2- (TRIA 750 ppm + SA 100 ppm + B 0.5%), T_3 – (TRIA 750 ppm + PUT 0.1mM + $ZnSO_4$ 0.5%), T_4 -(TRIA 750 ppm + PUT 0.1mM + B 0.5%), T_5 - (TRIA 750 ppm + SPM 0.01mM + $ZnSO_4$ 0.5%), T_6 - (TRIA 750 ppm + SPM 0.01mM + B 0.5%), T_7 - (NAA 25 ppm + SA 100 ppm + $ZnSO_4$ 0.5%),T_8 - (NAA 25 ppm +SA 100 ppm + B 0.5%), T_9 –(NAA 25 ppm + PUT 0.1 mM + $ZnSO_4$ 0.5%), T_{10} –(NAA 25 ppm + PUT 0.1 mM + B 0.5%), T_{11} –(NAA 25 ppm + SPM 0.01 mM + $ZnSO_4$ 0.5%),

T_{12} –(NAA 25 ppm + SPM 0.01 mM + B 0.5%), T_{13} –(CPPU 3 ppm + SA 100 ppm + $ZnSO_4$ 0.5%), T_{14} –(CPPU 3 ppm + SA 100 ppm + B0.5%), T_{15} –(CPPU 3 ppm + PUT 0.1mM + $ZnSO_4$ 0.5%), T_{16} –(CPPU 3 ppm + PUT 0.1 mM + B 0.5%), T_{17} –(CPPU 3 ppm + SPM 0.01mM + $ZnSO_4$ 0.5%), T_{18} –(CPPU 3 ppm + SPM 0.01mM + B 0.5%),T_{19} –(Control). The foliar application of different chemicals used in the present experiment was done at different stages *i.e.* Triacontanol at full bloom, pea and marble stage; NAA and Putrescine at full bloom and pea stage; CPPU, Salicylic acid and Zinc Sulphate at pea and marble stage; Spermine once at full bloom stage and Boron at full bloom and marble stage. The yield attributes *viz.,* number of fruits per treewas counted at the time of harvesting, fruit weight was measured from each of the treatment five marketable size fruits were randomly selected from each experimental tree and their weight was recorded separately and average fruit weight was worked out in grams. The yield per tree was recorded by weighing total number of fruits per tree at harvest. Regarding, quality parameters *viz.,* fruit firmness (kg/cm^2) was tested by penetrometer on two opposite sides of a fruit and average values were worked out, pulp of the ripe fruits from was weighed and treatment wise average pulp weight (g) was calculated. Total Soluble Solids (%) was recorded by using Hand Refractometer (Erma, Tokyo).Ascorbic acid content was calculated adopting the formula given by Ranganna, 1986. Total sugars was determined by Benedict Reagent methodand expressed in percent. Sugar: acid ratio was determined by dividing the total sugar content of particular treatment with acidity content of the fruit juice, acidity was estimated by titration against 0.1 N sodium hydroxide solution and expressed as percentage of citric acid. However, the pulp: stone ratio was calculated by dividing weight of pulp to weight of stone. The data obtained on above various variables were analysed by analysis of variance method suggested by Panse and Sukhatme (1985) [11].

Results and Discussion

The findings related to yield and quality (Table 1) revealed that these parameters are affected significantly by various pre-harvest chemical treatments. The pooled data of two years (2019 and 2020) pertains to yield observed that the maximum number of fruits per tree was in treatment T_7 *i.e*., NAA 25 ppm + SA 100 ppm + $ZnSO_4$ 0.5% (289.25) which was 60.66 per cent increased over control and was found to be statistically at par with treatment T_{14} (281.50). The increase in fruit number might be due to NAA as it causes cell elongation by enlargement of vacuoles and loosening of cell wall after increasing cell wall plasticity (Abd El-Rhman *et al.* 2017) [1]. The micronutrients particularly zinc and borax when sprayed alone or in combination involved directly in various physiological processes and enzymatic activities thereby increase in the total number of fruits per tree. The present findings are in agreement with the findings of Haldavnekar *et al*. (2018) [4] and Mahida *et al*. (2018) [6]. The significant highest fruit weight (239.36 g) was also recorded in T_7 treatment which was 61.12 per cent increased over control and was found to be statistically at par with treatments T_{14} (232.93 g) and T_{13} (232.63 g). The best result pertaining to fruit weight might be due to the combine application of different chemicals as auxin accelerated the fruit growth and fruit size by increasing, elongation and enlargement. These results are line up with findings of Nkansah *et al.* (2012) and Naleo *et al.* (2018) [8] in mango. Significantly maximum fruit yield (69.21 kg tree^{-1}) was also recorded in treatment T_7 which was 158.52 per cent increased over control and which was followed by treatments T_{14} (65.63 kg) and T_{13} (63.16 kg). The beneficial effect of chemicals in increasing fruit yield is due to the combined application of salicylic acid with growth regulators and micronutrients like zinc and boron which can be attributed to increased photosynthetic activity in leaves and translocation of more photo-assimilates to fruits results in higher yield. These results are in line with the findings of Rahmani *et al.* (2017) [12] in mango.

The investigation pertains to quality of fruits revealed that the highest fruit firmness (14.67 kg/cm^2) was noted in treatment T_7 which was found to be statistically at par with T_{14} (14.31 kg/cm^2). Improved fruit firmness might be due to synthesis of auxin in plants and as it increases the physiological activities leading to increased firmness in fruits. These findings are supported by the results obtained by Naleo *et al.* (2018) [8] in mango. Similarly, highest pulp weight (164.71 g) was obtained in treatment T_7 which was 136.99 per cent increased over control and was found to be statistically at par with treatments T_{14} (160.25 g) and T_{13} (157.03 g). The increase in pulp weight might be due to CPPU as it increases cell size and is also responsible for the production and transport of plant sugars that might have help to increase the pulp content in mango cv. Kesar. However, the perusal of the literature available fails to throw light on these findings. Significantly highest TSS (19.66%) was recorded in treatment T_7 which was 28.19 percent increased over control and was found to be statistically at par with treatment T_{14} (19.41%). An increase in TSS could be attributed to higher solutes as a result ofenhanced mobilization of carbohydrates in these treatments. This might be due topromoted effect of salicylic acid on improving the biosynthesis and translocation of plant pigment and sugar (Muthulakshmi and Lingakumar, 2017) [7]. The obtained results regarding the effect of NAA on TSS go in line with the findings of Bhati and Yadav (2003) [3]. The highest ascorbic acid (46.14 mg 100 g^{-1}) was recorded in treatment T_7 which was 17.97 per cent increased over control and was found to be statistically at par with treatments T_{14} (45.40 mg 100 g^{-1}) and T_{13} (45.19 mg 100 g^{-1}). The obtained results regarding the effect of NAA on ascorbic acid content go in line with the findings of Waqas *et al*. (2012) [16] in mango, Uniyal and Misra (2015) [16] in bael. The data pertaining to per cent acidity revealed that lowest acidity (0.24%) was recorded in treatment T_7 which was found to be statistically at par with treatments T_{14} (0.24%), T_{13} (0.25%) and T_{15} (0.25%). However, the highest acidity (0.33%) was recorded in T_{19} (control). Decrease in acidity might be due to the reason mentioned under TSS. The maximum total sugars (13.13%) was recorded in treatment T_7 which was 19.08 per cent increased over control and was statistically at par with T_{14} (13.03%), T_{13} (12.97%) and T_8 (12.88%). An increase in the content of total sugars in fruits is due to degradation of polysaccharides into simple sugars by metabolic activities, conversion of organic acids into sugars, and loss of moisture. The above results regarding the effect of NAA on total sugars content go in line with the findings of Bhati and Yadav (2003) [3] in Ber. The maximum sugar: acid ratio (55.98) was recorded in treatment T_7 which was found to be statistically at par with treatments T_{14} (55.05) and T_{13} (52.09). The increased sugar: acid ratio might be due to salicylic acid which increased translocation of more photosynthetic assimilates to the fruits and breakdown of starch during ripening. The findings of Ahmed *et al*. (2015) [2] and Noorullah *et al*. (2018)

[10] are in agreement with the present investigation. The highest pulp-stone ratio (4.04) was observed in treatment T_{14} *i.e.* CPPU 3 ppm + SA 100 ppm + B 0.5% which was found to be statistically at par with treatments T_{13} (4.02) and T_7 (3.93). The increase in pulp content might be due to faster movement of simple sugars into fruit as CPPU increases cell size and is also responsible for the production and transport of plant sugars ultimately increases pulp weight (Kulkarni, *et al*., 2017) [5]. The lowest values for all yield and quality related parameters than rest of the treatments under the present study were recorded in treatment T_{19} *i.e* control.

The results obtained under present study clearly indicated that, there was improvement in fruit yield and quality of mango due to application of plant growth regulators along with micronutrients at different growth stages of fruit.

Table 1: Influence of different chemicals on yield and quality of mango cv. Kesar

Treat. No.	Pooled mean for the years 2019 and 2020										
	No. of fruits per tree	**Fruit weight (g)**	**Yield (kg tree^{-1})**	**Firmness (kg/cm^2)**	**Pulp wt. (g)**	**TSS (%)**	**Ascorbic acid (mg 100 g^{-1})**	**Acidity (%)**	**Total sugars (%)**	**Sugar: acid ratio**	**Pulp: stone ratio**
T_1	190.00 (5.53)	175.65 (18.24)	33.40 (24.76)	11.47	98.41 (41.60)	16.47 (7.37)	40.42 (3.34)	0.31	11.77 (6.71)	38.65	2.30
T_2	201.75 (12.06)	180.07 (21.22)	36.31 (35.64)	11.50	100.39 (44.44)	15.59 (1.60)	39.47 (0.89)	0.31	11.36 (2.99)	36.74	2.16
T_3	250.13 (38.93)	170.59 (14.83)	42.72 (59.57)	11.77	97.00 (39.57)	16.26 (5.95)	40.99 (4.78)	0.30	12.44 (12.78)	41.84	2.40
T_4	181.50 (0.81)	158.38 (4.93)	28.75 (5.69)	10.28	84.80 (22.01)	15.40 (0.39)	40.60 (3.80)	0.32	11.07 (0.36)	34.59	2.18
T_5	188.63 (4.77)	154.73 (4.16)	29.22 (9.07)	10.53	84.19 (21.13)	16.16 (5.35)	40.63 (3.87)	0.32	11.30 (2.40)	35.58	2.13
T_6	190.25 (5.67)	153.37 (3.24)	29.18 (9.02)	10.49	86.19 (24.01)	15.50 (1.04)	39.32 (0.51)	0.32	11.09 (0.50)	34.19	2.37
T_7	289.25 (60.66)	239.36 (61.12)	69.21 (158.52)	14.67	164.71 (136.99)	19.66 (28.19)	46.14 (17.97)	0.24	13.13 (19.08)	55.98	3.93
T_8	227.38 (26.29)	196.53 (32.30)	44.75 (67.17)	12.79	112.86 (62.38)	17.55 (14.41)	40.23 (2.85)	0.26	12.88 (16.82)	49.64	2.25
T_9	244.75 (35.94)	190.23 (28.06)	46.56 (73.93)	13.68	116.01 (66.91)	17.09 (11.39)	44.45 (13.63)	0.28	12.76 (15.73)	46.89	2.83
T_{10}	222.73 (23.71)	185.92 (25.15)	41.44 (54.77)	12.77	108.11 (55.55)	16.63 (8.39)	39.88 (1.94)	0.27	12.73 (15.37)	47.22	2.64
T_{11}	237.63 (31.99)	184.06 (23.90)	43.76 (63.47)	13.53	112.48 (61.83)	17.40 (13.43)	43.62 (11.52)	0.28	12.66 (14.78)	45.21	2.84
T_{12}	235.50 (30.81)	180.74 (21.67)	42.55 (58.95)	12.50	108.09 (55.51)	16.20 (5.61)	39.40 (0.72)	0.29	12.44 (12.78)	43.13	2.74
T_{13}	271.00 (50.52)	232.63 (56.60)	63.16 (135.89)	13.70	157.03 (125.94)	18.92 (23.32)	45.19 (15.53)	0.25	12.97 (17.52)	52.09	4.02
T_{14}	281.50 (56.36)	232.93 (56.80)	65.63 (145.18)	14.31	160.25 (130.57)	19.41 (26.48)	45.40 (16.07)	0.24	13.03 (18.18)	55.05	4.04
T_{15}	206.50 (14.70)	221.36 (49.01)	45.78 (70.99)	13.67	142.70 (105.32)	18.77 (22.36)	44.12 (12.80)	0.25	12.55 (13.78)	50.30	3.37
T_{16}	209.25 (16.23)	205.36 (38.24)	43.03 (60.74)	13.11	129.92 (86.93)	18.40 (19.95)	43.47 (11.13)	0.26	11.78 (6.75)	45.40	3.16
T_{17}	213.25 (18.45)	215.44 (45.03)	45.96 (71.68)	13.99	135.10 (94.39)	18.60 (21.27)	43.81 (12.00)	0.25	12.63 (14.48)	50.62	3.17
T_{18}	203.50 (13.03)	197.47 (32.93)	40.26 (50.41)	13.09	118.61 (71.01)	18.08 (17.83)	43.10 (10.19)	0.27	12.20 (10.61)	44.44	2.60
T_{19}	180.04	148.55	26.77	10.49	69.50	15.34	39.12	0.33	11.03	32.96	1.65
S.E.m ±	3.55	2.51	0.84	0.22	3.30	0.19	0.47	0.01	0.21	1.42	0.12
C.D.at 5%	10.09	7.13	2.38	0.64	9.37	0.54	1.32	0.02	0.59	4.05	0.35

(Figures in parenthesis indicates the values in per cent over control)

Conclusion

It can be concluded from the above investigation that, the application of Naphthalene Acetic Acid 25 ppm (full bloom and pea stage) + Salicylic acid 100 ppm + Zinc sulphate 0.5% (pea and marble stage) found to be at par with treatment of Forchlorfenuron (CPPU) 3 ppm (pea and marble stage) + Salicylic acid 100 ppm (pea and marble stage) + Boron 0.5% (full bloom and marble stage) for enhancing yield and quality of mango cv. Kesar.

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