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Effect of foliar application of humic acid, salicylic acid and novel liquid on shelflife and quality of mango (*Mangifera indica* L.) cv. Amrapali

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Abstract
An experiment was carried out to study the "Effect of foliar application of humic acid, salicylic acid and novel liquid on fruit yield and quality of mango (*Mangifera indica* L.) cv. Amrapali" at Horticultural Research Farm, and P.G. Laboratory, Department of Horticulture, B. A. College of Agriculture, Anand Agricultural University, Anand, during March to June, 2018. Treatments comprised foliar application (At 50 % flower opening stage, pea stage and marble stage) of of humic acid @ 1, 1.5 and 2 %, salicylic acid @ 1000, 1500 and 2000 mg/l and novel liquid @ 1, 1.5 and 2 % along with control. The experiment was carried out in completely randomized design with three repetitions. Among all the treatments T_2 (Humic acid @ 1.5 %) treatment was found most effective treatment and recorded significantly maximum shelf life, TSS, total sugar, reducing sugar, non reducing sugar and ascorbic acid, While minimum in acidity, physiological loss in weight and spoilage.

Keywords: Humic acid, salicylic acid, novel liquid, fruit drop and yield

Introduction
Mango (*Mangifera indica* L.) fruit is having excellent adaptability and regarded as "King of Fruits" (Radha and Mathew, 2007) [15]. Moreover, Mango has been cultivated in Indian sub-continent for well over 4000 years and favorite of the kings and common people as well, because of its nutritive value, taste, attractive fragrance and health promoting qualities. India is proud of having the largest available germplasm wealth of mango with about 1,000 cultivars (Bose, 1999) [3]. Mango is one of the major fruit crop of Asia and has developed its own importance all over the world (Bose *et al.* 2001) [4]. Mango is a national fruit of India because of its excellent flavour, delicious taste, delicate fragrance and attractive colour. In India thousands of varieties of mango are grown in a wide range of agro climatic conditions from tropical to sub-tropical and humid tropic to semi humid tropics. Amrapali is a mango variety introduced in 1971.The tree is dwarf, regular bearer, cluster bearing, small sized fruits, and good keeping quality. Fruits are green, apricot yellow, medium sized, sweet in taste with high TSS and pulp content (75 %), while flesh is fibreless and deep orange red. Humic acid stimulate plant enzymes and increase their production. It is known to thicken the cell wall in fruit and prolong the storage as well as shelf life. Humic acid also stimulate plant growth (higher biomass production) by accelerating cell division, increasing the rate of development in root systems and increasing the yield of dry matter. Therefore, use of humic acid improve nutrient availability especially microelement in calcarious soil since it promotes nutrient uptake as chelating agent.

Material and Methods
An experiment was framed with ten treatments *viz,* humic acid @ 1, 1.5 and 2 %, salicylic acid @ 1000, 1500 and 2000 mg/l and novel liquid @ 1, 1.5 and 2 % along with control. A completely randomized design was used with three repetitions. An experiment was carried out during March to June, 2018 at Horticultural Research Farm, and P.G. Laboratory, Department of Horticulture, B. A. College of Agriculture, Anand Agricultural University, Anand, thirty uniform size tree sprayed three time i.e at 50 % flower opening stage, pea stage and marble stage. The mature fruits were harvested and sum up to record yield/plant.

Result and Discussion
Significantly maximum TSS (21.63 ºBrix) was observed in the treatment T_2 (humic acid @ 1.5 %) which was at par with treatment T_6, T_8, T_9, T_5 and T_4. Whereas, minimum TSS recorded in T_{10} (Control) i.e. 17.75 ºBrix (Table 1.).

Increase in TSS might be due to positive effect of humic acid on nutrient availability and stimulation of pigment accumulation, resulting in greener leaves with greater photosynthetic efficiency which produce more assimilates, that assimilates depicted in terms of total soluble solids (Abdel-Mawgoud *et al.*, 2007) [22] in tomato. Similar results were also reported by Giuseppe *et al*. (2005) [11] in grape and El-Razek *et al*. (2012) [8] in peach. Foliar application of humic acid 1.5 % (T_2) recorded significantly, the minimum acidity (0.19 %) which was found statistically at par with treatments T_6, T_1, T_5 and T_4. While, maximum acidity (0.28 %) was in control (Table 1.). Minimum acidity might be due to humic acid improved TSS synthesis which in parallel decreased acidity in fruits (El-Razek *et al.*, 2012) [8]. Similar results were also reported by Fathy *et al*. (2010) [10] in apricot.

Significantly, highest total sugar (18.88 %) was recorded in treatment T_2 humic acid 1.5 % which was found statistically at par with treatments T_6 and T_1. While, minimum total sugar (15.16 %) was recorded in control (Table 1.). The increase in total sugar in response to humic acid might be due to formation of maximum amount of carbohydrate within the leaf and fruit tissues, which then converted to the specific sugar like glucose and sucrose (Abbas *et al.*, 2013) [1]. Similar findings were also reported by Zachariakis *et al.* (2001) [18] in grape. Significantly, maximum non-reducing sugar (10.56 %) was recorded in treatment T_2 humic acid 1.5 % which was found statistically at par with all the treatments except T_7 and T_8. While, minimum non reducing sugar (9.41 %) recorded in control (Table 1.). It can be hypothesized that foliar application of humic acid had positive effects on nutrient availability. This favourable nutritional status, induced by foliar applications of humic acid could be the indirect cause of the accumulation of sugar in fruit. Similar finding was also reported by Neri *et al*. (2002) [14] in strawberry.

Foliar application of humic acid 1.5 % (T_2) recorded significantly, the highest reducing sugar (7.62 %) which was statistically at par with treatments T_6, T_1 and T_9. While, minimum reducing sugar (5.78 %) was recorded in control (Table 1.). The accumulation of more reducing sugar by the foliar application of humic acid might be due to increased translocation of more photosynthetic assimilates to the fruit and breakdown of starch during ripening (Abbas *et al.*, 2013) [1]. Similar result was also reported by Karakurt *et al.* (2009) [12] in pepper. Significantly, maximum ascorbic acid (41.04 mg/100 g pulp) was recorded in treatment T_2 (humic acid 1.5 %) which was at par with the treatments T_6 and T_3. While, minimum ascorbic acid recorded in control i.e. 34.4 mg/100 g pulp (Table 1.). It might be due to humic acid increase the permeability of bio membranes for electrolytes accounted for increased uptake of phosphorus and potassium which increase the ascorbic acid percentage of the fruit (Reuther, 1973) [16]. Similar results were also reported by Carvajal *et al.* (1995) [5] in paprika, Yildrim (2007) in tomato and Abbas *et al.* (2013) [1] in Kinnow mandarin.

Significantly, maximum shelf life of fruits (15.93 days) was recorded in treatment T_2 (humic acid 1.5 %) followed by treatments T_6, T_1, T_3, T_8, T_4 and T_1. While, minimum shelf life (11.33 days) was observed in control (Table 2.). Increase in shelf life of fruits might be due to humic acid which stimulate plant enzymes activity and firmness of cell wall in fruit which prolong the shelf life (El-Nemr *et al.* 2012) [7]. Similar findings were also reported by Mohamadineia *et al*. (2015) [13] in grape and Farahi *et al.* (2013) [9] in strawberry.

Table 1: Effect of foliar application of humic acid, salicylic acid and novel liquid on TSS, acidity, total sugar, non reducing sugar, reducing sugar and ascorbic acid of mango cv. Amrapali

Sr. No	Treatments	TSS (^{0}Brix)	Acidity (%)	Total sugar (%)	Non Reducing sugar (%)	Reducing sugar (%)	Ascorbic acid(mg/ 100 g fruit pulp)
T_1	Humic acid 1 %	20.50	0.21	17.92	10.56	7.22	37.57
T_2	Humic acid 1.5 %	21.63	0.19	18.88	11.27	7.62	41.04
T_3	Humic acid 2 %	19.60	0.23	17.18	10.51	6.68	38.65
T_4	Salicylic acid 1000 mg/l	19.93	0.22	16.99	10.63	6.37	36.37
T_5	Salicylic acid 1500 mg/l	20.06	0.22	17.45	10.79	6.65	35.53
T_6	Salicylic acid 2000 mg/l	20.70	0.20	18.50	11.02	7.46	39.70
T_7	NOVEL liquid 1 %	19.83	0.24	16.39	10.16	6.23	37.01
T_8	NOVEL liquid 1.5 %	20.33	0.23	17.23	10.43	2.79	37.50
T_9	NOVEL liquid 2 %	20.43	0.24	17.48	10.53	6.96	36.23
T_{10}	Control	17.75	0.28	15.16	9.41	5.78	34.40
	S.Em. ±	0.61	0.01	0.38	0.25	0.26	0.85
	C.D. at 5 %	1.79	0.03	1.11	0.74	0.77	2.50
	C.V. %	5.26	7.88	3.76	4.16	6.69	3.93

The minimum physiological loss in weight (10.58 %) was observed in the treatment T_2 (humic acid 1.5 %) which was at par with treatments T_6 and T_1. Whereas, maximum physiological loss in weight (17.66 %) was recorded in control (Table 2.). The reduction of physiological loss in weight by application of humic acid might be due thickening of cell wall of fruit which leads to slow down respiratory rate and delayed senescence (Chen *et al.*, 2004) [6]. The foliar application of humic acid 1.5 % (T_2) recorded significantly, minimum spoilage (58.33 %) up to 15th day of storage followed by treatments T_6, T_1 and T_3. While, maximum spoilage (73.00 %) was recorded in control (Table 2.). It might be due to humic substances increase the firmness of cell wall which inhibit the penetration and spread of pathogens in fruit (El-Nemr *et al.* 2012) [7]. Similar findings were also reported by Mohamadineia *et al*. (2015) [13] in grape and Farahi *et al.* (2013) [9] in strawberry.

Table 2: Effect of foliar application of humic acid, salicylic acid and novel liquid on shelf life, physiological loss in weight and spoilage of mango cv. Amrapali

Sr. No	Treatments	Shelf life (Days)	Physiological loss in weight (%)	Spoilage (%)
T_1	Humic acid 1 %	15.07	12.27	62.74
T_2	Humic acid 1.5 %	15.93	10.58	58.33
T_3	Humic acid 2 %	14.87	13.51	63.30
T_4	Salicylic acid 1000 mg/l	14.07	14.66	67.33
T_5	Salicylic acid 1500 mg/l	13.67	12.95	69.96
T_6	Salicylic acid 2000 mg/l	15.60	11.93	62.00
T_7	NOVEL liquid 1 %	13.83	14.83	71.07
T_8	NOVEL liquid 1.5 %	14.20	15.16	66.71
T_9	NOVEL liquid 2 %	14.03	16.38	68.67
T_{10}	Control	11.33	17.66	73.00
	S.Em. ±	0.71	0.60	2.13
	C.D. at 5 %	2.09	1.77	6.30
	C.V. %	8.60	7.43	5.57

Conclusion

The result obtained from research experiment, it can be concluded that humic acid 1.5 % was found beneficial to increases TSS, total sugar, non reducing sugar, reducing sugar, ascorbic acid, shelf life and minimize the acidity, PLW and spoilage in mango cv. Amrapali.

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