

ENHANCEMENT OF HARVESTABLE MANGO (*MANGIFERA INDICA* L.) FRUIT YIELD BY SALICYLIC AND METHYL-2,6 DICHLOROISONICOTINIC ACIDS

S.S.M. NAQVI, M.A. KHAN, S.M. ALAM,
S. MUMTAZ AND A. SHEREEN

Plant Physiology Division
Atomic Energy Agricultural Research Center,
Tando Jam, 70060, Pakistan.

Abstract

The effect of aqueous sprays of salicylic acid (SA), acetylsalicylic acid (ASA) and methyl-2,6 dichloroisonicotinic acid (INA), which mimics SA action, was investigated and compared with naphthaleneacetic acid, Ag and Co ions sprayed on juvenile fruits at pea size (5-6 mm) and two weeks later when they had attained marble size (10-15 mm). All the chemicals significantly ($P(0.05)$) enhanced harvestable fruits in all the three cultivars tested. Considering the cost, easy availability and convenience of preparing aqueous solution, use of soluble ASA is suggested.

Introduction

Mango (*Mangifera indica* L.) is one of the popular and extensively cultivated fruit trees of tropical and subtropical areas of the world. The excellence of flavor, delicious taste with high nutritive value have merited it the title as the "King of Fruits". However, it has been reported that fruit loss occurs at all stages (Singh, 1960; Desai *et al.*, 1985), but is extensive ($>90\%$) during the first 4 weeks after fertilization (Nunez-Elisea & Davenport, 1983, 1986; Prakash & Ram, 1984).

Van Lelyveld (1978) suggested that ethylene may be involved in the juvenile mango fruit drop which was later experimentally demonstrated by Nunez-Elisea & Davenport (1983, 1986). Ethylene is the only gaseous phytohormone involved in diverse aspects of plant growth (Naqvi, 1995); its production is normally low, but is greatly enhanced at specific stages of development including abscission (Yang & Hoffman, 1984). We, therefore, adopted a strategy to regulate the ethylene action/biosynthesis through the spray applications of Ag or Co ions or the growth regulator naphthaleneacetic acid (NAA) and succeeded in enhancing the harvestable mango fruit yield (Naqvi *et al.*, 1990, 1992). In addition to Co^{2+} (Yang & Hoffman, 1984), salicylic and acetylsalicylic acids have also been shown to inhibit the putative ethylene-forming enzyme (EFE) that converts 1-aminocyclopropane-1-carboxylic acid (ACC) to ethylene (Leslie & Romani, 1986, 1988). Following similar strategy as adopted for NAA, Ag⁺ or Co^{2+} we investigated the effect of spraying salicylic acid (SA), acetylsalicylic acid (ASA), an inexpensive and easily available chemical, and recently synthesized methyl-2, 6 dichloroisonicotinic acid (INA; Ciba-Geigy, Anon., 1995), which mimics SA action, on harvestable mango yield.

Materials and Methods

Mango (*Mangifera indica* L.) trees, growing in the orchard of Atomic Energy Agricultural Research Center, Tando Jam, were selected on the basis of similar maturity. The test cultivars, Sindhri, Langra and Dasehri flowered only once a year from late January and fruits matured from late May to June.

Aqueous solutions of salicylic acid (SA), acetylsalicylic acid (ASA; soluble aspirin), methyl-2,6 dichloroisonicotinic acid (INA), 1-naphthaleneacetic acid (NAA), silver nitrate (AgNO_3) and cobalt nitrate [$\text{Co}(\text{NO}_3)_2$] were sprayed on panicles to the point of run-off at concentrations of 5 mg/L (SA & ASA), 5 and 10 mg/L (INA); 10 mg/L (NAA); 100 mg/L (nitrates of Ag^+ & Co^{2+}). Control was sprayed with distilled water. Tween-80 at 0.1% was used as a wetting agent in all the treatments.

Five uniform panicles from 3 trees of cvs. Sindhri, Langra and Dasehri (about 20 + years old) were randomly selected and total number of fruitlets counted at the time of first spray and at harvest. Since fruitlets abscise excessively within 15-30 days of setting, 2 sprays were applied at about 0800 hours: the first when the fruitlets had attained pea size (5-6 mm; 10-15 days after fertilization) and the second at marble size (10-15 mm; 21-26 days after fertilization). One tree of each cultivar was considered as a replicate and the experiment was repeated for 3 years. Normal cultural practices were adopted throughout the year to maintain the orchard in healthy condition. The data pertaining to percent fruit retained within each year were statistically analysed for mean separation.

Results and Discussion

Our mango cultivars are well known for their heavy and lean bearing in alternate years. Therefore, the experiment was conducted for three consecutive years to cover the bearing habit as well as the climatic variability. Data given in Table 1 shows that all the treatments enhanced fruit retention in Sindhri but the maximum enhancement of 140% over the control (100%) was obtained with ASA (5 ppm), followed by INA (10 ppm). Similarly, fruit retention in Dasehri was enhanced to 115% by INA (5 ppm) followed by NAA (10 ppm) and Ag^+ (100 ppm). In Langra, however, aqueous sprays of ASA (5 ppm) enhanced fruit retention to 155% closely followed by INA (10 ppm), SA (5 ppm) and INA (5 ppm). The low percentage enhancement in the year 1997 was due to a hail storm before the fruits matured.

Aqueous sprays of synthetic auxins, NAA (Planofix; May & Baker) and 2,4-D have been reported to enhance fruit retention in a number of mango cultivars. Available literatures show that NAA (10 ppm) and 2,4-D (10 ppm) were effective in enhancing fruit retention in cultivars Hindy Be Sinnara, Khasa, Dasehri, Neelam, Langra and Sindhri (Aravindakshan *et al.*, 1979; Dahshan & Habib, 1981; Singh & Ram, 1983; Naqvi *et al.*, 1990, 1992). The present studies along with the earlier published reports lend further support to the findings that irrespective of the cultivars, NAA treatment is effective in enhancing harvestable mango fruits.

Singh & Ram (1983) reported for the first time that 200 ppm of AgNO_3 sprayed at marble stage of mango fruitlet, enhanced harvestable fruit in cv. Dasehri. Along with

Table 1. Effect of aqueous spray applications of various chemicals to fruit panicles of mango cultivars.

Treatments (ppm)	Cultivars/years							
	Sindhri			Dasehri			Langra	
	1996	1997	1998	Av.	1996	1997	1998	Av.
Control	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
AgNO ₃ -100	169.84	29.29	71.00	+90.04	166.76	58.99	161.80	+129.18
CO(NO ₃) ₂ -100	236.36	24.73	66.67	+109.25	157.61	52.09	135.70	+115.13
NAA-10	50.32*	71.55	147.67	+89.85	197.11	27.44	167.80	+130.78
SA-5	164.29	33.37	119.50	+105.72	166.76	46.74	120.30	+111.24
ASA-5	218.04	41.10	161.67	+140.27	178.15	46.74	101.70	+108.86
INA-5	28.76*	106.36	212.00	+115.71	123.25	46.74	175.90	+115.30
INA-10	113.51	127.73	166.67	+135.97	100.09	49.01	118.40	+89.17

Low percentage increase was due to human activity.

AgNO_3 we also experimented with $\text{Co}(\text{NO}_3)_2$ and observed that aqueous sprays, at pea and marble sized fruitlets of these two chemicals at a concentration of 100 ppm effectively increased the fruit retention in cvs., Sindhri, Dasehri and Langra. Thus, we confirmed the results of Singh & Ram (1983) and also demonstrated for the first time that Co^{2+} was also a potent enhancer of harvestable mango fruits (Naqvi *et al.*, 1990). L.J. Van Lelyveld (personal communication, 1980) also sprayed mango (cv. Haden) with various concentrations of AgNO_3 and observed enhanced fruit retention. However, he noted that the fruits were embryoless and remained small and unmarketable. By contrast, we did not observe such adverse effects in our experiments, where the appearance of fruits were normal and marketable. Besides, the elite cultivars grown in the Indo-Pakistan sub-continent are grafted, therefore, embryo maturity may not be important. It is also possible that AgNO_3 concentration and/or the stage of fruit development may not have been optimal in Van Lelyveld experiments at Nelspruit (South Africa).

We have not come across with any report where salicylic acid (SA) or its derivative acetylsalicylic acid (ASA) has been used to minimize fruit drop in any crop. Similarly, recently synthesized methyl-2, 6 dichloroisonicotinic acid (INA; Ciba-Geigy), which mimics SA action, has also not been experimented with for enhancing harvestable fruit yield.

The convincing demonstration that ethylene production by pericarp was involved in premature mango (cvs. Keith and Tommy Atkins) fruitlet abscission (Nunez-Elisea & Davenport, 1986) and that maximum abscission of fruitlets occur during the first 30 days after fertilization (Singh, 1960; Jagirdar & Choudhry, 1967; Nunez-Elisea & Davenport, 1983) offered the opportunity to explore the possibility of enhancing fruit retention in problem crops by interfering with the chemical(s), at appropriate stages of fruit development, which are reported to influence ethylene production/action. Like Co^{2+} , salicylic and acetylsalicylic acids also inhibit the putative ethylene forming enzyme (EFE) that converts ACC to ethylene (Leslie & Romani, 1986, 1988). Therefore, it is highly probable that aqueous spraying, at the pea and marble sized fruitlets, with NAA, Ag^+ , Co^{2+} , SA, ASA or INA may have interfered with the biosynthesis/action of ethylene, which in turn reduced fruitlet abscission and enhanced harvestable mango fruits.

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Materials and Methods

Mature fruits of *Washingtonia filifera* (L. Lindley) H. Wendl. were collected and stored for use as described earlier (Khan, 1982). Fruits were surface sterilized for 1 min. with 0.1 % $HgCl_2$ solution and washed 2 times with sterile distilled water. Ten grams of fruits were soaked, with occasional shaking, either in 30 ml of sterile distilled water or methanol at 15° C in dark. For each treatment, the extracts were adjusted to 100, 500 and 700 mg fruit dry weight equivalent. These extracts were applied to two sheets of Whatman filter paper No. 5 in 9 cm Petri dishes. The dishes were dried using a hair drier. Five ml of distilled water was added to each dish, including a water control, and 100 seeds of lettuce (*Lactuca sativa* L.) cv. Grand Rapids or 25 seeds of