

Original Research Article

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Effect of Bio-Regulators on Improvement in Chemical Traits, Storage Life and Organoleptic Quality of Ratol Mango

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ABSTRACT

The field experiment was conducted at Horticultural Research Centre (HRC), old campus of Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, Uttar Pradesh, during 2011-12 and 2012-13. The study was concentrated on improvement in chemical traits, storage life and organoleptic quality of Ratol mango through application of biological regulators. Three biological regulators viz. Daminozide (50 ppm and 100 ppm), NAA (25 ppm and 50 ppm) and GA₃ (25 ppm 50 ppm) were used. Water was used as control. TSS was found to be highest with 50 ppm NAA (24.44 °Brix) while control fruits had the minimum TSS (18.22 °Brix). A 29.86 % increase in TSS over control was registered in the present study with 50 ppm NAA over control. Titratable acidity was found to be maximum with 50 ppm GA₃ (0.17 and 0.18 %), while control fruits had registered minimum titratable acidity (0.09 and 0.10 %) during both the years of investigation, respectively. Maximum increase of 100 % increase in titratable acidity with 50 ppm GA₃ when compared with control. 50 ppm GA₃ (23.39 %) had resulted in maximum increase in total. Storage life was also found to be maximum (12.16 days) with 50 ppm GA₃. Lowest decay loss of fruits was recorded with 50 ppm GA₃ (7.76 % and 8.30 %) during both the years of investigation, respectively. Maximum organoleptic score was obtained with 50 ppm GA₃ (4.50 score value).

Keywords

Biological regulators,
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Introduction

Mango (*Mangifera indica* L.) is one of the popular fruits in the world due to its attractive colour, delicious taste and excellent nutritional properties. Known for its sweet fragrance and flavour, the mango has delighted the sense for more than 4000 years. A celebrated fruit mango now produced in most of the tropical parts of the globe.

Mango is greatly relished for its succulence exotic flavour and delicious taste in most of the countries of world. It is an important nutritious fruit as it is a good source of β-carotene (a potent precursor of Vitamin-A) and Vitamin-B and Vitamin-C.

Though mango is a tropical fruit, it grows equally well under sub-tropical conditions. In India, this premium fruit is having a great

cultural, socio-economic and religious significance since ancient time. In northern India mango flowers from February to March and the period of full bloom may be some time during March. Bloom period in eastern India is earlier than in the north. In north India the duration of flowering in mango is for about 20 to 25 days (Singh, 1958). Ratol is one of the finest cultivars which possess most of these cited qualities. This cultivar originated in small village of RATOL in the district Baghat (U.P.). Pakistan has monopoly in the export of this important mango cultivar and the country earns handsome foreign exchange by exporting Ratol to European and gulf countries. The carrot flavour of the fruit is the unique characteristics of this delicious cultivar. However, small fruit size, bigger stone, higher stone pulp ratio and poor shelf life are the most limiting factors in its successful cultivation.

The plant bio-regulators or hormones are the organic chemical compounds, which modify or regulate physiological processes in an appreciable measure in the plant when used in small concentration. They are readily absorbed and move rapidly through the tissues, when applied to different plant parts. These chemicals are specific in their action. It would be therefore worthwhile to improve the quality of fruit crops by foliar application of plant growth regulators. The use of plant growth regulators has assumed an integral part of modern crop husbandry for increasing production and productivity of quality fruits. Thus the use of plant growth regulators has resulted in some outstanding achievements in several fruit crops with respect to fruit quality. Use of bio-regulators is a new approach of manipulating plant biological activities for enhancing quality and nutritive value in fruit crops. Foliar sprays of growth regulators (NAA and GA₃) could be used as one of these horticultural practices that reduce fruit drop

enhance yield and fruit quality of mangoes (Anila and Radha, 2003). Moreover, NAA application reduced flowers drop, and gave high flowers retention and increased yield as well as improved fruit quality of mango (Vejendla *et al.*, 2008). Furthermore, foliar spray of NAA and GA₃ enhanced yield and fruit quality as well as reduced fruit drop of mango trees (Nkansah *et al.*, 2012).

Despite of its excellent taste and flavour, due importance has not been given to this premium cultivar in the country. The complete knowledge of bio-chemical attributes of this cultivar is lacking which is the most important pre-requisite for successful orcharding. Scientific research work has not been made to study the bio-chemical attributes of the premium cultivar in the country. Therefore, keeping in mind the role and action of these bio-regulators in fruit crops and considering the importance of this cultivar it was realised to study the effect of bio-regulators on chemical traits and organoleptic quality of Ratol mango.

Materials and Methods

The field experiment was conducted at Horticultural Research Centre (HRC), old campus and also in the laboratory of Department of Horticulture of Sardar Vallabhbhai Patel university of Agriculture & Technology, Meerut (U.P.) 2011-12 and 2012-13. Three biological regulators viz. Daminozide (50 ppm and 100 ppm), NAA (25 ppm and 50 ppm) and GA₃ (25 ppm 50 ppm) were used as treatment. Water was used as control treatment. The experiment was conducted in RBD (Randomized Block design) with 7 treatments replicated thrice. The experiment was carried out in the same orchard during both the years of investigation. During the study, observations were taken for Total soluble solids (TSS), titratable acidity, total sugars, storage life, decay loss per cent

and organoleptic quality. The data were analyzed by using the 'Analysis of Variance Technique' as per the procedures described by Panse and Sukhatme, 1985. The treatment means were compared at 5% level of significance.

Results and Discussion

Chemical attributes

Total soluble solids

The total soluble solids (TSS) content in Ratol mango was significantly affected by the foliar application of bio-regulators. Data presented in Table 1 revealed that level of total soluble solids influenced by various treatments which varied from 18.82 °Brix (control) to 24.44 °Brix (50 ppm NAA) during both the years of study. The pooled value of TSS was also found affected due to foliar application of plant bio-regulators in the same way as was observed during 2011-12 and 2012-13. The pooled data revealed that TSS was found to be highest with 50 ppm NAA (24.44 °Brix) while control fruits had the minimum TSS (18.22 °Brix). A 29.86 % increase in TSS over control was registered in the present study with 50 ppm NAA which was found to be at par with 25 ppm NAA (26.04%) increase in TSS over control. A maximum improvement of 5.62 °Brix in total soluble solids was observed with 50 ppm NAA followed by 4.90 °Brix increase in TSS with 25 ppm NAA when compared with control.

These results are similar to the findings of many mango researchers who observed higher level of TSS in mango fruits with the application of NAA (Osama *et al.*, 2015 and Bairangi, 2013). Improvement in TSS content in mango fruit could be attributed to higher solutes as a result of enhanced mobilization of carbohydrates in these treatments. Present findings are further supported by the fact that activity of sucrose phosphate synthase, a key

enzyme regulating the pool size of sucrose in the leaf, had been shown to be stimulated by foliar application of auxin and promotes phloem loading (Baker, 1985).

Titration acidity

The perusal of data presented in Table 2 indicated the significant response of bio-regulators on titration acidity in Ratol mango. The titration acidity as influenced by different treatments ranged from 0.09 % (control) to 0.18 % (50 ppm GA₃). Among bio-regulators applied, titration acidity was found to be maximum with 50 ppm GA₃ (0.17 and 0.18 %) followed by 25 ppm GA₃ (0.15 and 0.17 %). The control fruits had registered minimum titration acidity (0.09 and 0.10 %) during both the years of investigation, respectively. Data also showed a maximum increase of 100 % increase in titration acidity with 50 ppm GA₃ when compared with control. Further, a maximum increase of 100 % titration acidity in Ratol mango over control was registered with 50 ppm GA₃ followed by 77.78 % increase titration acidity over control with 25 ppm GA₃.

The improvement in acidity in fruits due to foliar application of growth promoters could have been possible due to transformation of organic acids into sugars at the time of ripening. As a result, the Vitamin-C content of fruits was significantly improved by bio-regulators. The present findings obtained on above parameters are also supported by Bhowmick *et al.*, 2011 who observed highest acidity (0.257%) content in Himsagar mango with GA₃ application at 40 ppm. Similar observation on the effect of GA₃ on acidity content in mango fruit was also made by other mango researchers Sharma *et al.*, 1990 and Haidry *et al.*, 1997. Increase in acidity level in fruits treated with GA₃ may be due to the effect of GA on delaying maturity (Eman *et al.*, 2007).

Total sugars

The total sugars contents as influenced by bio-regulators in cv. Ratol have been depicted in Table 3. The pooled values of total sugars were also affected due to foliar application of bio-regulators in the same way as was observed in 2011-12 and 2012-13. Pooled data revealed that foliar application of 50 ppm GA₃ (23.39 %) had resulted in maximum increase in total sugars among all the treatments followed by 50 ppm GA₃ (21.03 %). However, the control fruits were found to have lowest level of total sugar (12.47 %). A maximum increase of 10.92 % in total sugars was registered with 50 ppm GA₃ in comparison with control. Furthermore, a maximum increase of 87.57 % in total sugars was found over control with 50 ppm GA₃ followed by 68.64 % increase in total sugars over control with 25 ppm GA₃.

The promotive effects of GA₃ on total sugars have also been reported by other mango researchers (Shrivastava and Jain, 2006 and Haidry *et al.*, 1997). The increase in the level of total sugars due to GA₃ application in the present study might be due to involvement of PGRs in the breakdown of organic acids into sugars at the time of fruit ripening. Further, plant bio-regulators might assist the

translocation of sugars from vegetative parts to developing fruits. Gibberellin is known to play a crucial role in the sugar metabolism of plants (Krishnamoorthy, 1993). Gibberellins actively participate in the hydrolysis of sucrose and starch. They promote the activity of enzyme invertase which catalyses the hydrolysis of sucrose, thereby yielding glucose and fructose. Further, GA is well known to delay senescence and fruit maturity. As a result, the level of acidity in GA₃ treated fruits might have increased.

Storage-life

Storage life of Ratol mango was affected significantly by the application of bio-regulators. Data recorded on above traits have been displayed in Table 4. The pooled data of storage life was also found to be maximum (12.16 days) with 50 ppm GA₃ followed by 25 ppm GA₃ (9.75 days), while the minimum storage life of Ratol mango was registered with control (5.22 days). Data further revealed that a maximum increase of 6.94 days in storage life was recorded with 50 ppm GA₃ as compared to control. Foliar application of 50 ppm GA₃ also registered a maximum increase of 132.95 % in storage life over control followed by 86.78 % increase in storage life over control with 25 ppm GA₃.

Table.1 Effect of plant bio-regulators on Total soluble solids content in Ratol mango during 2011-12 and 2012-13

Treatments	TSS (°Brix)			Improvement in TSS over control	Percent increase (+) or decrease(-) in TSS over control
	2011-12	2012-13	Pooled		
Control (Water spray)	18.43	19.20	18.82	-	-
GA ₃ (25 ppm)	20.50	20.80	20.65	(+) 1.83	(+) 09.72
GA ₃ (50 ppm)	21.80	21.90	21.85	(+) 3.03	(+) 16.10
NAA (25 ppm)	23.64	23.80	23.72	(+) 4.90	(+) 26.04
NAA (50 ppm)	24.18	24.70	24.44	(+) 5.62	(+) 29.86
Daminozide (50 ppm)	22.30	22.50	22.40	(+) 3.58	(+) 19.02
Daminozide (100 ppm)	23.10	23.40	23.25	(+) 4.43	(+) 23.54
Mean	21.99	22.33	22.16	(+) 3.57	(+) 20.71
LSD (P< 0.05%)	0.960	0.971	0.767	-	-
SEm ±	0.312	0.315	0.222	-	-

Table.2 Effect of plant bio-regulators on fruit titratable acidity in Ratol mango during 2011-12 and 2012-13

Treatments	Titratable acidity (%)			Improvement in titratable acidity over control	% increase (+) or decrease(-) in titratable acidity over control
	2011-12	2012-13	Pooled		
Control (Water spray)	0.09	0.10	0.09	-	-
GA3 (25 ppm)	0.15	0.17	0.16	(+) 0.07	(+) 77.78
GA3 (50 ppm)	0.17	0.18	0.18	(+) 0.09	(+) 100.00
NAA (25 ppm)	0.11	0.11	0.11	(+) 0.02	(+) 22.22
NAA (50 ppm)	0.13	0.12	0.13	(+) 0.04	(+) 44.44
Daminozide (50 ppm)	0.13	0.14	0.14	(+) 0.05	(+) 55.55
Daminozide (100 ppm)	0.15	0.16	0.15	(+) 0.06	(+) 66.66
Mean	0.13	0.14	0.135	(+) 0.05	(+) 61.11
LSD (P< 0.05%)	0.010	0.015	0.010	-	-
SEm ±	0.003	0.005	0.003	-	-

Table.3 Effect of plant bio-regulators on total sugars content in Ratol mango during 2011-12 and 2012-13

Treatments	Total sugars (%)			Improvement in total sugars over control	% increase (+) or decrease(-) in total sugars over control
	2011-12	2012-13	Pooled		
Control (Water spray)	12.30	12.63	12.47	-	-
GA3 (25 ppm)	19.77	22.30	21.03	(+) 8.56	(+) 68.64
GA3 (50 ppm)	22.17	24.61	23.39	(+) 10.92	(+) 87.57
NAA (25 ppm)	19.36	20.36	19.86	(+) 7.39	(+) 59.26
NAA (50 ppm)	16.43	18.30	17.37	(+) 4.90	(+) 39.29
Daminozide (50 ppm)	18.37	17.66	18.01	(+) 5.54	(+) 44.43
Daminozide (100 ppm)	19.43	19.50	19.47	(+) 7.00	(+) 56.13
Mean	18.26	19.34	18.80	(+) 7.38	(+) 59.22
LSD (P< 0.05%)	0.936	0.907	0.732	-	-
SEm ±	0.304	0.294	0.212	-	-

Table.4 Effect of plant bio-regulators on storage life in Ratol mango during 2011-12 and 2012-13

Treatments	Storage life (days)			Improvement in days of storage life over control	% increase (+) or decrease(-) in storage life over control
	2011-12	2012-13	Pooled		
Control (Water spray)	5.10	5.33	5.22	-	-
GA3 (25 ppm)	9.17	10.33	9.75	(+) 4.53	(+) 86.78
GA3 (50 ppm)	11.66	12.66	12.16	(+) 6.94	(+) 132.95
NAA (25 ppm)	6.20	6.80	6.50	(+) 1.28	(+) 24.52
NAA (50 ppm)	7.66	8.10	7.88	(+) 2.66	(+) 50.96
Daminozide (50 ppm)	7.33	8.33	7.83	(+) 2.61	(+) 50.00
Daminozide (100 ppm)	9.55	9.67	9.61	(+) 4.39	(+) 84.10
Mean	8.10	8.75	8.42	(+) 3.73	(+) 71.55
LSD (P< 0.05%)	0.607	0.601	0.480	-	-
SEm ±	0.197	0.195	0.139	-	-

Table.5 Effect of plant bio-regulators on decay loss in Ratol mango during 2011-12 and 2012-13

Treatment	Decay loss (%)			Improvement in decay loss over control	% increase (+) or decrease(-) in Decay loss over control
	2011-12	2012-13	Pooled		
Control (Water spray)	51.67	54.45	53.06	-	-
GA3 (25 ppm)	11.20	12.50	11.85	(-) 41.21	(-) 77.67
GA3 (50 ppm)	7.76	8.30	8.03	(-) 45.03	(-) 84.87
NAA (25 ppm)	15.69	16.83	16.26	(-) 36.80	(-) 69.36
NAA (50 ppm)	18.50	19.26	18.88	(-) 34.18	(-) 64.42
Daminozide (50 ppm)	17.43	18.76	18.10	(-) 34.96	(-) 65.89
Daminozide (100 ppm)	20.83	21.89	21.36	(-) 31.70	(-) 59.74
Mean	20.44	21.71	21.08	(-) 26.74	(-) 7.33
LSD (P< 0.05%)	1.203	0.768	0.801	-	-
SEm ±	0.390	0.249	0.232	-	-

Table.6 Effect of plant bio-regulators on organoleptic quality in Ratol mango during 2011-12 and 2012-13

Treatment	Organoleptic quality			Improvement in organoleptic quality over control	%increase (+) or decrease(-) in organoleptic quality over control
	2011-12	2012-13	Pooled		
Control (Water spray)	1	1.33	1.16	-	-
GA3 (25 ppm)	3.67	3.67	3.67	(+) 2.51	(+) 216.37
GA3 (50 ppm)	4.33	4.67	4.50	(+) 3.34	(+) 287.93
NAA (25 ppm)	2	2.33	2.17	(+) 1.01	(+) 87.06
NAA (50 ppm)	3	3.33	3.17	(+) 2.01	(+) 173.27
Daminozide (50 ppm)	3.33	3.67	3.50	(+) 2.34	(+) 201.72
Daminozide (100 ppm)	4	4	4	(+) 2.84	(+) 244.82
Mean	3.047	3.280	3.167	(+) 2.34	(+) 201.86
LSD (P< 0.05%)	1.350	1.099	0.074	-	-
SEm ±	0.433	0.353	0.024	-	-

Similar response of GA₃ on shelf-life of mango fruits was observed by Islam *et al.*, 2013 and Singh *et al.*, (2008) who had reported that GA₃ enhanced the storage life of mango up to 6 days under ambient temperature between 36±2 and 40±3 °C. The promotive effect of GA₃ on extending shelf-life of mango fruits may be due to the fact that GA is well known for maintaining chlorophyll and delaying senescence (Eman *et al.*, 2007). This is further supported by the

fact that GA₃ application decreases the tissue permeability and thereby reduced the rate of water loss leading to delayed fruit ripening (Nirupama *et al.*, 2010).

Decay loss

Foliar application of bio-regulators significantly affected decay loss in Ratol mango during both the years of investigation. Data on decay loss have been depicted in

Table 5. Data revealed that the decay loss ranged from 8.03% (50 ppm GA₃) to 53.03 % (control) during both years of the investigation. Significantly lowest decay loss of fruits was recorded with 50 ppm GA₃ (7.76 % and 8.30 %) followed by 25 ppm GA₃ (11.20 % and 12.50 %), while maximum with control (51.67 % and 54.45%) during both the years of investigation, respectively. A maximum reduction of 45.03% in decay loss was registered with 50 ppm GA₃ in comparison with control. Data also revealed a maximum reduction of 84.87 % in decay loss over control.

Similar promotive effect of GA₃ in reducing decay loss in mango fruit was also observed by Kumar *et al.*, (1993) who found that pre-harvest sprays of GA₃ (50 or 75 ppm.) brought forward fruit maturity by 8-11 days and significantly reduced decay loss during storage.

Organoleptic quality

The acceptability of fruit quality in the current study was judged on the basis of colour, aroma, flavour, taste, texture and firmness on 5 points hedonic scale by the panel of 4 judges. The perusal of data indicated the significant response of bio-regulators on organoleptic quality of Ratol mango (Table 6). The pooled data of organoleptic quality was also affected significantly due to foliar application of bio-regulators. The pooled data revealed significantly maximum organoleptic score with 50 ppm GA₃ (4.50 score value).

Further, a maximum increase of 287.93 % in organoleptic quality over control) was observed with 50 ppm GA₃ increase in organoleptic quality over control with 100 ppm Daminozide. Foliar application of 50 ppm GA₃ resulted in maximum improvement in organoleptic quality of Ratol mango during both the years of investigation.

The application of exogenous bio-regulators can bring changes in chemical properties of fruits which can improve the organoleptic quality. These findings are in accordance with the findings of Chahal and Bal (2004) who also reported higher organoleptic ratings in mango fruits when treated with GA₃; Rubi *et al.*, (2003) who also recorded high consumer acceptability (6.91) with 100 ppm GA₃. The promotive effect of GA₃ on Organoleptic quality was also reported by Arora *et al.*, (2014) who recorded maximum palatability rating of mango fruits with 50 ppm GA₃ application. Conclusively, NAA @ 50 ppm treatment induced maximum TSS while GA₃ @ 50 ppm induced maximum titratable acidity, total sugar, storage life and reduction in decay loss. GA₃ @ 50 ppm also enhanced organoleptic quality of fruits. Therefore, both NAA @ 50 ppm and GA₃ @ 50 ppm can be utilized for enhancing the chemical parameters storage life and improving the organoleptic quality of Ratol mango.

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