Pak.J.Bot., 30(2): 239-243, 1998.

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 asprin), methyl-2,6 dichloroisonicotinic acid (INA), 1-naphthaleneacetic acid (NAA), silver nitrate ($AgNO_3$) and cobalt nitrate [$Co(NO_3)_2$] 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.

Aqeuous 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 1996	1997	1998	Av.	Dasehri 1996	1997	1998	Av.	Langra 1996	1997	1998	Av.
Control	100.00	100.00	100.00	100.00	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	112.07	51.54	110.70	+91.44
$CO(NO_3)_2$-100	236.36	24.73	66.67	+109.25	157.61	52.09	135.70	+115.13	224.01	49.10	100.00	+124.37
NAA-10	50.32*	71.55	147.67	+89.85	197.11	27.44	167.80	+130.78	188.49	21.74	152.51	+120.91
SA-5	164.29	33.37	119.50	+105.72	166.76	46.74	120.30	+111.24	255.11	76.78	105.02	+145.64
ASA-5	218.04	41.10	161.67	+140.27	178.15	46.74	101.70	+108.86	189.09	41.36	240.80	+155.42
INA-5	28.76*	106.36	212.00	+115.71	123.25	46.74	175.90	+115.30	158.24	44.46	236.80	+146.56
INA-10	113.51	127.73	166.67	+135.97	100.09	49.01	118.40	+89.17	201.28	96.92	162.90	+153.70

*Low percentage increase was due to human activity.

$AgNO_3$ we also experimented with $Co(NO_3)_2$ 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 & Davenpart, 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 inteferring 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 interferred with the biosynthesis/action of ethylene, which in turn reduced fruitlet abscission and enhanced harvestable mango fruits.

Acknowledgements

We are grateful to Ciba-Geigy (Basel, Switzerland) management for providing us with the sample and technical informations of INA. We thank M. Farooq and M. Ali for technical assistance and Zahid Pervez for computer composing of the manuscript.

References

Anonymous. 1995. *Genetic Engineering and Bio-technology Monitor* (UNIDO). 44, pp.42.

Aravindakshan, K., C. Ramachandran and I.S. Pynadath. 1979. Effect of Planofix on fruit set in mango (var. Neelam). *Agric. Res. J. Kerala*, 17: 105-107.

Dahshan, D.I. and S.S. Habib. 1981. Effect of 2,4-D sprays on fruit drop of 'Hindy Be Sinnara' mango.

Research Bulletin No. 1515. Ain Shams University, Shoubra El Kheima. Cairo, Egypt. pp. 12.

Desai, A.G., V.P. Limaye and R.T. Gunjate. 1985. Studies on fruit set and fruit drop in Alphanso, Goamankur and Kesar varieties of mango (*Mangifera indica* L.). Maharashtra *J. Hort.*, 2: 37-42.

Jagirdar, S.A.P. and M.R. Choudhry. 1967. Fruit drop control in mango by hormonal spray. *W. Pak. J. Agri. Res.*, 5: 33-42.

Leslie, C.A. and R.J. Romani. 1986. Salicylic acid: A new inhibitor of ethylene biosynthesis. *Plant Cell Reports*, 5: 144-146.

Leslie, C.A. and R.J. Romani. 1988. Inhibition of ethylene biosynthesis by salicylic acid. *Plant Physiol.*, 88: 833-837.

Naqvi, S.S.M. 1995. Growth Hormones: Growth promotors and inhibitors. In: Handbook of *Plant and Crop Physiology*. (Ed.) M. Pessarakli. Marcel Dekker, Inc., New York. pp. 527-556.

Naqvi, S.S.M., S.M. Alam and S. Mumtaz. 1990. Effect of cobalt and silver ions and naphthaleneacetic acid on fruit retention in mango (*Mangifera indica* L.). *Aust. J. Expt. Agric.*, 30: 433-435.

Naqvi, S.S.M., S.M. Alam and S. Mumtaz. 1992. Influence of growth regulators, cobalt and silver ions on fruit drop in mango (*Mangifera indica* L.). *Pak. J. Bot.*, 24: 197-200.

Nunez-Elisea, R. and T.L. Davenport. 1983. Abscission and ethylene production in mango (*Mangifera indica* L.) fruit cv. Tommy Atkins. *Proc. State Hort. Soc.*, 96: 185-188.

Nunez-Elisea, R. and T.L. Davenport. 1986. Abscission of mango fruitlets as influenced by enhanced ethylene biosynthesis. *Plant Physiol.*, 82: 991-994.

Prakash, S. and S. Ram. 1984. Naturally occurring auxins and inhibitors and their role in fruit growth and drop of mango 'Dashehari'. *Sci. Hort.*, 22: 241-248.

Singh, R.S. and S. Ram. 1983. Studies on the use of plant growth substances for fruit retention in mango cv. Dashehari. *Ind. J. Hort.*, 40: 188-194.

Singh, U.R. 1960. Studies in the fruit drop of mango (*Mangifera indica* L.) II. Nature and extent of fruit drop. *Hort. Adv.*, 4: 142-154.

Van Lelyveld, L.J. 1978. Peroxidase activity and isozymes in abscised and normal mango (*Mangifera indica* L.) fruits. *Zeit. fur Pflanzenphysiol.*, 89: 453-456.

Yang, S.F., and N.E. Hoffman. 1984. Ethylene biosynthesis and its regulation in higher plants. *Ann. Rev. Plant Physiol.*, 35: 155-189.

(Received for publication 3 October, 1998)