CHAPTER II
REVIEW OF LITERATURE

Mango, the king of fruit is an evergreen fruit crop of tropical and sub-tropical climate. It has great economic potentialities as it fulfils the following human requirements: Nutritional, medicinal, commercial, industrial, religious, etc. Its young unripe fruits earn high prices in the market for their culinary preparations and pickles, chutney, amchur, whereas ripe fruits are eaten as a fresh table fruit or are preserved in different forms like canning, juices, squash, jam, gellies, murraba and am papar. The fruit contains protein fat, carbohydrate, minerals, calcium, phosphorus, iron, vitamin A and C, riboflavin and nicotinic acid (Cheema et al., 1954 and Singh and Singh, 1960). Besides, it has a great importance in utilising its plantation potentialities in the unused common lands, saline soils, other waste land etc. The plantation potentials can also be improved by planting seedling mangoes in the interior of the villages, roadsides of the highways and interior roads, at the bank of ponds, lakes, canals, etc., in villages. This may certainly help to engage the poor villagers from March to August every year. Their families including children may also be utilised in its watch and ward. In this way our nation may solve the food problems of the poor citizens.

A lot of work has been done on the different crops for their improvement where emphasis has also been given for Mango (Prasad, 1969, 1970, 1977, 1982, 1983, Prasad and Malini, 1986).
Recently in pollen grain studies a lot of work has been reported by the scientists engaged in the horticulture crops (Bajpai, 1952, 1957; Disttaglia, 1957; Beeker, 1932; Brink, 1924; Crane and fawrence, 1947; Crawford, 1937; Ghai and Charia, 1976; Kapur and Bajpai, 1976; Kausik and Rao, 1942; Keller man 1915; Khan, 1954; 1959; King, 1963, King and Nense, 1938). Pollen shape and size have the interesting results. There is a lot of variation in the several aspects of pollen grain studies. Pollen is remained to the certain results where an useful work has been reported by the research workers who were engaged in this field (Koller, 1943; Kozma, 1958; Liyanagl, 1949; Martin, 1959; Mclanta, 1967; Mauriyal, 1952; Nayer, 1953; Nekel, 1939; Pancher, 1938; Panchakoharappa and Nalini, 1976; Panchoksharappa and Rudramaniyappa, 1976; Pool and Crimball, 1939, Porting, 1956; Pospiselova, 1964; pope, 1930; Prasad, 1962 a, 1962 b).

In the investigations of pollen grain viability, a good number of research findings have been reported (Prasad, 1963, 1963 a, 1963 b, 1964, 1966, 1966 a, 1969a; Prasad and Pandey, 1969; Prasad and Prasad, 1969, 1978; Prasad and Batham, 1975; Prasad and Tyagi, 1976; Prasad and Singh, 1980; Rajput and Singh, 1967; Raj, 1962).
Biennial Bearing Rhythm:— As early in the year 1950 Abul Fazal while giving an account of mango fruit in Ain-i-Akbari mentioned that some trees yielded a heavy crop in a year and light one in the next, while other produced one year and not in the following year. Afterwards it was confirmed that mango trees did not bear a heavy crop only in every alternate year Burns and Prayag, 1920. Alternate bearing was found to occur with most trees. Some workers believe that bearing habit of mango is an acquired character and can be corrected by resorting to proper cultural practices (Singh, 1958). All the factors cultural practices growth, flowering, fruit set, and total yield should be taken into account for bearing habit (Oppenheimer, 1947). Mango is a heterozygous fruit and its cropping pattern depends upon the several factors (Annon, 1946; Bailly and Miller, 1904; Higgins, 1943, Mathur 1958; Roy 1954; Sayed 1959, Singh 1963).

The mango tree starts the biennial bearing rhythm even from its early stage of fruiting for the first time (Malik 1961; Sen, 1943; Sen, 1946 and Singh, 1962). It was also reported that biennial bearing rhythm sets in at the age of 10 years or more (Khan, 1960). However, Gandhi
(1955) and Singh and Khan (1940) reported that young mango bears a regular crop. Although not of the optimum quantity every year and later on starts biennial bearing when the tree attain the age of 10 or 12 years.

The measurement of biennial bearing habit in the mango varieties is very difficult task. It can be assessed through the measurement of the yield of a certain variety on the successive year yield basis for a period of several years. But this scale of measurement seems not to be very accurate for the different sets of trees (Bajpai, 1965). Hoblyn et al. (1936) evolved a method to assess the intensity of biennial bearing habit and it has been fully described by Singh (1948) for measuring the intensity of biennial bearing in mango. The intensity is calculated for each pair of year by the formula given below.

\[ I = \text{Difference between successive yields} \]

Sum of successive yields where 'I' stands for intensity of the whole period for a particular tree.

2- Role Growth cycle: Growth cycle plays and important in fruiting of mango (Sen, 1957; Singh, 1958). Vegetative shoots are produced in different flushes and after attaining a certain age they give rise to the reproductive flush for bearing. These growth flushes emerge in different months in different parts of the country (Gandhi, 1955); Roy (1953, Singh 1961).
Burns and Prayag (1921) reported that the cold weather, hot weather and raining season growths produce in inflar-ergence in western parts of India. Krishnamurthi et al. (1961) reported 5 cycles of shoot growth in Dashehari a and Chausa where main growth flush took place in March to May and 8-10 months old shoots were found better to produce better panicles than the younger ones.

Golang and Lazaa (1935) reported that shoot has to attain a certain length, girth, number and size of leaves for producing panicles. However, Singh (1959) observed no relation-ship between length, girth and number of leaves per shoot regarding to flower bud for-mation as the fruit bud differentiation can take place from any point of the tree and its stimulation is ir-re-spective of the size and maturity of the shoots.

Potentiality of shoot or maturity:-- Shoots which appeared early after shedding their blossoms and having desirable extension of growths, have the greater poten-tial to produce panicles in the coming season Buell (1954), Naik and Rao (1942) and Nakasone et al. (1955( ). Mango variety Meelum and Swarnrekha gave rise to shoots as late as October with the potentiality to produce flowers in February (Burns and Naik, 1954). However, it has been emphasized that the mango shoots must cease
their growths early in order to give rise to flowers in the coming season (Khan, 1940; Naik and Rao 1942; Sena and Malik, 1941; Singh and Khan, 1939, Singh 1946. Shoots which appeared in February-May flush attained the physiological maturity for producing the flower panicles.

Previously the effect of shoot maturity on flowering was emphasized (Galang et al. 1935, Khan, 1960; Malik, 1953; Roy 1953 and Singh 1956). But recently some evidences are found against this theory; at least in the case of regular bearing varieties, where shoot maturity is not at all a pre-requisite to flowering Gangolly (1960) and the flower formation is governed by the 'off' and 'on' year conditions rather than the age of shoots Singh (1957), Singh (1959) reported that the type of shoots extended and unextended in biennial bearing varieties from the flower buds in the 'on' year while in 'off' year there is no fruit bud formation in the both the types of shoot. 'off' and 'on' year phase seemed to determine the formation of fruit buds in mango through some special mechanism in spite of the shoot growth Singh and Singh (1963).
**Fruit Bud Differentiation:** Fruit bud differentiation is a prerequisite stage for the development of a panicle. Chandler (1925) reported that it was not certain to conclude how long a bud sets in a condition that it may be caused to lead to fruit bud differentiation, while Singh (1956) found that the fruit bud differentiation and development is a continuous phase and takes a period of about one month. However, Reece et al. (1949) observed that differentiation begins within a very short period of the development of terminal buds in mango variety Haden and the process of differentiation goes on continuously with the time of bud expansion. 

Lanuza (1939) observed no definite floral characteristic to distinguish between a dormant flower and a vegetative bud, while Juliana and Cuevas (1932) found that floral parts develop in the order of calyx, corolla, stamens, pistil and finally ovules. Histological and morphological studies made by Singh (1959) revealed a clear distinction between flower and vegetative bud development and its different organs in the order of calyx, corolla, stamen-staminodes, corpel and disc except Barama variety.
Time of fruit bud differentiation: The times of fruit bud differentiation vary in different parts of country (Sen, 1939; 1942; Singh, 1960; Singh, 1954). In Florida fruit bud differentiation took place in the month of October and November Mustard and Lynch (1946), Reece (1939) and Sturrock (1934). Dry summers are more conducive to flower bud formation in the wet zones Hooker and Bradford (1921). Time of fruit bud differentiation ranges from middle of August to end of October in Punjab (1960), Reece, 1949 Mubhib and Dinsa, 1946; Sen and Malik, 1941) found the critical period of flower bud differentiation in October and first half of November in Bihar conditions while it was noticed after mid November and reached to its peak by mid December for Himsagar and by the end of December for Langra in Bengal condition (Sen and Guha, 1963).

Physiological aspects: Flowering is a pre-requisite to fruiting and fruit bud differentiation is pre-requisite to flowering. Fruiting depends on the nutritional status of the particular shoot along with the other factors. Carbohydrate nitrogen ratios and their increase or decrease content in the shoots play an important role in bearing of mango. For formation productive flush, a mature shoot should have its carbohydrate content much greater in
proportion to nitrogen bud when nitrogen is more than carbohydrates the shoot will certainly produce gevetative flush (Sen, 1946).

The problem of biennial bearing should be tackled from the point the physiological changes connected with the emergence of panicles Bajwa et al. (1956). Seasonal variation in the carbohydrate, nitrogen content were studied in Langra shoots by Naik and Shah (1937) for the first time. A sharp rise in carbohydrate content in the mango shoots in the period from October to November was reported which was considered favourable for fruit bud differentiation in the mango Malik (1953), Sen (1951).

Reece et al. (1946) reported that the flower inducing hormone determines the course of fruit bud differentiation of the tissue. Singh (1960) and (1960) studied the nutritional, biochemical and chemical composition factors of the shoots and found a high content of starch and total carbohydrates at the time of fruit bud differentiation and these appeared to favour the flower bud formation.

Tree vigour and nutrition; It is an accepted fact that in the 'on' year the fruits are generally harvested in
in June-July and thus the tree exhaust their reserve, further to give rise to new shoot growth for bearing fruits in the 'off' year and the tree can not replace their reserves since can not grow as long as there are fruits on them (Bajpai, 1965; Gandhi, 1955). Popono (1939) observed that crop failures sometimes occur due to the variation of soil moistures and to some extent of food supply while Roy et al. (1951) reported that the biennial bearing is caused due to nutritional deficiency which may be brought into order by application of manures. In Florida, Young (1942) found that the content of internal nutrition factors and moistures were not the main cause of unfruit fullness in mango variety Haden.

Singh (1959) in chemical composition studies of the bearing shoots had higher nutrients value than the non-bearing ones in respect of CaO and MgO in Bashehari and CaO, MgO, N, and P2O5 in Langra and concluded that biennial bearing in mango is initiated by some factors other than mineral nutrients. Nutritional factors of the shoots can not be correlated with a fruit bud formation (Singh, 1960), whereas, higher starch reserve, total carbohydrates content and carbohydrate-nitrogen ratio in the mango shoots at the time of fruit
bud differentiation was recorded. Singh (1960) observed a high content of dry matter linked up with the period of fruit bud differentiation which appeared due to the accumulation of carbohydrate.

Singh (1960) reported that biennial bearing of mango is a varietal characteristic and it comprises of strongly biennial, partial biennial, regular and extra-regular. Singh (1961) further reported that trees of regular or extra-regular varieties are less vigorous than the biennial ones and inferred that vigour is a measure of the biennial bearing habit of the variety and more vigorous in the variety the more biennial tendency it has. It was found that soil group also affected the vigour and cropping behaviour of mango tree (Iyenger, 1954; Krishnamurthi, 1954).

Role of Auxins :-

(a) Formation of auxins in leaf :- Auxins are produced in the leaves which are responsible for fruit bud differentiation in mango (Reece et al., 1946; Reece, 1949; Sen, 1939, 1942), and Singh (1956) and Chandler (1950) are of opinion that hormone induce flowering in plants and the source of hormone are leaves or some precursor
formed in the leaves, then leaf surface rather than accumulation of carbohydrates might be having dominant influence on flowering and further he reported that if hormone or some such substance is necessary for induction of the flower bud, then a fairly definite age and physiological condition of leaf may be necessary for it to induce flowering. Singh et al. (1962) and Thiman (1952) indicated that newly emerged leaves may generate the flowering stimulus in shoots of the regular bearing varieties like Neelum and Romani. Flowering depends on some sort of flowering stimulus transmitted by the leaves to the apical or auxiliary bud Singh (1959). Singh (1960) advocated a hypothesis that flower induction can take place only when cell division has started and that a flower inducing hormone plays no part in the initiation of growth but its presence in sufficient amount at the beginning of growth determines the course of differentiation of the tissue in the auxiliary buds.

Plant growth regulators affect the flowering of mango (Sen et al., 1963; Singh, 1961) sprayed GA (50-100 PPM) and MH (0.4 - 0.6%) and observed that a crop might be taken by the use of GA even in the "off" year. Singh and Singh (1963) tried NAA 2,4,5-T; 2,4-D (25-500 PPM) and MH (0.05-5.5 %) in Punjab and found that 2,4,5-T
significantly reduced fruit yield in 'on' year with only small compensation in the succeeding 'off' year while NAA, 2,4-D and MH showed very little effect on panicle emergence on new shoot growth during the following 'on' year.

Movement of Auxins: Flower inducing substance is generally transmitted from the leaves to the auxiliary bud when inhibiting effect of the terminal bud is removed. Reece et al. (1946), Reece (1949) and Singh (1959) observed that the flowering hormone used to move in all the directions in stock and by its effect seedling flower even in absence of leaves on them. It has been shown that a young mango seedling can be made to flower and fruit if grafted to a comparable stock of the bearing tree and given additional treatment of edefoliation along with the girdling of the scion shoot below the union.

Cytological and genetical causes: Regular bearing varieties can be evolved to overcome the biennial bearing tendency in mango. Bose, 1961; Malik, 1961; Mukherjee, 1950; Naik ad Rao, 1942 Singh, 1958. Besides environmental and physiological factors related to biennial bearing of mango varieties, this factor is controlled by genetic factors. Varieties, dalma, sukul and other have
been found to be regular bearers even under the same soil and climatic conditions of bearing (Ali and (Mazhar, 1960; Amin, 1966; Burns and Prayag, 1910; Roy, 1953; Singh, 1960; Tamhankar, 1912). Naik (1941) reported that trees of some particular variety in an orchard may be low yielding or sterile while other trees of the same variety in a new orchard may bear heavily.

Sex Ratio: The sex ratio plays an important role in determining the crop yield and the varieties producing maximum perfect flowers are usually more prolific bearers (Singh, 1961). In mango, pollination is essential for fruit setting and it is mainly performed by insect pejong (1934), Marloth (1947), Bi-Jhouvet (1937), Mukherjee (1951), Wagle (1929) and Singh (1954) reported that 50 per cent or more of the perfect flowers remain unpollinated in nature while Spencer and Kennard (1955) observed the low fruit set due to failure of gynaeceum to develop properly and reduction in viability of the small quantity of pollen produced by low humidity, high temperature and bright sun light. The variations were observed in the distribution
of perfect flowers on the different portions of panicles, and low and high ratio which lead to the low fruit set in mango (Anonymous, 1956-57; Bhujanga and Ramgacharlu, 1956; Hartless, 1913; Majumder and Mukerjee, 1962; Randhawa, 1961; Reece, 1958 and Venkataratnam, 1954). Waik et al. (1956) found that many of the flowers not pollinated at all and the restricted pollinations have adverse effect on the yield. Maheshwari (1934) in North India and Penelope (1917) in Florida found that the percentage of flowers which form mature fruits was less than in mango. Mukharjee (1953) found that the failure of pollen germination on stigma might act adversely whereas as Waik and Rao (1942) obtained better fruit setting by the varietal combinations in pollination in case of south Indian varieties. These essential reproductive organs of the mango flower were observed quite normal and healthy by Mukharjee (1946). But Singh (1954) reported various degrees of ovule disintegration, while in Florida, Young (1921) observed degeneration of embryo sac and in Phillipines
Pudgeon (1929) observed the loss in fruit set caused by flowers having abortive pistile. On the basis of sex ratio variety Simmonds and summer bahist Chausa were reported for prolific bearing habit Singh (1961). Similarly Ledin (1958) reported that palyembryonic philippine mangoes are reliable bearers and generally produce heavy yields, often fruiting in clusters. The high percentage of perfect flowers (40 to 80%) probably accounts for the heavy bearing.

Mixed panicle: Production of mixed panicles is favorable for regular bearing in mango Malik (1961). Mango varieties showing annual bearing tendency produce a high proportion of mixed panicles than the irregular ones. Chandler (1950), Sen (1943), Singh (1960) and Randhawa and Pmmodaran (1961) observed mixed panicles in Baramasi and Chausa, Pashehari and Krishna Bhog varieties. Thus this has got an important role for crop improvement.

Climatic factors: Climatic conditions may be taken into consideration as some factors which cause the biennial
bearing in mango and play an important role in its cropping (Cheema, 1948; de varies, 1931; Murti and Jogiraju, 1932; Roy, 1941). Climatic factors are associated with the biennial bearing of mango in two ways, either by directly damaging the fruit buds and crop or by creating such conditions which directly destroy the flower or fruit. A dry season, immediately preceding the period of blossom emergence is helpful for early cessation of vegetative growth which is a prerequisite for flowering in mango (Gunaratham, 1945; Holdsworth, 1963; and Marloth, 1947). It was found that for optimum cultivation of mango, the absence of very low temperature is essential (Allan, 1935; Anonymous, 1956-57; Gangolly et al., 1957; Oppenheimer 1947).

The drop in temperature during the height at bloom period inhibits the growth of pollen tube (Aoharkar, 1946; Young, 1956-57; and Young, 1957). Singh and Singh (1954) found that when air temperature dropped to 31°F, fruit bud at all stages killed out, and bloom was completely damaged. Formation of buds is affected by a
prolonged cold season harmless (1914). Prost showed a considerable effect on biennial bearing in the varieties singhara and vijai Raogarh singh (1960). Harris (1901) observed that the tree after flowering profusely, but fail to set fruit as the pollen, owing to excessive humidity is never in a suitable condition for cross-pollination. Disease like blossom blight during certain years are chiefly responsible for the failure of crop and thus induce irregular bearing singh (1957). In Guatemala, almost all the blossoms were attacked during rainy season palm (1932), while in Florida, disease becomes a limiting factor in rainy or foggy season west (1934). Insect pests and diseases play an important role for mango drop and they cause severe damage and induce irregular bearing (Baker, 1936; Mckes, 1940; MC. Murran, 1914; Rao, 1930; Sen, 1939). Insect cause 60 per cent to total failure of crop in India Singh (1954) and South Africa (Amin, 1966). Control of biennial bearing; There is no doubt that planned orchard management plays an effective role for mango cropping. Intensity of alternate bearing can be controlled by a considerable extent with proper planning.
and orchard management (Teotia and Srivastava 1960) and Venkataratnam and Sriramamurthi (1961). Cultural practices like mulching of their application also affect the absorption of nutrients and cropping of the mango (Hayes 1963; Lynch and Mustard 1950; Malik 1961; Roy 1954; Tripathi 1961).

Singh (1959) suggested that in India mango should be manured during the pre-bloom period also, as alternate bearers are supposed to suffer from malnutrition (Gasg 1960; Malik 1951 and Roy et al. 1951). Ruehle (1949, 1951) suggested application of N or N and K at the appearance of flower panicles first, followed 3 or 4 weeks later and again during the summer by complete N-P-K mixtures, as N controls the uptake of other elements and determines growth and shows the greatest effect in combination with P and K. In the year the ammonium sulphate dose should be doubled to force July-August shoots which mature and flower during the successive 'off' year Malik and de (1952), Sen (1946), Ledin and Malcolm (1956-67) found that Haden and Zill...
varieties, fertilized in winter, spring and summer continued
to yield more than when fertilized in spring, summer and
autumn. Attempts should be made for inducing sufficient
vegetative growth early in season of on year by cultural
practices burns and prayag (1921), gandhi (1955) and
katyal and chadha (1960).

Cultural practices such as root pruning, applications of salt and incision in the bark are also useful
(khan,1860; sen, 1933, shah,1960). Firminger (1884) is of
view that roots should be exposed for 2-3 weeks in november
and covered with fresh earth and manure in december to have
some use on biennial bearing habit. A favourable response of
cultural practices on flowering and fruiting have been
recommended for a good crop as they encounter the biennial
bearing in mango (bhat,1939; cheema,1948; peandole,1948;
ragambar,1915; fawcett and Harris,1901; firminger,1904;
1930; guratnam,1946; miranda,1916; malk,1937; pumans
1931, popanoe,1911,1913; prayag,1913; robinson,1928;
ratha,1911; sen,1944; woodhouse,1909 and woodrow,1904).
mango crop are sometimes severely damaged by insect pest and diseases etc. In the 'on' year and with the results the new shoots appear and give rise to panicles in the next year (Bajwa, 1956; Khan and Khan, 1960; Naik, 1946; Padmanabha, 1944; Rao, 1930; Singh, 1954; 1954, 1957 and Wagle, 1934). However, Singh (1961) concluded that biennial bearing habit of mango can not be prevented by restoring to manuring, irrigation, pruning and control of pest and emphasized that the real cause of biennial bearing is not yet known and till it is fully discovered, no 'hit and miss' method is likely to solve the problem, therefore the first attempt of the scientist engaged in this field towards the control of this phenomenon will be to determine the exact cause of fruit bud differentiation.

Deblossoming: Deblossoming early in the season induces the shoots to grow in the same season and produce fruits in the coming season (Iyengar, 1954; Singh and Khan, 1939 and Singh, 1946). The response to deblossoming appears a varietal feature as Pashehari respond fairly while Langra fails to show
the same response (Singh et al., 1940; Singh, 1960 and Singh, 1961).

Singh (1958) observed that half deblossoming of mango trees as an orchard practice is useful only to the extent of uniform spread of the biennial bearing orchard while Sen (1952) advocated that deblossoming, defruiting and branch ringing in 'off' year have response to bearing habit of mango.

Defoliation and decapitation: Rao and Muthusamy (1955) observed in Mulgoa variety that removal of scion shoots grafted showed its effect as a girdling and decapitating for inducing the axillary buds to differentiate the inflorescence. Defoliation may prove useful as a corrective measure for regulating the bearing in mango as it is cheaper and easier to practice (Singh, 1957; Singh, 1959).

Ringing and girdling: Ringing or girdling involves the removal of a ring or bark from the trunk or branches of a tree Malik (1951) and this has been practiced for many years particularly in Europe as a means of inducing
flower formation Courley and Houlett (1946). Flowering was increased substantially by girdling in October Gaskin (1963), Sen (1944). Ringing raised C/N ratio of the branches to force them to flower in "off" year, and practice was recommended for best results in early August (Ali and Ma-zhar, 1960, Wagle 1928, 1929) recommended girdling as a means to obtain flowering in mango.

Hybridization: There is no doubt that periodicity exists in most of the varieties and may be of inherent character, and it may be overcome by evolving new varieties through hybridization (Chander, 1950; Kinman, 1918; Mukherjee, 1946; Singh, 1961; Singh, 1958; Singh, 1958; Taeotia 1961). Singh (1961) suggested that regular bearing species of Mangifera should be introduced from other countries of the world and interspecific hybridization should be taken up. In North America alone above 70 research stations were engaged in fruit breeding work. Several new fruit varieties and hybrids have been evolved which have given better performance by way
of higher yield, superior fruit quality and resistance to disease and pest Alderman (1948). In Cuba Popenoe (1915) reports the possibility that occasionally variation may be found due to cross pollination in case of pelyembryonic varieties of mango. Singh (1961) reports that the hormone are generated by the genes. The remedy will therefore actually lie in regaining the old genetic setup which determines balanced growth and fruiting from season to season and the best way is the evolution of new plants forms through the cross breeding of existing irregularly bearing varieties with the regular ones.

In India early as in 1885 Lahiri (1885) reported that most of the famous varieties of Murshidabad mango had been evolved by cross pollination of Maldha and Choona Khali varieties. Genus Mangifera has allopeloid nature Mukherjee (1950). Taking the base of cytology, Mukherjee (1950) concluded that primitive types which
gave rise to mango varieties originated through allopolyploidy, most probably through amphidiploidy and the further differentiation of the various varieties has taken place primarily through gene mutation (Huete, 1960; Singh and Singh, 1940). Roy and Visweswariah (1951) are also of opinion that inter-varietal hybridization in nature may be another important factor in the production of new mango hybrid to attack of fruit fly and borer. New early or late maturing mango of high quality with good keeping quality as well as having regular bearing tendency can be produced through hybridization (Allan, 1935; Gallagher, 1954; Juliano, 1960; Juliano and Cuevas, 1960; Pope, 1929 and Wolff, 1960). Of 39 varieties originated in Florida a few have the desirable characteristics of commercial varieties Ruhle and Ledin (1960). Attempts were made in West Indies to combine the good qualities of Indian mango with the indigenous types by artificially crossing them Brooks (1912). In India Burns and Prayag (1921) were the first to report
artificial crosses from poona (Naik, 1948), sen et al. (1946), sturrock (1944), traub and robinson (1938) and young and ledin (1954) attempted crossing and have produced a few hybrids of promise. planned hybridization work in india was attempted at kodur (Naik 1948). In Lagalpur, roy (1951) and singh and jawandah (1963), sabour sen et al. (1946) and saharanpur, singh (1957) reported the same. two promising hybrids, one each of the cross, neelum x hymaguddin and swarn rekha x jahangir have been evolved at kodur. mahumud bahar and prabha shanker hybrids have been evolved from the cross of bombay at kalapady at sabour (roy and singh, 1956); which have been appealing characters. At saharanpur, the hybrids of pashehari and romani have been evolved which combined in, the good qualities and they are under observation.

Manila from mexico, Cecil from cuba, Cambodian and saigon from Indochina were introduced to florida all are pollyembrgonic and are generally better producers than the
Indian mangoes and some like saigon types are regular bearers and are resistant to anthruchose. The Edward and Simmonds are considered crosses of Haden x Carabao and Semini which is a cross between Saigon x Amini made by Edward - Simmonds of the United States. Plants introduced garden in Miami in 1920 (Ledhin, 1958).

Smudging: The practice of smudging, depending upon climatic conditions, has been reported as a means to induce flowering. The mango trees are smudged day and night for a week and thereafter in the morning and evening for a month's time. Suitable period for smudging is October and December. Smudging heat, not the smoke, helped to induce flowering in non-bearing trees (Alcala and San Pedro, 1935; Barja and Putista, 1932; Dejong, 1934; Gonzalez, 1923; Lanuza, 1939; Western, 1929; and Wolfe, 1960). A well planned research project should be carried out assess the responses of smudging treatments to mango tree (Cheema and Naik, 1954; Galang and Agati, 1937).
propagation; regular bearing varieties can also be obtained through propagation (nejong, 1934, 1934, garg, 1960; prayag, 1920). Role of polyembryony has a good deal of scope and stock from polyembryonic varieties should be taken for the regular bearing varieties (horn, 1943). In Florida, brooks, haden, eldon and smith varieties have been evaluated and in ceylon stocks of certain varieties have been selected for propagation. Besides the utilization of apogamic seedlings has also been recommended by webber and degree of apogamym peach variety is about 100 per cent which is valuable for vegetative propagation (webber, 1931).

grafting and double grafting; the desired change in the bearing habit of mango can be sought through the alternative method of stonic studies webber (1931). Among the root stocks may also be included mango spp other than the indica as may be observe to possess the desirable characteristics of growth and regularity in the bearing
It has been reported that wild mango pulima is a very hardy, vigorous one and the trees grafted on it bear profusely and regularly in Ceylon (Gunaratnam, 1946). Similarly, Grant and Williams (1949) found that to be very good for the grafting of Indian varieties in Burma. Double grafting is believed to suppress excessive vegetative growth of the tree making it a dwarf and hastening and regulating the bearing. Double worked tree are generally of dwarf habit.

Cheema and Naik (1954) and Singh (1960) also observed that dwarf mango trees have generally less tendency towards alternation. This field also needs more intensive research than it has so far received (Singh, 1960).
Negi et al. (1982) and Prasad and Nalini (1985) reported that the variability in the available germplasm is very helpful in formulating a successful breeding programme for crop improvement. So before starting any breeding programme, it is very necessary to select the proper population. The selection of proper population depends upon the genotypic and phenotypic variability of the germplasm. The measurement of variability in a population is an important aspect. Variability in a given environment can easily be measured but the phenotypic variability is determined by the joint effects of genotypic and environment which reflects non-genetic as well as genetic influence upon the plant development (Prasad, 1970; 1985).

Like above, Heritability measures the value of selection for a particular character. Heritability value itself does not account for the magnitude of absolute variability and heritability along with genetic advance is essential and more useful than the heritability alone (Johnson et al., 1955; Prasad, 1985). The correlation coefficients of different parameters are useful assessments which give the basis for selection of desirable varieties strains where genotypic correlation is considered very much
useful in the construction of selection indices, which permits the production of correlated response. Correlation coefficient further permits the evaluation of the relative influences of various characters (Al-Jibouri et al., 1958; Prasad and Nalini, 1985; Negi et al., 1982).

Studies on morphology, varietal performance, reproductive organ, variability, heritability, correlation coefficients of different species and varieties of Mangifera are the important aspects which finally help in recommending them for improvement and cultivation to produce the improved quality of plant with attractive quality of fruits.

There are certain relationships in the plant characters. Some of them are apparent and some of them have been reported in their indirect relationships which neither become open to all the aspects but remain very much indirect relationship (Prasad, 1985; Prasad and Nalini, 1986). Such characters are found to matter the crop improvement programme and they are studied in path coefficient analysis. Therefore, path-coefficient analysis has been considered essential in the biometrical investigations. Such studies have their own importance in the fruit crops (Negi et al., 1982; Prasad, 1970, 1985; Prasad and Nalini, 1985).

There is rich germplasm collection of species/cultivars in our country. So promising ones can be selected. Thus realising the importance of this plant and its problems it was considered desirable to undertake the investigations on mango (Mangifera indica L.).