Proceedings:
International Symposium on
Prospects of Horticultural Industry in Pakistan
28th to 30th March, 2007
Institute of Horticultural Sciences, University of Agriculture, Faisalabad

CAUSES AND POTENTIAL REMEDIES OF MANGO (*Mangifera indica* L.) FRUIT DROP IN PAKISTAN

Mehdi Maqbool*, Muhammad Sohail Mazhar and Abdul Jabbar
Institute of Horticultural Sciences, University of Agriculture, Faisalabad, Pakistan
*Email: mehdimaqbool@yahoo.com

Abstract

Mango industry faces certain important problems like mango malformation, unfruitfulness and dieback etc. One such dilemma is the occurrence of high rate of fruit drop or in other words low fruit retention in mango. Individual panicles produce hundreds of ovules-bearing flowers, only a small proportion (0.1 to 0.25%) of which set fruit and reach at maturity. There are many waves of fruit drop at various stages of its growth and development. The most common drops are the June and preharvest drops. Certain cultivars shed fruit more severely than others. Among the various varieties like Langra, Dusehri, Sammar Bahisht, Anwar Ratoul and Fajri, Langra is the leading and popular variety of Indo-Pak sub-continent; however, it is distinctly prone to shedding which has become a limiting factor in its progress. Causes of early fruit drop are numerous. They include lack of pollination, self-incompatibility, failure of fertilization, embryo abortion, and competition among developing fruit, insect pests and diseases resulting in internal nutritional and hormonal imbalances. Varietal differences can also be noticed in the pattern of fruit drop. Various attempts have been made to improve set and retention with good irrigation and nutrition management, and exogenous application of plant growth regulators, nutrients and appropriate plant protection measures.

INTRODUCTION

Mango (*Mangifera indica* L.) is esteemed as one of the world's most popular fruits due to its delicate, sweet flavour and nutritive value. Mango is the 2nd largest fruit of Pakistan grown after citrus and occupies about 16% of the total fruit area of 652 thousand ha. From the total area of 1. 03 million hac around 52.4% is in the Punjab with Multan and Bahawalpur being prominent. Sindh's share is 45.6% with Hyderabad and Mirpurkhas forming the main tracts. Of the total 1.67 million tonnes production, Punjab's share is 66% and Sindh 32.5%. Balochistan and NWFP share the remaining less than 2% (Khan, 2005).

Despite adequate flowering and initial fruit set, severe fruit drop contributes to low fruit yields in mango orchards and causes great economic losses in various mango growing countries of the world. Individual panicles produce hundreds of ovule bearing flowers, only a small proportion of which set fruit and reach maturity. Various attempts have been made to improve fruit set and retention with exogenous application of plant growth regulators, nutrients and pesticides (Singh and Malik, 2005).

Fruit Drop Stages

There are four stages in case of mango fruit drop: mustard stage, pea stage, marble stage and normal stage (preharvest stage). A number of factors may be involved in heavy flower drop and low fruit set and heavy fruitlet abscission, such as rains and high winds at the time of flowering and fruit setting, deficient nutrition for the development of embryo, pests like mango hopper, mango mealy bug and anthracnose disease. Drop at mustard and pea stages are attributed to ovule abortion and embryo sac degeneration (Singh, 1960). The peak fruit drop in cultivar Langra and Dusehri takes place in the first three weeks of April and varies significantly from the drop in the following weeks (Singh, 1954).

Fruit Drop Varietal Difference

Among commercial varieties of Indo-Pak sub-continent, Langra is considered to be distinctly prone to shedding which has become a limiting factor in its progress. The studies revealed that fruit drop was high during the initial two weeks after fruit set, with maximum drop in Anwar Ratoul (96.3%), followed by Langra (90.3%), whereas Dusehri exhibited the highest final fruit retention and was regarded as the best-performing cultivar (Figure 1) (Asif et al., 2002).

CAUSES OF MANGO FRUIT DROP

1. Biotic and Abiotic Factors Affecting Fruit Drop

a. Pollination and fertilization: In nature initial fruit set in mango is low due to the predominance of staminate flowers, lack of pollination, failure of pollen to germinate or poor pollen tube growth due to self-incompatibility and unfavorable weather conditions prevailing at anthesis (Quintana et al., 1984). Individual panicles produce hundreds of ovule bearing flowers but small proportion (0.1 to 0.25%) set fruit and reach maturity.

b. Embryo abortion: Abscission zone forms at the attachment point of floral pedicels to terminal peduncles of mango panicles. Pea stage is most often associated with embryo abortion. Generally, degeneration of the ovule or embryo abortion, which hinders normal fruit development, seems to play an important role in induction of the abscission process at early stages of fruit development (Mukherjee, 1953). Shriveling and blackening of the ovule sometimes observed in young abscised mango fruit. Fruits with aborted embryos are small in size, until normal fruit maturity resulting in seedless fruit "nubbins" (Figure 2).

c. Insect pests: Insect pest infestation is one of the most important factors contributing to mango fruit drop. Among these, midges, caterpillars, hoppers, thrips, fruit fly, and seed weevil are major contributors. The mango midge causes drop up to 70% and mango hopper is also a major pest, causing 25-60% fruit loss. Mango mealy bug has also been a serious pest causing great losses to immature fruit in India and Pakistan (Prassad and Singh, 1976; Mohyuddin and Mahmood, 1993). The mechanism by which insect damage induce fruit abscission is probably as varied as the damage they incur. It is likely; however, that generation of ethylene is involved either through wound affects or directly in infected tissues (Martinez et al., 2001).

d. Diseases: Infection by several mango blossom diseases results in poor fruit set and retention. Four main blossom diseases, i.e. blossom blight (anthracnose), powdery mildew, blossom malformation, and blossom spot are common whenever trees flower during wet or humid conditions. Application of contact and systemic fungicides during wet or humid weather are the most effective way of controlling anthracnose and blossom blight. Control is best achieved if fungicides are applied before flowering (Jeffries et al., 1990).

e. Temperature and winds: Mango is a tropical and sub-tropical fruit. Low temperature during flowering affects the development of male and female organs and pollination. Temperature below 12°C during flowering interferes with pollen tube growth. Cool temperature (15°C day/5°C night) will cause morphological changes in style, stigma, ovaries and anther size. Temperature below 15°C for as little as 12 hrs will reduce pollen viability. High temperature during flowering leads to embryo abortion ultimately fruit will not reach to maturity. Fruit drop is more at day time than at

night. The temperature extremes and high winds are known to negatively affect pollination, fruit set, and retention. In general, low temperatures during flowering adversely affect organs, pollination and fertilization, resulting in low fruit set, high embryo abortion and fruit abscission (Dag et al., 2000). It was also observed that the pollination and poor fruit set problems due to unfavorable cool temperature during floral anthesis are common whenever mangoes are grown in the sub-tropics.

f. Water relations: Mango withstands moderate drought conditions for more than eight months. Water stress during the first 4-6 weeks of fruit set can affect fruit retention and yield (Gandhi, 1955). Deficiency of water during bloom adversely affects fruit retention because as a result of water stress abscisic acid is accumulated and ethylene biosynthesis resulted fruit drop in mango (Whiley and Schaffer, 1997).

2. Endogenous Factors Affecting Fruit Drop

a. Genotype: Cultivars with the highest percentage of perfect flowers are usually the most prolific and the percentage of fruit drop and final retention is mostly a cultivar characteristic (Rameshwar and Rao, 1980)

b. Competition for photo-assimilates: The competition among developing vegetative shoots and fruit for photo-assimilates causes fruit drop and vegetative flushing on non-bearing stems coincides with fruit development should be depressed to provide better availability of carbon resources for developing fruit (Purnomo, 1986).

3. Management Practices Affecting Fruit Drop

a. Fruit thinning: High initial fruit set leads excessive abscission. Fruit thinning at earlier stages of fruit development has been suggested to reduce the depletion of carbohydrate reserve and may be used as a tool to improve fruit retention.

b. Intercropping: Sharma (1999) observed that the intensity of fruit drop appears to vary with the nature of intercrop species and management practices being adopted. In a two year study he observed that intercropping of other crops with six-year old mango trees revealed that intercrops such as okra in summer stimulated high fruit drop. Similarly, intercropping with chilli as a long duration annual crop or soybeans in kharif and chilli in Rabi also resulted in more fruit drop than in non-interplanted trees; however, intercrops enhanced profit by generating additional monetary returns.

POTENTIAL REMEDIES OF MANGO FRUIT DROP

1. Phytohormonal Control of Abscission

a. Auxin: As level of Auxin decrease due to senescence or ethylene increases as a result of organ tissue damage, the abscission layer is formed in the abscission zone at the base of the petiole or fruit pedicel and the organ separates from the plant. Foliar application @ 20 mg l^{-1} of NAA or 2, 4-D reduces fruit drop in mango. Gokhale and Kanitkar (1951) reported that use of synthetic auxins, naphthalene acetic acid (NAA) and 2, 4-dichlorophenoloxyacetic acid (2, 4-D) reduced mango fruit drop.

b. Ethylene: The application of aminoethoxyvinylglycine (AVG) and aminooxyacetic acid (AOA) have been known to inhibit ethylene biosynthesis and reduce fruit drop; however, the high cost of chemicals and the huge size of mango trees limits their use in reducing fruit loss (Figure 3).

c. Gibberellins: Application of (Naphthalin acetic acid) NAA (200 mg l^{-1}) + ethephon (500 mg l^{-1}) once per season in November as well as Uniconazole (500 mg l^{-1}) + ethephon (500 mg l^{-1}) twice in December reduces the chances of fruit drop. Abou Rawash et al. (1998) reported reduced percentage of mango fruit drop at pea stage and increased final fruit retention after application of NAA (200 mg l^{-1}) + ethephon (500 mg l^{-1}) once per season in November as well as Uniconazole (500 mg l^{-1}) + ethephon (500 mg l^{-1}) twice in December.

d. Cytokinins: Application of synthetic Cytokinins reduced fruit drop. Exogenous application of 10 mg l^{-1} of the synthetic Cytokinins CPPU [N-(2-chloro-4-pyridyl)-N-phenylureal] 14 days after bloom gave effective control against fruit drop.

e. Polyamines: Aqueous solutions containing putrescine, spermine, and spermidine applied to panicles at full bloom stage results high fruit retention. Application of spermine at 10^{-1} M prior to anthesis in Dusehri and 10^{-4} M putrescine at full bloom in Langra increased fruit retention (Figure 4). Malik and Singh (2003) reported that the exogenous application of polyamines reduced fruitlet abscission in mango cv. Kensington Pride, but the response is significantly influenced by type, concentration and time of application.

2. Contact and systemic fungicides application

Benomyl, copper oxychloride and mancozeb @ 2 g l^{-1} applied weekly during bloom and then monthly until harvest. Maneb @ 2.5 g l^{-1}, spray application at starting two to three weeks after fruit set control Alternaria rot.

3. Nutrition

Plant nutrient application either through soil or foliar sprays reduced the chances of fruit drop. Fertilizer application @ 1 kg N + 2 kg P + 1 kg K per tree in mid-September reduced fruit drop significantly. Syamal and Mishra (1989) studied that the application of 1 kg N + 2 kg P + 1 kg K per tree in mango cv. Langra in mid-September significantly increased fruit retention.

Ortho phosphoric acid @ 0.5% and urea @ 2%, foliar application in September, November and March controlled fruit drop (Arora, 1961). Micronutrient ZnSO4 @ 0.2-0.8%, spraying during January increased perfect flowers per panicle and yield (Singh and Ram, 1997).

4. Miscellaneous Control of Fruit Drop

Datar (1985) studied that among various insecticides tested, Fenvalerate (Sumicidin) at 0.01% performed well in controlling mango hopper populations and reducing fruit drop in cv. 'Neelum'. Carbamate (Carbaryl) can be used to control mango seed weevil. Wrapping burlap around tree trunk proved good practice to stop the climbing mealy bug nymphs. Hayes (1953) demonstrated that irrigation in the dry season from fruit set to monsoon reduced fruit drop. Using artificial windbreaks during summer from southeasterly winds effectively controlled fruit drop in mango.

REFERENCES

Abou Rawash, M., N. Abou El Nasr, H. El Masry and S. Ebeed. 1998. Effect of spraying some chemical substances on flowering, fruit set, fruit drop, yield and fruit quality of Taimour (Egyptian) mango trees. *Egypt. J. Hort*., 25:83-99.

Arora, K.S. 1961. Study on fruit drop in mango (*Mangifera indica* L.). IARI, PhD. Thesis, New Delhi, India.

Asif, M., M. Usman, B. Fatima, M.J. Jaskani and M.M. Khan 2002. Fruit set and drop behaviour of three commercial cultivars of mango. *Pak. J. Agr. Sci*., 39:129-131.

Dag, A., D. Eisenstein and S. Gazit. 2000. Effect of temperature regimes on pollen and the effective pollination of Kent mango in Israel. *Sci. Hort.*, 86; 1-11.

Gandhi, S.R. 1955. The mango in India. Indian Council of Agri. Res. New Delhi Farm Bull. 6.

Gokhale, A.V. and U.K. Kanitkar. 1951. Fruit drop in Alphonso mango and its control. *Proc. Ind. Sci. Congr*., 38:151.

Hayes, W.B. 1953. Fruit growing in India. Kitabistan, Allahabad, India.

Jeffries, P., J.C. Dodd, M.J. Jeger and R.A. Plumbley. 1990. The biology and control of *Colletotrichum* species on tropical fruit crops. *Plant Pathol*. 39:343-366.

Khan, S.R.A. 2005. Management in mango production. A Newsletter of PHDEB, HortiMag, August 2005. pp:6-7.

Malik, A.U. and Z. Singh. 2003. Abscission of mango fruitlet as influenced by biosynthesis of polyamines. J. Hort. Sci. Biotechnol., 78:721-727.

Martinez, G.P., R.L. Gomez and M.A. Gomez-Lim. 2001. Identification of an ETR 1-homologue from mango fruit expressing during fruit ripening and wounding. *Plant Physiol*. 158:101-108.

Mohyuddin, A.I. and R. Mahmood. 1993. Integrated control of mango pests in Pakistan. *Acta Hort.*, 341:467-483.

Mukherjee, S.K. 1953. The mango, its botany, cultivation, uses and future improvement. *Econ. Bot*. 7:130-162.

Prassad, V. and R.K. Singh. 1976. Prevalence and control of mango mealy bug *Drosicha stebbingi* (green) in Bihar. *Ind. J. Entomol*., 38:214-224.

Purnomo, S. 1986. Possible agronomics technical manipulation for mango of Golek, Gadung and Manalagi cultivar. *Penelitian Hortikultura*, 1:22-36.

Quintana, E.G., P. Nanthaghai, D.B. Hiranpradit, J. Mendoza and S. Kesta. 1984. Growth and development of mango. In: Mendoza, D.B. and Wills, R.B.H. (Eds.). Mango: fruit development, postharvest physiology and marketing in ASEAN. ASEAN Food Handling Bureau, pp.21-39.

Rameshwar, A. and S.N. Rao. 1980. Why fruit drop in mango. *Intensive Agr*. 18:17-18.

Ram, S. 1992. Naturally occurring hormones of mango and their role in growth and drop of the fruit. *Acta Hort*., 321:400-411.

Sharma, D.P. 1999. Effect of intercropping and cultural practices on yield and economics of newly planted mango. *Adv. Plant Sci*., 12:337-340.

Singh, Z., A.U. Malik and T.L. Davenport. 2005. Fruit drop in mango. *Hort. Rev*. 31:113-156.

Singh, L.B. 1960. The mango. Leonard Hill (Books) Limited, Interscience Publisher Inc., New York.

Singh, R.N. 1954. Studies on the floral biology and subsequent developments of fruits in the mango (*Mangifera indica* L.) varieties of Dusehri and Langra. *Ind. J. Hort*., 11:69-88.

Singh, C.P. and S. Ram. 1997. Effect of irrigation on flowering, fruiting and malformation in mango. Acta Hort., 455:543-545.

Syamal, M.M. and K.A. Mishra. 1989. Effect of NPK on growth, flowering, fruiting and quality of mango. *Acta Hort*., 231:276-281.

Whiley, A.W. and B. Schaffer. 1997. Stress physiology. In: R.E. Litz (ed.), The mango: Botany, production and uses. CAB Int., Cambridge, UK.

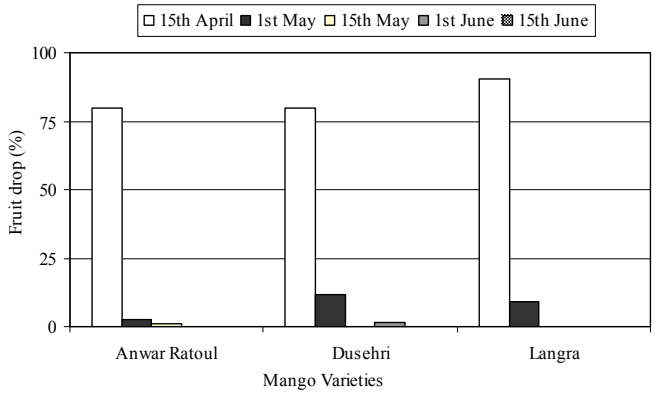

Figure 1: Fruit drop behavior in various cvs. of mango

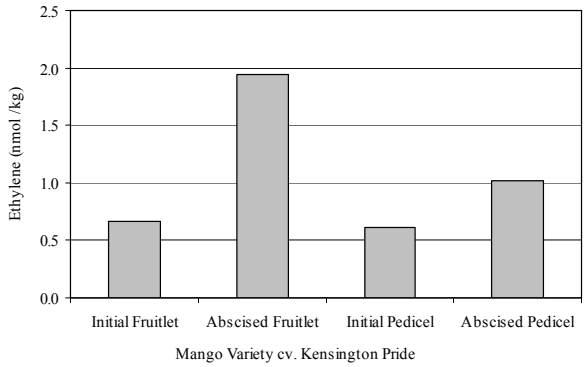

Figure 2: Ethylene concentrations in intact and about-to-abscise fruitlet and pedicels of mango cv. 'Kensington Pride'

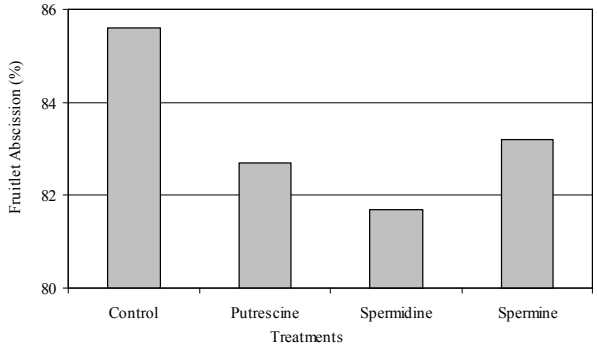

Figure 3: Effect of ethylene inhibitors on fruit retention in 'Kensington Pride' after 6 weeks of fruit set

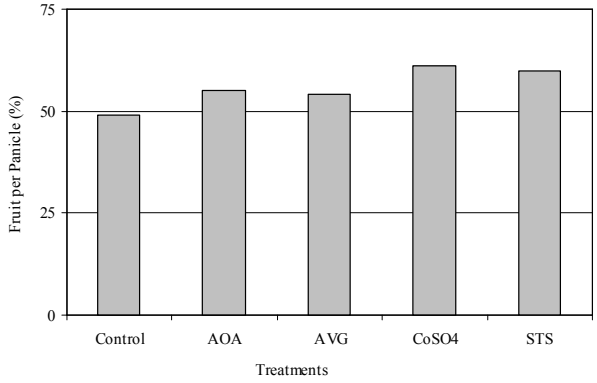

Figure 4: Effect of exogenous application of polyamines at fruit set on fruitlet abscission (%) in 'Kensington Pride' after 4 weeks of spray