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Studies on effect of bagging and foliar application of different chemicals on post-harvest quality of Mango fruits (*Mangifera indica* L.) cv. Amrapali

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Abstract
The present investigation entitled "Studies on effect of bagging and foliar application of different chemicals on post-harvest quality of Mango Fruits (*Mangifera indica* L.) cv. Amrapali" was carried out during the year 2020-2021 at Main Experimental Station, Department of Fruit Science, College of Horticulture & Forestry, A.N.D.U.A. & T., Narendra Nagar (Kumarganj), Ayodhya, Uttar Pradesh, India. The treatments comprised of spraying of various chemicals and bagging with eco-friendly materials to study the various Physico-chemical properties and effect of above treatments on quality and storage behaviour of mango fruits cultivar Amrapali.
The experiment was laid down in randomized block design (RBD) with (08) treatments and (03) replications. The experiment consists of 8 treatments including control, T_1 (Calcium Chloride @ 2%), T_2 (Salicylic acid @ 0.03%), T_3 (Calcium Chloride @ 2% + Salicylic acid @ 0.03%), T_4 (Calcium chloride @ 2% + Bagging), T_5 (Salicylic acid @ 0.03% + Bagging), T_6 (Calcium Chloride @ 2% + Salicylic acid @ 0.03% + Bagging), T_7 (Bagging), T_8 (Control) were used for this study. The results revealed that the foliar application of Calcium Chloride @ 2% + Salicylic acid @ 0.03% + Bagging was most effective in increasing Physico-chemical properties of mango fruits like fruit length, fruit width, fruit weight, pulp weight, stone weight, peel weight, Pulp stone ratio, fruit firmness, less insect damage fruit, Total Soluble Solids (TSS), Vitamin C (Ascorbic acid), reducing sugars, non-reducing sugar, Total sugars, and less acidity in quality point of view, Shelf life, Organoleptic quality, Cost: Benefit ratio, minimized PLW and spotted fruits.

Keywords: Bagging, foliar, chemicals, Mango, *Mangifera indica* L.

Introduction
Mango (*Mangifera indica* L.), often offered as the king of fruits, is the most important tropical fruit crops of the world after banana and plantation crops. It belongs to the family Anacardiaceae, and Genus Mangifera, having a basic chromosome number of 20 (2n = 2x = 40). The fruit is highly valued for its excellent flavour, appealing aroma, delicious taste, attractive colour and high nutritive value. It is a rich source of vitamin A (4800 IU/100 g of fruit). The total area and production of mango in India was 2283,000 Ha and 20955,000 MT, respectively in 2018-19 (NHB, 2020). Despite of higher coverage and higher production of mango fruits, the productivity of the crop in the country is still quite low (7.3 t/ ha) as compared to other fruit crops like papaya, banana, apple, grape, citrus etc. This might be due to biennial bearing habit of the crop, low fruit set and development of abscission layer and deficiency of different nutrients in different part of the country. Hence, there is huge scope to improve the national productivity of mango by rectifying all the production problems.
India ranked 5th in the exporting mango to global market with an export share of only 5.2%. However, in current scenario, even though the export of mango by volume is increasing day by day, but the share of quantity exported out of total production is very meagre (0.38%) (Kusuma and Basavaraja, 2014) [5]. The main reason behind this is the quality of the fruit. The international as well as the domestic mango market is facing different issues regarding management of mango fruit at post-harvest stage (Malik *et al*., 2010) [8].
Amrapali is a well-known late maturing and regular bearer dwarf hybrid variety. It was evolved as a result of a cross between 'Dashehari (alternate bearer) and Neelum (regular bearer)' varieties of mango species *indica* at IARI, New Delhi, in 1979. Amrapali possesses quality par excellence with very high pulp percentage and TSS with deep orange red flesh colour and excellent in taste.

Amrapali is one of the best suitable varieties for inter as well as overseas markets and processing industries. Anthracnose (*Colletotrichum gloeosporioides*) and stem-end rot (*Diplodia natalensis*) are the major post - harvest diseases of mango fruits, which cause black spots on fruits skin during ripening and storage.

Kumar *et al*. (2006) [4] reported that calcium spray (2%) increased the productivity of mango basically by reducing abscission layer formation on fruit peduncle which ultimately reduces the fruit drop per cent. Bagging, a physical protection technique, not only protects fruits from pest and disease but also influence of the produced by changing environment of fruits during development (Son and Lee, 2008) [10]. Salicylic acid belongs to phytohormone which classified as a phenyl propanoid compound and stimulated by biotic and abiotic stress to induce defence responses. Moreover, it is also classified as an ethylene inhibitor (Gerailoo and Ghasemnezhad, 2011) [3].

It has been observed that Amrapali is late maturing variety. Generally, maturity coincide with monsoon therefore, fruit remains green in colour even after repining and black spot-on skin is the major problem of this cultivar. Pre harvest application of Bagging, $CaCl_2$, and Salicylic acid may play an important role to minimize these problems. Therefore, present investigation has been selected.

Materials and Methods

The present investigation was carried out on the orchard of mango cv. Amrapali at main experimental station of Horticulture and Fruit Science laboratory, College of Horticulture & Forestry, Acharya Narendra Deva University of Agriculture & Technology-Kumarganj, Ayodhya, during the 2020-21.

Fruit length (cm)

The data on fruit length of three fruits per replication were recorded separately with the help of vernier calliper.

Fruit width (cm)

The data on fruit width of three fruits per replication were recorded separately with the help of vernier calliper.

Fruit Weight (g)

Weight of three fruits per replication were recorded by weighing the sample on pan balance.

Pulp weight (g)

After separation of peel, pulp of individual fruit was also separated from the stone and the data on the weight of fruit pulp three fruits per replication were recorded separately with the help of digital balance meter.

Stone weight (g)

After separation of fruit peel and pulp of three fruits per replication, stones were collected from individual fruit and average stone weight of individual fruit was calculated with the help of digital balance meter and their weight was expressed in grams.

Peel weight (g)

The ripened fruits were peeled off using a knife and peel of the fruit was separated from the fruit pulp. Therefore, the data on the weight of fruit peel three fruits per replication were recorded separately with the help of digital balance meter and average peel weight of individual fruit was calculated and expressed in gram.

Pulp: Stone ratio

Pulp: Stone ratio of the fruits was worked out by using the available data of pulp weight and stone weight. It was calculated by using following formula:

$$\text{Pulp Stone ratio} = \frac{\text{Total weight of fruit(g)} - \text{weight of stone (g)}}{\text{Total weight of stone (g)}}$$

Fruit firmness (kg/cm^2)

Fruit firmness was determined as reported by Magness and Taylor (1925) [6] with the help of pressure tester by using a 5/16 plunger in Kg/cm^2.

Insect damaged fruits (%)

Insect damaged fruits were taken and their weight was recorded with the help of physical balance. The percent of insect damaged fruits was calculated by using following formula:

$$\text{Insect damaged fruits (\%)} = \frac{\text{Insect damaged fruits weight}}{\text{weight of fresh fruits}} \text{ X } 100$$

Spotted fruits (%)

Black spotted fruits were taken and their weight was recorded with the help of physical balance. The per cent of black spotted fruits was calculated by using following formula:

$$\text{Balck spotted fruits (\%)} = \frac{\text{Black spotted fruits weight}}{\text{weight of fresh fruits}} \text{ X } 100$$

Results and Discussion

Randomly 5 fruits from each treatment had been collected from the experimental farm and the following observation recorded during investigation in Department of Fruit Science, College of Horticulture and Forestry, Kumarganj, Ayodhya. The present investigation was carried out during 2020-21.

Physical parameters of fruits

The mango Cv. Amrapali recorded significantly higher fruit length (9.72 cm), Width (6.33 cm), weight of fruit (285.00 g), pulp weight of fruit (207.56 g), stone weight (36.20 g), peel weight (26.00g) and pulp stone ratio (6.02%) when trees were sprayed with different chemicals and bagging (Calcium chloride (2%) + Salicylic acid (0.03%) + Bagging) at 45 days before harvest (Table 1) while those results were fruit length (7.82 cm), Width (4.73 cm), weight of fruit (168.60 g), pulp weight of fruit (115.26 g), stone weight (27.73 g), peel weight (41.13g) and pulp stone ratio (4.21%) in control. The improvement observed in the fruit quality by pre-harvest application of Calcium chloride and salicylic acid and bagging, may be due to the increase in cell division in the initial stages and later due to cell expansion associated with movement of water and other metabolites into the cell causing increase in overall weight of the fruit (Young *et al*., 1996) [11].

The maximum firmness (4.50 kg/cm^2) was recorded in treatment of Calcium chloride (2%) + Salicylic acid (0.03%) + Bagging. while the lowest fruit firmness (1.75 kg/cm^2) was noticed in control. That pre harvest application of SA 2m M and 1mM treatments retained about 40% and 23% higher firmness respectively over control. Fruit firmness is one of the most important quality attributes determining product

acceptability to the consumer. The higher fruit firmness in SA- treated fruit may be ascribed to reduced activities of cell wall and membrane degrading enzymes. Ezzat *et al.* (2016) [2] used various types of polythene bags in guava fruits during rainy season reported that were more beneficial than other treatments in increasing fruit firmness.

Table 1: Effect of different chemicals and bagging on Physical parameters of mango fruits cv. Amrapali

S. No.	Treatments	Fruit length (cm)	Fruit width (cm)	Fruit weight (gm)	Pulp weight (gm)	Stone weight (gm)	Peel weigh (gm)	Pulp stone ratio (%)	Fruit firmness (Kg/cm^2)	Incest damage (%)	Spotted fruits (%)
1	T_1, Calcium chloride (2%)	8.09	5.07	199.66	149.23	32.53	30.23	5.00	3.80	10.67	22.00
2	T_2, Salicylic acid (0.03%)	8.69	5.38	218.26	160.33	29.73	28.00	5.39	2.50	6.33	16.00
3	T, Calcium chloride (2%) + Salicylic acid (0.03%)	9.64	5.84	279.86	204.73	35.20	25.42	5.89	4.25	4.67	12.00
4	T_4, Calcium chloride (2%) + Bagging	8.90	5.25	212.00	138.53	27.40	30.66	4.47	3.25	4.00	10.33
5	T_5, Salicylic acid + Bagging	8.87	5.44	277.60	201.66	34.11	33.00	5.57	4.25	2.67	6.00
6	T_6, Calcium chloride (2%) + Salicylic acid (0.03%) + Bagging	9.72	6.33	285.00	207.46	36.20	26.00	6.02	4.50	1.33	2.33
7	T_7, Bagging	8.44	5.00	193.80	133.33	29.80	39.73	4.59	2.16	4.33	12.00
8	T_8, Control	7.82	4.73	168.60	115.26	27.73	41.13	4.21	1.75	12.67	32.33
S.Em±		0.29	0.24	7.93	9.37	1.45	1.65	0.09	0.18	2.779	3.576
CD at 5%		0.87	0.72	24.06	28.41	4.40	5.02	0.28	0.56	0.907	1.168

The fruits from plants treated with Calcium chloride (2%) + Salicylic acid (0.03%) + Bagging were the lowest insect damage with value of (1.33%) while the most maximum insect damage fruits (12.67%) found in control. Similar findings were reported by Sarker *et al*. (2009) [9] that different bagging materials (black polybag, transparent polybag, brown paper bag) were evaluated for the control of mango fruit fly attacking.

Less number of spotted fruits were found in plants treated with Calcium chloride (2%) + Salicylic acid (0.03%) + Bagging (2.33%) and followed by (6.00%) found in plant treated with Salicylic acid (0.03%) + Bagging and large number spotted fruits were recorded in control (32.33%). Spots on fruits occur mainly due to high humid condition because it is congenial for pathogen attack. Bagging creates a micro environment which is save for fruits and it also avoid pathogen attack and spot formation, the results corroborate with Majumdar *et al*. (2020) [7] reported that spraying of mango tree with Salicylic acid (2.0mM) effective treatments with disease reduction of 66.67%over control for a storage period of 15 days at ambient room temperature.

Conclusion

From the ongoing summery of the present investigation, it can be inferred that fruit length, fruit width, fruit weight, pulp weight, stone weight, peel weight, pulp stone ratio, fruit firmness and spotted fruit, insect damage. was recorded maximum in Calcium chloride (2%) + Salicylic acid (0.03%) + Bagging. It can be concluded that all the treatments show higher net return and benefit cost ratio but the effect of Calcium chloride (2%) + Salicylic acid (0.03%) + Bagging was found more pronounced among all the treatments and can be used in increasing the quality of mango.

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