CHAPTER - 2
REVIEW OF LITERATURE
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In the recent years, mango industry is suffering due to the widespread of mango malformation malady. Mostly all the varieties are found affected with this serious problem and mango industry is badly affected due to the reasons of the failure of crop. Now-a-days it was considered in certain projects and symposia even at international level that this malady should be studied deeply with the planned research programme. Therefore, findings of earlier research workers are reviewed in this chapter.

In the earlier and preliminary investigations of growth behaviour in vegetative and reproductive shoots it was observed in variable nature. Growth of panicles in certain varieties starts in different times under the different climatic conditions (Burn's and Prayag, 1920; Popenoe, 1927; Dudgeon, 1929; Prasad, 1985). Variability in certain useful aspects of mango tree and fruit had also been reported by Pope (1929), Elezabeth (1939), Naik (1940) and Sturrock (1940). Juliana and Cauvas (1932) reported that all the floral parts of the mango developed on the basis of calyx, carolla, stamens, pistil and ovaries. Launza (1939) studied the bud differentiation in carabao Mango (Mangifera indica L.) and reported that there were no any floral characters which revealed the differentiation in dormant flower and vegetative bud.

Ramasanne and Banerjee (1941) studied the Vitamin 'C' content in Mango and suggested that the sap of fruit contains total soluble solids in aggregate compounds. Infact different changes takes place at certain stages of growth and development in different varieties.
Naik and Rao (1942) and Nakasone et al. (1955) observed that some factors governing fruit bud formation, terminal growth and flowering behaviour of mango. They reported that shoot which develop earlier have a great potential to produce panicle in next season.

Bajawa and Musahib-Ud-din (1946) studied the present situation of mango industry in the Punjab and observed that in ripe fruits ascorbic acid was found in very high content (150 mg/100 g). The ascorbic acid content was also revealed a great variability in different varieties. Recce (1949) and Mukherjee (1950) reported a considerable variability in the germ-plasm of mango. Terminal growth of panicles was also found responsible for different parameters in mango.

Mukherjee (1951) conducted trials on pollen analysis in mango and obtained that there were variations in the shape and size of pollen grains in different varieties of mango. Lal et al. (1952) during their research trials; found that the Badami variety of Mango contains 52.7 mg/100g ascorbic acid content.

Mathur et al. (1953a) reported that 28 mg/100 g in nature green Raspuri and 39.39 mg/100 g Vitamin C content in Badami variety of mango. Nirwan (1953) and Cheng and Bray (1953) reported that malformation disease intensity increased at advanced stages but at mid and late stages, cultivars showed less intensity of malformation.

Cheema et al. (1954) reported that protein, fat, carbohydrate, minerals, calcium, Phosphorous, iron, vitamins 'A' and 'C' and nicotinic acid present in mango. Except these, it has also importance in plantation and potentialities for nation. Siddappa
Bhatia (1954a) reported that ascorbic acid content present in Rajpuri variety of green mango has its own importance. The ascorbic acid content varied from 32 g to 348.5 mg/100g in green mango variety.

Young and Juliano (1955) studied influence of temperature on growth of mango pollen where they observed that time of flowering of those panicles was the highest. However, the climatic conditions were unfavourable for pollination and development of fruit in certain varieties of mango.

Malik (1957) studied morphology and biology of mango flower and obtained that pollen variability was the highest in Langra variety of mango at early morning, but at noon, it decreased. However, increased slowly again, just after noon, as well as temperature falls down. It has been revealed that after 15 minutes of bursting of anthers, the grains which collected were more viable than the fresh flower. It clearly indicated the climatic effect.

Randhawa and Damodar (1961) studied floral biology and sex-ratio in different varieties of mango and reported that panicles were mixed, which were producing a good crop development.

Singh and Jawanda (1961) observed that there were less capability of growth of Dashehari in Punjab region. Krishnamurthy et al. (1961) studied the growth of mango in Delhi conditions where they found that total soluble solids contents varies in different varieties of mango. It was only due to climatic condition.

Research trials conducted by Cottingham and Susan (1962), Singh (1963) reported that bearing capacity of trees increased by Manuring but its producing capacity of average was not good. Rao et al. (1963) reported that mango cultivars better react in stooling to IBA than NAA. Rooting increased by the mixture of IBA and NAA. When other
growth regulators applied alone did not exhibit any effect but when that growth regulators applied with IBA, showed beneficial effect on rooting (Wilde et al., 1964), Lingraj (1965) and Prasad et al. (1965) reported that mango varieties are gaining popularity with the grower because its higher yield and good returns and for growing them under waste land conditions. Muhr et al. (1965), Jackson (1967) and Pathak and pandey (1976) where they reported that composit soil and leaf samples were collected during the month of September and January in each year and analysed for major and minor elements using standard methods. Sudha and Curtis (1964) studied on the mode of action of malformation and observed that there was no any substance which control to the fungal malformin in mango. Burnett and Audus (1964) carried out trials on the use of flourimetry in estimation of naturally occurring indoles in plants.

Schwartz (1968) and Elechtmann et al. (1970) reported that malformed mango have small, thick main and primary rachises with excessive branching. Mainly malformed flowers were male sterile and larger in comparison to healthy and hermaphrodite flowers. This disease was the major problem by which large amount of mango varieties were found in loss (Malo and Mc-Millon, 1973). Krishnamurthy and Subramanyam (1973) reported Physico-Chemical changes with respect to fruit maturity and quality in different varieties of mango. Chacko et al. (1970) conducted analysis work and reported that due to the presence of auxin and gibberellin like substances mangoes were found to be affected in connection with certain problems including malformation (Sharma and Singh, 1970).
Chadha et al. (1973), Lodh et al. (1974) carried out Physico-chemical studies of some important mango varieties and observed specific gravity of different varieties of mango which ranged from 0.932 to 1.006. It revealed variability in this parameter. Pandey et al. (1974) observed to harmonal regulation of mango malformation and found that in malformed mango panicles, auxins were low and inhibitor had activity was high.

Shant (1975) and Chaturvedi and Prasad (1975) reported that the changes in the growth and development usually occur by the changing in the climatic factors by which production of crop yield also affected. Prasad (1977) conducted research experiment on the behaviour and fruit quality of different varieties of South Indian Mangoes and reported that in Alphanso (21.5%), Allampur Benishan (19.8%), Bangolora (16.4%), Janardan Pasand (19.6%), Jahangir (20.4%) total soluble solids content in these varieties of mango. Chattopadhyay and Nandi (1977) analysed the chemical control of mango malformation and found prosidose and polyphenol compounds which showed malformed inflorescence in Himsagar and Bombay Green increased considerably as flowering infestation.

Bajpai and Shukla (1978) and Ram and Sirohi (1979) reported that the main cultivar of mango was Alphanso. It showed a good condition only in coastal conditions and suffers from spongy tissue disorder in the pulp of mango fruit.

In past it was reported in research trials that malformed panicles have low auxin content in comparison to healthy panicles of mango. In malformed panicles auxin content increased previously but in later stage it decreases so there was no any relation in
between 1973). Auxin level increased with the growth rate of malformed panicle (Singh et al. 1979; Sekhawat et al., 1979).

Due to malformation a large number of flowers was found to be dried up and black colour bunches hanged down but some were grown up continuously upto next season (Nijjar, 1976; Sinh, 1978; Shawky, et al. 1980). Chadha et al. (1980) and Kalra et al. (1981) carried out trials on some mango cultivars for bio-chemical compositions and reported that 17.713 percent total soluble solids were obtained in mango pulp.

Prasad (1983) carried out correlation studies in mango varieties and reported that from the given environment, variability can be measured easily but Phenotypic variability was measured by joints efforts of genotypic and environment which reflects genetic and non-genetic influenced upon the plant development.

Yadav et al. (1983) suggested that the fruit which has total soluble solids, vitamins, all sugars, proteins crude fibre etc. came under good quality. Fruit sugar plays a very essential role, it present in free or derivatives stages in mango.

For the beauty of colour and good taste, mango has attained the top position in all the fruits in the World. There were so many varieties/types of mango so there was great variability in different varieties. Knowledge of morphological characters of plants, flowers, malformation, its role to gametophytes was found helpful for maintaining the situation and purity of a variety. On the basis of its resistance and morphological characters, the variety could easily be identified (Prasad, 1985a, Prasad and Nalini, 1985; Bist and Ram, 1985).
Prasad and Pandey (1985, 1987) studied the physiochemical parameters in mango (*Mangifera indica* L.) and reported variability in variability of pollen grains.

Prasad and Nalini (1987) recommended that dangerous and serious disease of mango malformation has been increasing day by day, by which devastation occurs in the commercial cultivation. So the future of the mango, cultivation will be in dark. Selection of less affected varieties/seedlings and improvement work should be done in different regions.

Prasad (1985) studied the incidence of malformation in 40 varieties of mango considerable variation were observed to be affected with floral as well as vegetative malformation. In the contribution of the fruit aspects, variability and correlation play major roles. Plant growth and fruit setting growth and ultimate yield is affected by abnormal vegetative and reproductive traits.

Kalra and Tandon (1983) studied the ripening behaviour of Dashehari mango in relation to harvesting period where they found useful results. Although, at the time of panicle emergence morpho-physiology of inflorescence was observed changing. Khader et al. (1987) and Khader (1989) observed the effect of de-blossoming on mango malformation, fruit quality, productivity and physico-chemical composition of fruits. In morphological characters new panicles were recorded just like small panicle with few flowers and perfect flower number per panicle of mango.

Srivastava et al. (1987) carried out evaluation of mango varieties in Madhya Pradesh and found that there were so many varieties with variability of commercial nature in that region.
Singh et al. (1989) conducted trials on the effect of time and grading on storage of mangoes and observed at the time of storage, ripening characters of fruit was found to be related to the time of emergence of panicles. Panicles emerged from during last week of December upto first week of February produced fruits which ripen earlier and were small in size. Dietz et al. (1989) studied on structure and development of cuticle and lenticels and loss of weight of mango fruits. They observed that at the time of development and ripening lenticels plays a very important role in exchange of gases and regulate the loss of moisture. They also reported that with the fruit development, number of lenticels was increased. Again they explained positive correlation in between the loss of moisture and number of lenticels.

Prakash et al. (1989) in their preliminary studies reported incidence of powdery mildew in mango panicles and biochemical changes. They observed powdery mildew infection, changes in metabolites of the mango inflorescence which usually take place. This infection has been observed in pH, moisture contents, reducing sugar, tannins and proteins.

Singh (1990) and Ram et al. (1990) in research trials studied the malformation of mango with reference to variety and age of tree and reported the possible factors and affected Panicles were found higher in number in older trees.

Recently, Prasad et al. (1991-94) studied heritability and genetic advance in late varieties of mango and they observed that number of male flowers per panicle revealed the highest heritability 99.99 and genetic advance 331.58 per cent. The next highest heritability and genetic advance
was found in volume of fruit, diameter of second internode and number of hermaprodite flowers per panicle.

Khader (1991) carried out research trials on the control of tree-height, trunk girth, shoot growth and total assimilation in young grafted mango trees by paclobutrazol. He found that paclobutrazol use as foliar spray gave significant reduction in plant-height, trunk girth, shoot growth and total weight of plant at optimum concentration. They suggested that foliar spray of paclobutrazol controlled the growth of trees.

Khader and Pal (1992) conducted experiments on the morphophysiology of inflorescence and post harvest behaviour of mango fruits in relation to period of panicle emergence. They found that early emerged panicles or late emerged panicles were small in size, short life with undesirable shrinkage and weight loss. With the loss of weight and shrinkage and increase in shelf life, the storage quality of these fruits was recorded much better as compared with others.

Khader et al. (1992) observed in their trials that Dashehari mango had an increase in lenticel number and change by epicuticular wax at the time of growth and development. Apical region revealed higher folds in lenticels per unit area.

Teactia and Singh (1991) studied the varieties of Mango, morphological and physio-chemical studies of mango and observed that mango was the national fruit of India. Mango cultivars were found large in number, production and commercially valuable for the country (Singh, 1991). Sirohi and Ram (1993) studied the stooling of dwarf mango cultivars and reported that
different mango cultivars responded differently with different growth regulators and concentrations.

Kumar et al. (1993) and Ram (1991) explained that mites, virus, fungus, mycoplasma, physiological factors etc. may be the main causes for malformation. Use of acaricides, fungicides and other chemicals were failed to control the malformation.

Tripathi and Ram (1994) carried out experiments on the effect of chelated iron and zinc on growth nutrient status and control of vegetative malformation in mango seedling trees. They found that Zn and Fe failed to control the malformation of mango and also failed to reduce malformin contents in the malformed seedlings of mango.

Kalra et al. (1994) studied on screening in mango varieties for processing purposes and reported that varieties which had higher carotenoid contents blended with that varieties which had low carotenoid contents. Mallika variety of mango was suitable for processing having least fibrous large fruit size (320 g). Some other varieties of mango were also suitable for processing.

Bhaghel et al. (1994) studied the morphological and biochemical studies of healthy and malformed panicles of different cultivars of mango and found that the fungus (Fusarium moniliformae) was asserted immediately but it was suggested, due to hormonal imbalanced and antiauxins production in malformed panicles.

In preliminary trials of mango research, Pandey and Ram (1995) found due to the changes in endogenous auxin during floral development of
mango malformation. They observed that acidic, non-acidic and total auxin contents were found lower in malformed panicles in mango. According to them, the deficiency of auxins was the main cause of malformation in mango. Singh and Khan (1995) carried out effect of fertilization on the uptake of minor elements in roots.

Singh and Ram (1995) studied on nutritional status of Dashehari mango as influenced by various inter-crops and found that annual variation in mineral content of mango leaves were noted. Various inter-crops not affected to the nitrogen content.

Khan and Singh (1995) reported that the nutritional status and yield of mango orchards depends upon soil, variety and maintenance along with cultural practices. Similarly, Bhandwalkar and Desai (1995) observed pollination and fruit set in mango cultivar Kesar and reported that 24.4 per cent fruits were obtained by self compatible conditions.

Chaudhari and Desai (1996) carried out studies on the performance of mango hybrid under semi-arid region of Western Maharashtra represented that hybrids No.3/7 was recorded better than the other quality i.e., 2/4 and 1/7. Although commercially Kesar variety was higher than hybrid No.3/7 but its yield was very high so hybrid No.3/7 was considered for commercial cultivation.

Singh and Khan (1996) observed the effect of fertilization on the uptake of major elements in mango leaf Cv. Dashehari and found that their effect on mineral composition of leaf and C.E.C. of root were observed with the higher rate of nutrient application method was much better than foliar treatment.
Singh et al. (1998) and Mishra and Singh (1998) conducted experiments on some varieties of mango for studying the malformation disease. They reported that assimilating enzymes associated with floral malformation of mango and found that the floral malformation. The healthy and malformed panicles of mango. Amrapali and Dashehari were analysed for the activity of Nitrate Reductose (NR), Glutamine Synthetase (GS), Glutamate Synthase (GOGAT) and Glutamate dehydrogenase(GDH). The shoot bearing healthy and malformed buds a full grown panicle and bud the level of NR is found less. However, at stage of full bloom it was higher by 10-18 per cent.

Chakrabarti and Kumar (1998) conducted experiment and studied the epidemiology of mango malformation and obtained that the various aspects of epidemiology including appraisal of loss in yield. Pattern of the epidemic and Spatial pattern of its spread.

Selvaraj (1998) conducted experiments on Alphanso mango. He found that Alphanso mangoes fruits is of great economic and scientific interest as the onset and the progress of this disorder is not clearly understood. In order to elucidate the causes, systematic bio-chemical investigations were undertaken and useful results were reported for certain aspects.

Mishra et al. (1998) commended to spray of carbendazim for the control of mango malformation and obtained that the malformation of mango, a century old problem is wide occurring in the north west part of India. One of the strong causes considered for the disease of its fungal etiology, i.e. Fusarium moniliforme var. Subglutinans. In vitro evaluation revealed that the pathogen grows well at temp. range of 15-25°C. Carbendazim was found to check the growth of F. moniliforme var. Subglutinans completely
at 0.1 per cent in vitro test. Considering the fact, a trail was laid for the control of malformation with spray of 0.1 per cent carbendazim at 10,15 and 30 days interval starting from October to Feb. during the flower bud differentiation stage and when the average maximum and minimum temp. started decreasing. Control of the malformation was upto 76.93 per cent in 10 and 15 days spray schedule while it was 65.39 per cent in 30 days spray schedule over control.

Dob et al. (1998) and Chander et al. (1998) studied malformed inflorescence of mango and obtained that the number of leaves/shoot, leaf area/shoot, percentage of hermaphrodite flowers, length of panicle and number of branchlets/panicle were significantly higher in healthy panicles. Basal diameter of main rachis and total number of flowers/panicle were observed markedly higher in malformed panicles than in healthy ones.

Singh et al. (1998) conducted the research trials on the effect of NAA and other chemical on floral malformation, flowering and fruit set in mango and found that NAA 200 ppm, COSO₄⁻ -1000 ppm, NiSO₄⁻ 440 ppm and AgNO₃⁻400 ppm were evaluated against floral malformation. Maximum reduction in the occurance of malformation single spray of COSO₄⁻ (73.43%), AgNO₃⁻ (54.69%) and K₂S₂O₃⁻ (43.63%) over control treatment.

Pandey and Pandey (1998) recorded the effect of three sprays on physiological changes in floral buds of mango and found that mango malformation is a serious threat to the mango industry and occurs widely in India as well as many other mango producing countries of the world. Kumar et al. (1998) studied floral malformation in the Cv. Chausa by regression analysis. In 32 plants, contents of micronutrients C/N ratio, mangiferim and Auxin and population of Fusarium moniliforme prior to flowering were
estimated in addition to vegetative malformation and total emerging panicles.

Thus, foregoing review of literature indicated to take up planned experiments for studying present project on mango plant material.