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Improved fruit retention and yield by exogenous application of chemicals in mango (*Mangifera indica* L.) cv. Kesar

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Abstract
Aqueous solutions (0.1 and 0.01 mM) of PAs (Putrescine and spermine), Triacontanol 750 ppm, NAA 25 ppm, CPPU (Forchlorfenuron) 3 ppm, Salicylic acid (SA) 100 ppm, $ZnSO_4$ 0.5% and Boron 0.5% were sprayed onto panicles of mango (*Mangifera indica* L. cv. Kesar) at different stages to investigate their effects on fruit retention and yield. The result revealed that significant minimum number of days taken from flowering to fruit set (25.70) was recorded in treatment T_8 (NAA 25 ppm + SA 100 ppm + B 0.5%). However, the maximum days from flowering to fruit set (35.05) was observed in treatment T_{19} (control). The minimum days taken from fruit set to harvest (88.95) was recorded in treatment T_7 (NAA 25 ppm + SA 100 ppm + $ZnSO_4$ 0.5%) while the maximum days required from fruit set to harvest (99.45 days) was observed in treatment T_{19} (control). The maximum number of fruit set per panicle at initial stage (62.18), number of fruits retained per panicle at pea stage (39.57), number of fruits retained per panicle at maturity stage (3.89) and maximum fruit yield per tree (69.21 kg) was also found in treatment T_7 (NAA 25 ppm + SA 100 ppm + $ZnSO_4$ 0.5%) whereas, lowest number of fruits retention per panicle at above different stages and minimum yield per tree was recorded in treatment T_{19} (control).

Keywords: Fruit retention, yield, chemicals, mango, Kesar

Introduction

Mango (*Mangifera indica* L.) belongs to the family Anacardiaceae. It is one of the most important fruit crops of India as well as tropical and subtropical countries of the world. Among different descript varieties or cultivars; Kesar, being generally regular and high yield potential, adaptable to a wide range of soil and agro-climatic conditions, is one of the choicest cultivars grown in Maharashtra particularly in Marathwada. Over the last decade despite an increase of 42.5% in mango growing area, there has been only 1.3% increase in average fruit yield (7.5–7.6 MT/ha). 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 (Chadha, 1993) [4]. It is observed that, the farmers of Maharashtra are facing problems of more fruit drop, low fruit retention and poor yield mostly because lack of information about effective chemicals like plant growth regulators, micronutrients and polyamines with their stages of application in mango.

However, there has been very less work carried out on use of chemicals and growth regulators on mango in general and Kesar in particular under Marathwada conditions of Maharashtra. Hence, it was felt necessary to conduct the present experiment on this aspect.

Materials and Methods

The present investigation entitled "Improved fruit retention and yield by exogenous application of chemicals in mango (*Mangifera indica* L.) cv. Kesar" was carried out at Central Nursery Farm, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani (MS) during the years 2019 and 2020.The present experiment was conducted on 11 years old mango trees of uniform growth, which were spaced at 5×5 m and the experiment was laid out in Randomized Block Design (RBD) with 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) with two replications.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 fruit retention attributes *viz.*, number of days taken from flowering to fruit set and days taken from fruit set to harvest was counted on tagged panicles of four different sides per tree for each treatment and the average was computed in each treatment. Regarding, yield parameters *viz.*, number of fruit set per panicle at initial stage, number of fruits retained per panicle at pea stage, number of fruits retained per panicle at maturity stage and fruit yield (kg tree^{-1}) were recorded. Data obtained on above various variables were analysed by analysis of variance method suggested by Panse and Sukhatme (1985) [9].

Results and Discussion

The findings related to fruit retention and yield revealed that these parameters are affected significantly by various pre-harvest chemical treatments. The pooled data of two years (2019 and 2020) pertaining to number of days taken from flowering to fruit set showed (Table. 1) significantly minimum (25.70) days required for fruit set in treatment T_8-(NAA 25 ppm + SA 100 ppm + B 0.5%) which was found to be statistically at par with treatment T_6 *i.e.* TRIA 750 ppm + SPM 0.01mM + B 0.5% (26.15 days) while the maximum days taken to fruit set (35.05 days) was recorded in treatment T_{19}- (control). The minimum number of days required from flowering to fruit set might be due to NAA application because of the fact that it maintains the on-going physiological and bio-chemical process of inhibition of abscission. The similar results were obtained with Patel *et al.* (2018[b]) [11] in kagzi lime. The significant effect on early fruit setting might be due to the application of boron as it has various roles, *i.e.*, sugar transport, cell wall synthesis, lignifications of cell wall structure, carbohydrate, RNA, phenol metabolism, plasma membrane integrity, pollen germination and pollen tube growth. Similar results with the application of boron were observed in mango by Bhowmick *et al.* (2012) [3].

In the investigation it has been observed that the days taken from fruit set to harvest was also affected significantly and the lowest number of days from fruit set to harvest (88.95 days) was recorded in treatment T_7- (NAA 25 ppm + SA 100 ppm + $ZnSO_4$ 0.5%) whereas, the maximum days required from fruit set to harvest (99.45 days) was observed in treatment T_{19}-(control). This might be due to NAA application because NAA improves the internal physiology of developing fruits. The similar results were obtained with Patel *et al.* (2018[b]) [11] in kagzi lime. The significant effect of salicylic acid has been found to generate a wide range of metabolic and physiological responses in fruit plants thereby affecting their growth and development (Baba *et al.* 2017) [1]. Early fruit maturity might be due to the application of zinc as it increases the synthesis of tryptophan that is a precursor of auxin (Bhowmick *et al.*2012) [3]. The pooled data of two years (Table. 1) related to number of fruit set per panicle at initial stage was affected significantly by different treatments. Significantly highest number of fruit set per panicle at initial stage (62.18) was recorded in the treatment T_7- (NAA 25 ppm + SA 100 ppm + $ZnSO_4$ 0.5%). The lowest number of fruit set at initial stage (43.50) was recorded in treatment T_{19}- (control). This might be due to external foliar application of NAA made up for internal deficiencies and hence, resulted in enhanced fruit set. The results are in accordance with the findings of Shinde *et al.* (2006) [13]. The beneficial effect on increasing fruit set might be due to the improving effect of such treatment combinations on nutritional status of the trees specially boron which reflected on increasing fruit set (Gurjar *et al*. 2015) [6]. Significantly highest number of fruit retention at pea stage (39.57) was also observed in treatment T_7- (NAA 25 ppm + SA 100 ppm + $ZnSO_4$ 0.5%). However, the lowest number of fruits retained per panicle at pea stage (29.44) was recorded in treatment T_{11}- (NAA 25 ppm + SPM 0.01 mM + $ZnSO_4$ 0.5%). This result is in confirmation with result obtained by Gurjar *et al*. (2015) [6] and Patel *et al.* (2018[a]). Similarly the highest number of fruit retention at maturity stage (3.89) was observed in treatment T_7- (NAA 25 ppm + SA 100 ppm + $ZnSO_4$ 0.5%) which was 48.47 per cent increased over control, however it was statistically at par with treatment T_{14} *i.e.* CPPU 3 ppm + SA 100 ppm + B0.5% (3.70).The lowest number of fruits retained per panicle at maturity stage (2.62) was recorded in treatment T_{19}- (control).The increased fruit retention up to maturity might be due to prevention in formation of abscission layer by inhibiting the enzymatic activities with the application of NAA. These results are line up with findings of Baghel *et al.* (1987) [2] and Rawash *et al.* (1998) [12]. An exogenous application of CPPU acts early cell division in the fruit and also on subsequent growth thus, fruit becomes able to attract so much water, minerals and carbohydrates that enable the fruit for better retention up to maturity stage (Greene, 2001) [5]. The higher fruit retention at maturity stage might also be due to the foliar application of $ZnSO_4$ and salicylic acid these findings are in conformity with the results obtained by Baba *et al.* (2017) [1] and Mahida *et al.* (2018) [8].

The pooled data of two years pertaining to yield (kg tree^{-1}) showed highly significant differences among the treatments by the exogenous application of various chemicals. Significantly maximum fruit yield per tree (69.21 kg) was recorded in treatment T_7 *i.e.* NAA 25 ppm + SA 100 ppm + $ZnSO_4$ 0.5% which was 158.52 per cent increased over control while, the minimum yield per tree (26.77 kg) was recorded in treatment T_{19} (control). The results obtained under present investigation clearly indicated that, there was improvement in fruit retention and yield of mango fruits due to application of plant growth regulators along with micronutrients at different growth stages of fruit development. Application of NAA and CPPU was found to be beneficial for increasing yield of mango cv. Kesar. The application of PGRs at full bloom, pea and at marble stage were found effective in increasing yield of fruit than single application at any stage (Kulkarni *et al.*, 2017) [7]. Similar results were also obtained by Sugiyama and Yamaki (1995) [14] in Japanese persimmon.

Table 1: Effect of different chemicals on fruit retention and yield of mango cv. Kesar

Treat. No.	Treatment details	Pooled mean for the years 2019 and 2020					
		Days taken from flowering to fruit set	Days taken from fruit set to harvest	Number of fruit set per panicle at initial stage	Number of fruits retained per panicle at pea stage	Number of fruits retained per panicle at maturity stage	Yield (kg $tree^{-1}$)
T_1	TRIA 750 ppm + SA 100 ppm + $ZnSO_4$ 0.5%	30.25	97.35	51.83	32.98	3.30 (25.95)	33.40 (24.76)
T_2	TRIA 750 ppm + SA 100 ppm + B 0.5%	30.45	95.80	48.36	30.77	3.08 (17.56)	36.31 (35.64)
T_3	TRIA 750 ppm + PUT 0.1mM + $ZnSO_4$ 0.5%	27.15	94.15	56.14	35.72	3.57 (36.26)	42.72 (59.57)
T_4	TRIA 750 ppm + PUT 0.1mM + B 0.5%	30.00	95.70	56.06	35.68	3.57 (36.26)	28.75 (5.69)
T_5	TRIA 750 ppm + SPM 0.01mM + $ZnSO_4$ 0.5%	32.50	95.70	51.50	32.77	3.28 (25.19)	29.22 (9.07)
T_6	TRIA 750 ppm + SPM 0.01mM + B 0.5%	26.15	95.75	53.67	34.16	3.42 (30.53)	29.18 (9.02)
T_7	NAA 25 ppm + SA 100 ppm + $ZnSO_4$ 0.5%	27.70	88.95	62.18	39.57	3.89 (48.47)	69.21 (158.52)
T_8	NAA 25 ppm +SA 100 ppm + B 0.5%	25.70	91.25	52.70	33.53	3.35 (27.86)	44.75 (67.17)
T_9	NAA 25 ppm + PUT 0.1 mM + $ZnSO_4$ 0.5%	30.65	95.45	51.68	32.89	3.29 (25.57)	46.56 (73.93)
T_{10}	NAA 25 ppm + PUT 0.1 mM + B 0.5%	33.90	97.35	53.05	33.76	3.38 (29.01)	41.44 (54.77)
T_{11}	NAA 25 ppm + SPM 0.01 mM + $ZnSO_4$ 0.5%	30.15	97.20	46.26	29.44	2.94 (12.21)	43.76 (63.47)
T_{12}	NAA 25 ppm + SPM 0.01 mM + B 0.5%	30.70	93.85	55.16	35.10	3.51 (33.97)	42.55 (58.95)
T_{13}	CPPU 3 ppm + SA 100 ppm + $ZnSO_4$ 0.5%	27.70	98.30	50.50	32.14	3.21 (22.52)	63.16 (135.89)
T_{14}	CPPU 3 ppm + SA 100 ppm + B0.5%	32.15	96.95	56.49	35.95	3.70 (41.22)	65.63 (145.18)
T_{15}	CPPU 3 ppm + PUT 0.1mM + $ZnSO_4$ 0.5%	26.75	92.05	50.49	32.13	3.21 (22.52)	45.78 (70.99)
T_{16}	CPPU 3 ppm + PUT 0.1 mM + B 0.5%	31.05	98.55	55.67	35.43	3.54 (35.11)	43.03 (60.74)
T_{17}	CPPU 3 ppm + SPM 0.01mM + $ZnSO_4$ 0.5%	26.40	95.25	51.08	32.50	3.25 (24.05)	45.96 (71.68)
T_{18}	CPPU 3 ppm + SPM 0.01mM + B 0.5%	31.60	98.15	55.88	35.56	3.56 (35.88)	40.26 (50.41)
T_{19}	Control (Water spray)	35.05	99.45	43.50	30.07	2.62	26.77
S.E. m ±		0.17	0.13	1.05	0.99	0.14	0.84
C.D. at 5%		0.50	0.38	3.01	2.80	0.39	2.38

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

Conclusion

The application of Naphthalene Acetic Acid 25 ppm (full bloom and pea stage) + Salicylic acid 100 ppm (pea and marble stage) + 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 increasing fruit retention and yield of mango cv. Kesar. Hence, it may be advisable for large scale use in mango orchards.

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