“Study on flowering and fruiting behaviour of mango cultivars in relation to weather parameter. (Temperature, Humidity, Wind, Sunshine)”

THESIS

Submitted to the

Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur in partial fulfilment of the requirments for the degree of

MASTER OF SCIENCE
IN

AGRICULTURE
(HORTICULTURE)
FRUIT SCIENCE

By

MANOJ KUMAR MANAV

Department of Horticulture
Jawaharlal Neharu Krishi Vishwa Vidayalaya, Jabalpur
College of Agriculture
REWA (M.P.)
2013

CERTIFICATE- I

This is to certify that the thesis entitled **"Study on flowering and fruiting behaviour of mango cultivars in relation to weather parameter. (Temperature, Humidity, Wind, Sunshine)"** Submitted in partial fulfillment of the requirements for the degree of ***"MASTER OF SCIENCE in ARGICULTURE' of the Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur*** is a record of the bonafide research work carried out by ***MANOJ KUMAR MANAV*** under my guidance and supervision. The subject of the thesis has been approved by the Student's Advisory Committee and Director of Instructions.

No part of the thesis has been submitted for any other degree or diploma (certificate awarded etc.) or has been published/published part has been fully acknowledged. All the assistance and help received during the course of the investigations have been duly acknowledged by him.

Place: Rewa

Date:

(Dr. Jagdish Singh)

Chairman of the Advisory Committee

THESIS APPROVED BY THE STUDENT'S ADVISORY COMMITTEE

Chairman	(Dr. Jagdish Singh)	…….....
Member	(Dr. Rajesh Singh)	.....
Member	(Dr. S.K. Payasi)	……
Member	(Dr. A.K. Jain)	.....

CERTIFICATE- II

This is to certify that the thesis entitled **"Study on flowering and fruiting behaviour of mango cultivars in relation to weather parameter. "(Temperature, humidity, Wind, sunshine)"** Submitted by ***Manoj Kumar Manav*** of the Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur in partial fulfillment of the requirements for the degree of ***"MASTER OF SCIENCE IN AGRICULTURE*** in the ***Department of Horticulture, Fruit Science,*** College of Agriculture, Rewa (M.P.) has been, after evaluation, approved by the external examiner and the Student's Advisory Committee after and oral examination on the same.

Place: Rewa

Date:

(Dr. Jagdish Singh)

Chairman of the Advisory Committee

THESIS APPROVED BY THE STUDENT'S ADVISORY COMMITTEE

Head of the Section & Chairman (Dr. Jagdish Singh) .....

Director of Instruction (Dr. P.K.Mishra) .....

ACKNOWLEDGEMENT

The author of this manuscript expresses the deep sense of adoration towards the Omniscient and Almightily God who gave him this opportunity of doing M.Sc. (Agri.)

I express gratitude and indebtedness from core of my heart towards my honorable guide and chairman of my advisory committee ***Dr. Jagdish Singh***, Professor (Horticulture), College of Agriculture, Rewa for his constrictive and valuable guidance during the course of investigation and preparation of this manuscript.

I am highly obliged to the members of my advisory Committee, ***Dr. Rajesh Singh***, Deptt. of Horticulture. ***Dr. S.K. Payasi***, Deptt. of Plant Breeding ***Dr. A.K. Jain*** Deptt. of Mathematics and statistics college of agriculture, Rewa for their relevant guidance, valuable suggestion and necessary help provided during the investigation period.

I own a special debt. of gratitude of ***Dr. M.S. Baghel***, Dean, College of Agriculture, Rewa (M.P.) who provided necessary facilities during the course of present investigation.

Thanks are also due to ICAR, New Delhi for providing experimental facilities and funds to conduct the present investigation.

I express my most cordial thanks to ***Dr. P.K. Jain*** Prof. & Head, Department of Horticulture, College of Agriculture Jabalpur, ***Dr. U.S. Bose***,

Associate professor, Deptt. of Horticulture, and ***Dr. T.K. Singh***, Scientiset, FRS, Rewa., ***Shri. D.B. Singh*** College of Agriculture Rewa

I feel duty bound to express my sincere thanks to ***Dr. P.K. Mishra,*** Director of Instructions, JNKVV, Jabalpur, for their valuable cooperation and providing necessary facilities during the course of this investigation.

I Also thankful to the cooperation of Shri Chatrasal Pandey, S.K. Mahobia. I Express my cordial thanks to my father Shri Bheemsen manav, Mother Smt Madhu manav, Wife Pinki Manav,Brother Vinod manav, Vivek Manav .

I Express my thanks to Shri V.V.Verma, G.S.Verma, G.P.Bagma, G.M. Saheb, R. S. Kushwaha, G.C.kushwaha, Smt Sita Kushawa.

I also appreciate the co-operation and encouragement received from my friends Deepak Shrivastva, S.Rohit, D.K. Ahirwar, Durga Singh, Amrendra Mishra, Bhawna Singh, J.K. Panika, Ravindra Hanumat, Akhilesh Kurmi.

I Dedicated this thesis to my Grand father Shri Bihari lal kushwaha.

Date:

Place: ***(Manoj Kumar Manav)***

LIST OF ABBREVIATIONS

Words		**Abbreviation**
Calculated	:	Cal
Centimeter	:	cm
Co-Worker	:	*et al.*
Days after sowing	:	DAS
Degree of Centigrade	:	^{0}C
Degree of Freedom	:	d.f.
East - West	:	E-W
Error mean sum of squares	:	M.S.S.E.
Figure	:	Fig.
Fisher's Value	:	"F" Value
Gram (s)	:	g.
Hectare	:	ha
Kilometer	:	Km
Maximum	:	Max.
Minimum	:	Min.
Mean sum of squares	:	M.S.S.
Non- Significant	:	N.S.
North - South	:	N – S
Number	:	No.
Per	:	/
Percent	:	%
Relative Humidity	:	R.H.
Replication	:	R.
Randomized block design	:	RBD
Significant at 5% level	:	**
Source of variance	:	S.V.
Standard Error of Difference	:	S.Ed.
Sum of Square	:	S.S.
Tabulated	:	Tab.
Temperature	:	Temp.
Total soluble solids	:	TSS

CONTENTS

LIST OF TABLE

LIST OF FIGURES

VITA

The author of this thesis Manoj Kumar Manav was born on 3rd of april 1988 at Rewa (M.P.).

He passed his Higher Secondary School Certificate Examination in 2005, from Model H.S. School Rewa (M.P.) and secured 1st Division obtaining 72.88% marks.

He joined his higher studies in 2006 at Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur College of Agriculture Rewa (M.P.) and passed B.Sc. (Agriculture) Examination with 7.03 out of 10 points scale in the year 2010.

After graduation the author took admission in the college of Agriculture, Rewa (M.P.) for Postgraduate studies and now submitting this thesis in partial fulfillment of M.Sc. (Agriculture) Horticulture, Fruit science with and OGPA 7.20 out of 10 points scale in year 2013.

CHAPTER - I
INTRODUCTION

Mango (*Mangifera indica* L.) is a most important tropical and subtropical fruit grown in more than 110 countries of the world. It belongs to the family Anacardiaceae. History indicates that in India, the mango cultivation is very ancient of about 4000 years old. The mango is indigenous to North indo Burma region. From there, it was introduced in the neighboring as well as in western countries

Mango is a highly nutritive fruit. Immature and green mature fruits are suitable for pickling and Chutney preparation due to the acidic nature. Ripe mangoes are excellent table fruit and also can be transformed into a variety of products. Mango pulp is the most important which is utilized for human consumption, fruit pulp predominates in water, carbohydrates, organic acids, fats, minerals, Pigments, tannin, vitamins. The ripe fruit pulp contain about 11.8 percent carbohydrates 4800 IU of vitamin A, and 13 mg/100mg ascorbic acid. The pulp is a rich source of beta carotene, Sucrose, glucose and fructose

Mango trees perform well both under tropical and subtropical climatic conditions. It requires good rain fall during its growing season (June to October) and rainless dry weather from November on wards. Flowering season of mango tree in a region is mainly influenced by climatic conditions especially the temperature level. Rains during pre-flowering and flowering period lead to delayed flowering and increase vegetative growth. Cloudy weather at the time of flowering results in heavy flower drop mainly due to increased population of hoppers.

Mango is produced throughout the world specially in the countries like Philippines, Indonesia. Thailand, Burma, Malaya, Shrilanka, Egypt, South East Africa, Isreal, Tropical Australia, USA (Howaii and Florida). Though mango is cultivated in almost all the states of India, UttarPradesh, Bihar and Andhra Pradesh are the leading ones both in area and production. Other states where mango cultivation exists include Orissa, West Bengal, Karnatka, Gujarat, Maharashtra, Madhya Pradesh, Tamil Nadu, Kerala and Punjab.

In India it occupies an area of 2,35,607 thousand hectares 42 percent area devoted to fruit crops and with a total production of 1,35,570 thousand metric tonnes. In which Madhya Pradesh occupies 16.3 thousand hectare and production of 146.6 thousand metric tonnes (Anonymous 2010). Mango is grown in all districts of M.P., but the maximum acreage is in Jabalpur, Rewa and Satna.

A large number of mango varieties in India owe their origin to chance seedling spotted by enthusiastic orchadists and multiplied by vegetative propagation. India has unique and varied climate which enable to grow successfully almost all, varieties of mango all over the country. Cultivation of mango faces so many problems due to environmental conditions. Climatic factor viz. temperature, Humidity, wind and sunshine affects the growth, flowering fruiting and quality of fruits.

The varieties of North, South and central region are found suitable for this region. Weather is highly variable in this region, weather affects the growth, development, flowering, fruiting and quality behaviours of mango varieties. Many environmental factor, like temperature, rainfall, light intensity, cloudy weather, relative humidity etc. effect the fruit fullness in mango varieties. Temperature is one of the most important environmental factor, which effect the flowering, pollination, fruit set of mango variety, cloudy weather may also act as one the factor for unfruitfulness the mango plant by making condition favorable for development and spread of diseases.

The experiment “Study on flowering and fruiting behavior of mango cultivars in relation to weather parameter (Temperature , Humidity, wind, sunshine)”. Was conducted at Fruit Research Station Kuthulia, College of Agriculture, Rewa (M.P.) during the year 2011 with the following objectives.

1. To evaluate the suitable variety for growth, yield and fruit quality in geographical location of Kyamore plateau.
2. To study the variability of diversified in germplasm.
3. To study association among economic important character.

CHAPTER –II
REVIEW OF LITERATURE

Openheimmer (1960) observed a significant relationship between the tree size and yield in Haden and Pairee mango variety.

Chakrawar and Jature (1980) studied the correlation coefficient between different characters of Kagzi lime and reported that the correlation was significantly positive between the yield and number of fruits per plant. The yield component fruit number and weight of fruit showed significant positive association with yield.

Prasad (1987) carried out correlation studies on grown behaviours, fruit characters and yield component of forty varieties of mango and noted positive significant association between the number of fruits, their size with T.S.S., ascorbic acid, fruit weight and fruit volume. Plant spread in N-S and E-W had positive indirect through different aspect and yield.

Thimmappaiah and Suman (1987) reported that the number of flowers ranged from 302 to994, hermaphrodite flower from 2.8 to 31.4 % and panicle size from 11.25 to 42.2 cm. Varieties having longer panicle produced largest number of flower consisting mostly of male flower. The yield was found affected only when hermaphrodite percentage was very low. Only those varieties with moderate number of hermaphrodite flower and good retention on fruit gave better yield.

Singh and Bhagat (1988) found that on experiment was conducted on four cultivars of mango, namely, Gulab Khas Mithua (early cultivars), Sukul and Sipia (late cultivars). Early cultivars were found superior to late cultivars in many traits like number of branches per flower size of pollen grains and percentage of germination of pollens, receptivity of stigma. Fruit set was also better in early cultivars than late cultivars. Anthesis and dehiscence took place between 6 and 8 A.M. and 9 And 10 A.M. in early and late cultivars respectively.

Mukund *et al*. (1988) reported that the percentage of fruit set under open pollination differ in different cultivars, viz, alphonso (2.83), Dashehari (2.68), Langra (2.43), Mallika (1.89) and Pairi (1.77). the highest percentage of fruit set was recorded in the western direction and least in eastern direction. However. Fruit set was highest in middle portion of but and least in bottom portion.

Ghosh and Chattopadhyay (1995) found that the performance of 19 mango cultivars was evaluated under rainfed semi-arid conditions at the Regional Research Station, Jhargram, West Bengal. The cultivar Himsagar was the highest yielder with good fruit size, medium fruit quality and was recommended for commercial orcharding. Cv. Gulabkhas grew the most and was placed second in fruit production with good fruit quality while Safdar Pasand, having average fruit production, good fruit size and highest TSS and total sugar in fruit juice, was placed third for large scale plantation under rainfed farming conditions of the semi-arid region of West Bengal.

Tsai *et al.* (1996) reported that when grown under unfavourable climatic conditions in Yuching, Taiwan, mango trees suffer from embryo abortion. Studies were carried out on 8-year-old cv. Irwin mango trees during 1993-94, to investigate the effects of climatic conditions during flowering on the incidence of seedless fruits and yields. The percentage seed abortion was determined 60 days after flowering and the total sugar content of the mango fruit pulp was determined by a refractometer at harvest. Climatic data were recorded from 10 days before to 30 days after anthesis. Early flowering in January/early February resulted in a high proportion of fruits showing seed abortion and consequently reduction of yields. Cumulative temperature was negatively correlated with the percentage seed abortion and total sugar content, whereas cumulative precipitation was positively correlated with both. Temperature and precipitation during the 30 days after anthesis were more important than those during the 10 days before flowering.

Kumar and Chakrabarti (1997) found that yield losses attributed to malformed panicles were determined in Faizabad during 1993-94 for 7-year-

old trees of alternate-bearing cultivars Dashehari, Langra, Himsagar and Gilas, and the regular-bearing Neelam. The relationship between frequency of malformed panicles and yield losses was determined by linear regression. Fruit yield in Dashehari was affected by the number of non-bearing panicles and not malformed ones. For all cultivars, number of malformed panicles was negatively related to the number of non-bearing panicles. Malformation did not affect flowering either in the same or subsequent year, but an increase in the number of inflorescences coincided with a greater incidence of malformation. Yield losses for Neelam, Langra, Himsagar and Gilas were 36.2, 2.3, 15.7 and 41.5%, respectively. Yield declined by 0.2, 0.6, 0.89 and 0.96% for every 1% increase in the number of malformed panicles in Langra, Himsagar, Gilas and Neelam, respectively. For the regular bearer, Neelam, yield losses could be predicted by counting the number of malformed panicles, provided the number of non-bearing panicles was not unduly affected by biotic or abiotic stress.

Rajput and Pandey (1997) reported that the fruits of 6 cultivars (Langra, Dashehari, Sunderja, Mallika, Amrapali and Neeleswari) growing at the College of Agriculture, Raipur (Madhya Pradesh, India) were evaluated for their physico-chemical properties. Cv. Mallika was superior to the other cultivars with regard to fruit size, fruit weight and pulp weight, with low stone and peel percentages. Langra and Sunderja also produced fruits of good weight and size, with high pulp and low stone percentages. TSS and total sugar contents were highest in Sunderja, Langra and Neeleswari. Langra had the highest ascorbic acid content. With regard to low acidity and high sugar/acid ratio, the best results were obtained for Dashehari and Sunderja. Organoleptic quality of Dashehari was best, and this cultivar was closely followed by Langra. On the basis of quality parameters, taste and general acceptance, Dashehari and Langra were superior to the other cultivars.

Pongsomboon *et al.* (1997) found that during the dormant period in 1988-89, 4-year-old mango cv. Nam Dok Mai trees grown in an orchard at Kasetsart University (Kamphaengsaen Campus), Nakhon Pathom Province, Thailand, were studied. The changes and relationships between leaf xylem water potential (psi x), relative water content (RWC), total nonstructural

carbohydrates (TNC) in terminal shoots, and GA3- and ABA-like substances in shoot tips during November and December, and flowering were studied. Changes in psi x and RWC were from -0.31 MPa and 97% at the beginning of the dry period (mid-November) to -0.82 MPa and 93%, respectively, in mid December. There was a positive correlation between psi x and RWC. Low TNC levels were about 70-98 mg glucose equivalent/g DW at the beginning of the dormant period and thereafter increased to 110-120 mg glucose equivalent/g DW and finally declined to about 70 mg glucose equivalent/g DW prior to flowering. TNC values were poorly correlated negatively with RWC, but not correlated with psi x. GA3-like substances were high (1.5-1.7 micro g equivalent/g FW) at the beginning of the dormant period, but declined by about 50% in late November prior to increasing slightly through to inflorescence emergence. The change in ABA-like substances was comparatively small during the dormant period. GA3-like substances were negatively correlated with RWC and psi x whereas ABA-like substances were not. Flowering intensity was negatively correlated with average RWC and average psi x, but was correlated with TNC. Flowering intensity was negatively correlated with GA3-like substances, but not with ABA-like substances.

Chakarbarti *et al.* (1997) reported that field experiments were conducted in Uttar Pradesh, India, on 5-year-old plants of mango (cv. Baramasi) to determine if there was any correlation between seasonal fluctuation of F. moniliforme [Gibberella fujikuroi] inoculum density on the host surface and the anti-fusarial metabolite, mangiferin, content in the host tissues. Although the correlation between fungal density, maximum temperature, relative humidity and mangiferin content were not significant, the results indicated that the fungal population and mangiferin content of shoots were negatively correlated (r=-0.325), the inoculum density was positively correlated with relative humidity (r=0.304) but negatively related to maximum temperature (r=-0.141). It is concluded that environmental parameters and mangiferin content affect the population dynamics of G. fujikuroi and subsequently cause seasonal variation in disease incidence.

Avilan *et al.* (1998) found that the panicles of 21 cultivars from the mango collection of the Centro Nacional de Investigaciones Agropecuarias (CENIAP), Maracay, Venezuela were classified according to morphology, flower number and sex, position of fertile pistil and flowering intensity. Flower numbers ranged from 601 in cv. Haden to 4859 in cv. Irwin. With the exception of 3 cultivars with a fertile flower percentage of <less or =>4%, the potential fruit yield was high. Flowering period averaged ~ 6 weeks, commencement coinciding with the end of the rainy season. For most cultivars flowering commenced in the first half of December and continued until the latter part of January with maximum flowering intensity in the 3rd and 4th weeks of January.

Jana and Sharangi (1998) reported that a study was conducted to assess the nature and extent of fruit drop in 16 popular mango cultivars in West Bengal, India. The study revealed that irrespective of year of observation (1995 and 1996), the initial fruit set per panicle was lowest in Mallika, while it was highest in Meghlanthan (10.0) in 1995 and in Baramasi (119.17) in 1996. In major cultivars, fruit drop was relatively high initially, then decreased; it increased in the last week of March, and finally approached zero. The total percentage fruit drop was high in all cultivars, varying from 75.69% (Himsagar) to 100% (Mallika) in 1995, and from 89.47% (Mallika) to 98.30% (Bombay Yellow) in 1996. This variation was considered to be due to cultivar and environment.

Singh *et al.* (1998) reported that seven-year-old trees of mango cv. Amrapali were covered with clear 400-gauge polyethylene sheets before the onset of flowering (first week of January) in 1996 and 1997. Covers were removed from trees after full growth of panicles. Polyethylene covers significantly increased the outer and inner temperatures and relative humidity of the trees. Average maximum and minimum temperatures around the covered trees were 4.1 and 0.89 degrees C higher, respectively, than those around uncovered trees. Internal temperature of leaves also increased by 1.8 degrees C through covering. Covered trees showed earlier panicle emergence and higher growth rates, and set their fruits 10 days earlier, than uncovered

trees. Transpiration rate and chlorophyll contents were significantly higher in covered trees, on which the incidence of malformed fruits was much lower (1.14 and 12.50% on covered and uncovered trees, respectively).

Liv *et al.* (1998) reported that during 19-22 January 1997, frost occurred repeatedly in China with a minimum temperature of -4 degrees C. Many mango seedlings died, and the autumn shoots of young trees were damaged. KH2PO4 (0.3%) solution was sprayed on lightly damaged trees to promote normal flowering. Treated trees exhibited more flowering (22.2%) and earlier flowering (by 7-10 days) than control trees.

Singh *et al.* (1998) reported that the fruit of Gola require less degree days for their maturity. The canopy of Gola cultivar maintains better and favourable micro-environment through higher rate of transpiration from its leaves during good rainfall year. Over all, favourable phytoclimate created inside the orchard due to net increase in relative humidity (1-10 %), vapour pressure (0.5-2.1 mb) and to reduction in wind speed by 56-58 percent.

Kumar (1999) reported that the experiment was conducted with 12 genetically diverse strains/varieties of mango (Mangifera indica) in a randomized block design with three replications. The malformation showed significantly negative associations with fruit total soluble solids (TSS) for one year and with petiole length for both years. Path coefficient analysis revealed that the characters shoot length, petiole length, panicle diameter, fruit length, fruit volume, acidity content and seed stone diameter, with direct negative effects on malformation during both the years, should be given due consideration, while selecting for crop improvement.

Dod *et al.* (1999) found that the flowering and fruiting behaviour of 10 mango cultivars was studied in Akola, India, during 1996-97. Results indicated that cultivars Kesar and Dashehari were the most suitable for the hot and dry climatic conditions of Akola. The greatest number of panicles/ msuperscript 2 and the lowest ratio of hermaphrodite to male flowers were observed in cv. Kesar. The total number of fruits/tree (yield) was significantly higher in Kesar and Dashehari (146.75 and 143.0, respectively) than in other cultivars.

Sukhvibul *et al.* (1999) found that the effect of temperature on inflorescence development and sex expression in two mono-embryonic (Irwin and Sensation), and two poly-embryonic (Nam Dok Mai and Kensington) mango cultivars was studied. Trees were subjected to natural winter temperatures to induce flowering prior to transfer into controlled environment glasshouse rooms under day/night temperature regimes of 15/5, 20/10, 25/15 and 30/20 ^{o} C for 20 weeks. Inflorescence development did not progress when trees were held at 15/5^{o} C. Cooler temperatures (20/10^{o} C) delayed the start of anthesis (42.4 days) compared with trees grown at 25/15 ^{o} C (23 days) and 30/20^{o} C (16.1 days). At 20/10 ^{o} C, the delay in the start of anthesis was greatest for Sensation (55.5 days) and least for Nam Dok Mai (25.5 days) while at other temperatures there was little difference between cultivars. The distribution of hermaphrodite flowers within the inflorescence was independent of temperature with the highest percentage found in the apical half of the inflorescence. There was an inverse relationship between the length of the anthesis period and temperature, with anthesis occurring over 30 days at 20/10^{o} C and reducing to fewer than 10 days at 30/20^{o} C. Temperature also had an inverse effect on the total number of flowers per inflorescence with 619.6 +or- 108.0 (mean for all cultivars) at 20/10^{o}C decreasing to 431.3 +or- 80.5 at 30/20^{o} C.

Lad *et al.* (1999) found that climatic requirements for economic mango production are exacting but unless these requirements are fully met, the yield will be severely reduced resulting heavy financial losses. In spite of this fact, the response of mango trees to various climate factors has never been precisely studied. Two important aspects of the environment influencing induction of flowering in mango are photoperiodism and thermoperiodism. Information available so far is inadequate with regard to the response of mango trees to these factors causing various biochemical and physiological changes leading to flowering. An attempt was made to find out correlation between the fluctuations during day and night temperatures and time of induction of flowering in mango. The present studies indicated that minimum temperatures below 10 o C and above freezing point stimulated heavy

flowering in cvs. Alphonso, Kesar, Ratna (hybrid) etc. and even in the mango grafts at nursery stage (6 month old) under the climatic conditions of coastal region of Maharashtra. Moreover, flowering occurred only in a single flush compared with 2-3 flushes under normal environmental conditions. However, the percentage of perfect flowers was lower in all the cultivars resulting in poor yield.

Shu (1999) found that the effect of 3 temperature regimes (31/25 (warm), 25/19 (moderate) and 19/13^{o} C (cool), day/night) on flowering and pollination in 4 mango cultivars (Haden, Irwin, Keitt and Local) was investigated in Taiwan. Compared with the moderate treatment, warm temperatures hastened growth rates of panicles and flowers, shortened flowering duration and life span of individual flowers, and decreased the number of hermaphrodite and male flowers. Warm temperatures increased the rates and percentages of anther dehiscence and pollination. In contrast, cool temperatures retarded the growth of panicles and flowers, extended flowering duration and life span of flowers, and increased the number of hermaphrodite and male flowers. Sex ratio was statistically not different among the 3 temperature treatments. The highest number of hermaphrodite flowers occurred during the first third of the flowering period. The highest number of male flowers occurred halfway through the flowering period.

Selvraj *et al.* (1999) reported that Guava fruits of Allahabad safeda and Sardar harvested at different developmental stages were analysed for their physio-chemical and mineral constituents. The growth of fruit followed a double sigmoid curve.

Dag *et al.* (2000) found that 'Kent' mango (Mangifera indica) flowers were sampled in an orchard in the coastal plain of Israel during the 1997 flowering season to elucidate the relationship between effective pollination rate and temperature conditions and to determine seasonal variation in the ability of the pollen to germinate and reach the ovule. Effective pollination rate was determined at two stages of the fertilization process: (a) pollen germination on the stigma; (b) pollen-tube penetration into the ovule. Pollination rates were negligible during the first part of the flowering season (31 March to 18 April)

but reached a high value at the end of the season (21 May) with an average of 4.9 germinating pollen grains per stigma. The same phenomenon occurred when detached flowers were pollinated and incubated for 24 h at the presumed optimal temperature of 30^{o} C, indicating that the reproductive organs were not fully functionally viable. All the pollen was deformed at the start of the flowering season but Alexander's staining showed at least 23% viability when pollen grain shape started to appear normal (16 April). The functional viability of the pollen and pistils of orchard- and phytotron-grown (22/27 ^{o} C, night/day) flowers was determined in detached flowers. At the beginning of the flowering season, both orchard pollen and pistils tended to be defective. Orchard pollen germinated poorly, even on phytotron-adapted stigmas (30% of flowers with germinated pollen). Ovule penetration was hampered in orchard pistils, even when phytotron pollen was used for pollination (5% of flowers with pollen tube in ovule). Chilling injury appeared to be responsible for the damage to the reproductive organs of the orchard flowers. The negligible rate of effective pollination found in mango orchards in Israel during a significant part of the flowering season therefore appears to be due to the detrimental effect of cold weather on the pollination and fertilization processes as well as on the functional viability of the male and female reproductive organs.

Sukhvibul *et al.* (2000) reported that trees of 2 mono-embryonic (Irwin and Sensation) and 2 poly-embryonic (Nam Dok Mai and Kensington) mango cultivars were exposed to winter temperatures (21.6/9.5 ^{o} C) to induce flowering. Plants were transferred into controlled environment glasshouse rooms under day/night temperature regimes of 15/5, 20/10, 25/15 and 30/20 ^{o} C for 20 weeks. Inflorescence development only occurred on trees that were maintained at 20/10, 25/15 and 30/20^{o} C. Higher temperatures generally increased inflorescence size while there was an inverse effect on the mean number of flowers per inflorescence with 619.6 at 20/10 ^{o} C decreasing to 431.3 at 30/20 ^{o} C. There was an inverse relationship between the length of anthesis period and temperature. Low temperatures of 20/10^{o} C decreased the percentage of hermaphrodite flowers in poly-embryonic cultivars but

increased the percentage in mono-embryonic cultivars. Style length and stigma width were reduced when trees were held at 20/10 ^{o} C compared with those held at either 25/15 or 30/20^{o} C. Kensington grown at 20/10 degrees C mainly produced flowers which had short styles (0.62 mm) and small stigmatic surfaces. Nam Dok Mai and Irwin trees produced some flowers which had deformed ovaries or fused ovaries. Such developmental variations due to low temperatures (20/10^{o} C) are likely factors contributing to low fruit set when grown in subtropical climates.

Singh and Arora (2000) found that the peach fruits gave TSS (15.45^{0}brix), acidity(0.24%), ascorbic acid (2.10mg/100ml juice), total sugars (12.67%), starch(0.0096%) , chlorophyll (1.05mg/100gm fresh weight), carotenoids (4346 ug/100gm fresh weight) at 84 days after anthesis, whereas in flordasun ,the corresponding volues were 14.5^{0} brix ,0.54 % traces ,11.52%, 0.16 %, 1.71mg and 3452ug respectively at 90 days after anthesis.

Singh *et al.* (2000) reported that the ripe fruits of 8 selected genotypes of beal were analyzed for their physio-chemical character under tari condition of Uttar Pradesh, significant variation in fruit characters i.e, shape , size ,weight ,volume , rind thickness , fiber mucilage , peel , pulp , seed , TSS and total titratable acidity contents were recorded among various genotypes while fruit specific gravity, TSS, acid ratio and ascorbic acid in fruit pulp did not differ significantly.

Shinde *et al.* (2001) found that a study was conducted during 1996-99 in two locations in Maharashtra, India (Vengurle and Rameshwar) to determine the heat units required for the fruit maturity of mango cultivars (Alphonso, Kesar and Ratna). The days required for the maturation of Alphonso, Kesar and Ratna fruits at Vengurle were 103.33, 110.33 and 118.00 days, respectively, vs. 80.0, 86.0 and 97.5 days at Rameshwar. Alphonso, Kesar and Ratna fruits matured 23.33, 24.33, 20.50 days earlier at Rameshwar than at Vengurle. The total heat units required for maturation of fruits were more or less equal at both locations and these varied in Alphonso,

Kesar and Ratna from 752 to 803, 843 to 898, and 932 to 977 day-degrees, respectively.

Chang and Chao (2001) reported that field experiments were conducted on 20-year-old mango cv. Irwin trees to determine the influence of air temperature and rainfall during the flowering and fruiting period on the frequency of flower and fruit drop, during 1994 and 1995 at Yuching area, Chai-Yi, Taiwan, ROC. Low temperature and rainfall were the important factors on flower and fruit drop. The flowering period was most sensitive to low temperature. During the flowering period, air temperature below 5 degrees C resulted in flower drop. During the fruit growth stage, air temperature below 15 degrees C resulted in fruit drop which appeared at fruit length of 0.5 to 3.0 cm. However, the influence of rainfall on flower and fruit drop was not limited to any flower and fruit growth stage.

Jacobi *et al.* (2001 a) reported that conditions that promote loss of heat tolerance, or dehardening, of 'Kensington' mango fruit (*Mangifera indica*) were investigated. Fruits were conditioned at 40 ^{o} C for 8 h, and then placed at 22^{o}C (dehardened) for 8, 16, 24, or 48 h prior to hot water treatment (HWT) (47 ^{o} C held for 15 minutes). The greatest reduction in fruit heat tolerance occurred in fruit placed at 22 ^{o} C for 16 h. Compared with the other conditioned fruit, these fruits had the highest incidence and severity of skin scalding, external cavities, starch layer, increased F0 values and a lack of recovery in FV/FM ratios after HWT. It was concluded that the loss of heat tolerance in 'Kensington' fruit occurred at a slower rate than the increase in heat tolerance brought about by the 40 ^{o} C conditioning treatments. Exposure of fruit to 22 ^{o} C for 24 h or longer accelerated fruit ripening, and induced some protection against heat injury.

Jacobi *et al.* (2001 b) found that the effects of conditioning and hot water treatments on immature and mature mangoes cv. Kensington were examined. A hot water treatment of 47 ^{o} C fruit core temperature held for 15 minutes increased weight loss (50%), fruit softness (15%), disrupted starch hydrolysis and interacted with maturity to reduce the skin yellowness (40-51%) of early harvested fruit. Immature fruit were more susceptible to hot water

treatment-induced skin scalding, starch layer and starch spot injuries and disease. Conditioning fruit at 40 ^{o} C for up to 16 h before hot water treatment accelerated fruit ripening, as reflected in higher total soluble solids and lower titratable acidity levels. As fruit maturity increased, the tolerance to hot water treatment-induced skin scalding and the retention of starch layers and starch spots increased and susceptibility to lenticel spotting decreased. A conditioning treatment of either 22^{o} or 40 ^{o} C before hot water treatment could prevent the appearance of cavities at all maturity levels. The 40^{o} C conditioning temperature was found to be more effective in increasing fruit heat tolerance than the 22 ^{o} C treatment; the longer the time of conditioning at 40 ^{o} C, the more effective the treatment (16 vs 4 h). For maximum fruit quality, particularly for export markets, it is recommended that mature fruits are selected and conditioned before hot water treatment to reduce the risk of heat damage.

Muzaffar *et al*. (2002) reported that the experiment on the phonological relationship between mango hopper and mango inflorescence per fruit was conducted at Mir Ghulam Rasool Talpur Fruit farm, Tandojam during 1999-2000. the Results showed that mango hoppers were recorded during 30th December (0.06/ shoot) on all the mango varieties. The population density increased gradually on the varieties up till second fortnight of February and thereafter population of mango hopper increased rapidly. The peak populations of mango hopper on Almas (24.23/shoot) and sindhri (25.66/shoot) were recorded on 23rd march and 30th March, respectively. However peak population density in Neelum (22.52/shoot) was recorded on 16th march. There after population of hopper declined towards fruit maturation all the varieties.

Singh (2002) found that a study to determine intensity and varietal susceptibility of floral malformation was carried out in Sabour, Bihar, India in 1994-1995. Findings revealed that different germplasm had varying degree of incidence of floral malformation. Maximum intensity of light, medium, and heavy type of floral malformation was recorded in collection number 10/85, 1/80, and 20/85, respectively, whereas collection number 20/80 had less

incidence of all types (light, medium, and heavy) of malformation. Thirty-two types including the control, Langra, were examined and none were free from floral malformation.

Galvis *et al.* (2002) found that mango cv. Vandyke fruits were harvested at Tolima, Colombia (average temperature 29^{o} C and relative humidity (RH) of 70%) at physiological maturity and stored at low temperatures (12, 10 and 7^{o}C) and 85% RH for 10, 20 and 30 days. Control fruits were stored at 18^{o}C for 15 days. During storage, the physical characteristics were evaluated: percentage of weight, firmness, and fruit and pulp loss. The biochemical changes were observed: degrees Brix, pH, percentage acidity, sucrose, glucose and fructose contents and acids (citric, malic, succinic and ascorbic acids). Changes in fruit colour were also observed. Fruits stored at 12 ^{o} C ripened in 30 days. At 12^{o} C, storage life doubled compared to fruits stored at 18^{o} C. Fruits were sensitive to temperatures of 10 and 7 ^{o} C, resulting in the interruption of maturation particularly at 7^{o} C. At 10 ^{o} C, the evolution of characteristic maturation changes developed until 20 days of storage. However, between 20 and 30 days, changes were interrupted, indicating that chilling injury became irreversible starting from the 20th day.

Muhammad *et al.* (2002 a) found that differences in fruit setting and subsequent drop were evaluated among 3 mango commercial cultivars, namely Anwar Rataul, Dashehari and Langra, under local conditions in Faisalabad, Pakistan. Maximum fruit set was observed in all the cultivars on Eastern side of the plant. Langra showed the maximum fruit set (205.3) on the east, while the minimum fruit set (1.33) was recorded in Anwar Rataul on the west side of the plant. Among the 3 cultivars, Langra yielded the maximum number of fruit set (119.9). Fruit drop percentage was high in all cultivars in the first 15 days after the initial fruit set, with maximum drop in Anwar Rataul (96.25%), followed by Langra (90.34%). On the other hand, Dashehari showed the highest fruit retention of 1.60% until maturity and suggested as the best cultivar among the 3.

Anila and Radha (2003) found that an evaluation of physical, morphological and biochemical characters of four varieties and two hybrid of mango were made under Kerala condition. It was observed that Ratna fruits had the maximum length, breadth, weight, volume and circumference. The minimum contribution of stone to fruit weight was in Ratna and the maximum in Muvandan. Fruits of hybrids Ratna and H-151 recorded the highest values of T.S.S., sugar and ascorbic acid contents. The overall perusal of the data revealed that hybrid variety Ratna had all the desirable characteristics in terms of length, breadth, weight, volume, circumference, minimum stone weight, T.S.S. and Suger content.

Kudachikar *et al.* (2003) found that studies were conducted on the physicochemical changes associated with fruit development in mango cultivars Raspuri and Alphonso. Fruit growth was slow initially up to 35 days after fruit set and it rapidly increased further in terms of fruit weight (in Alphonso by 1.5- to 3-folds than that of Raspuri) until maturity. The trend in specific gravity of the fruits increased with fruit development and reached the value near to 1.0 at harvest maturity. Therefore, specific gravity of the fruit could be considered as a reliable physical index for harvest maturity. During early stages of fruit growth from 35 to 65 days after fruit set, both peel and stone percentage in both cultivars increased, thereafter, pulp percentage increased as fruit growth advanced towards maturity. The firmness of the fruit increased and reached a peak 85 days after fruit set and decreased at maturity. Alphonso had a better texture than Raspuri at each stage. The total soluble solids (TSS) to acidity ratio showed an increased trend during fruit development in both the cultivars. At maturity, the TSS to acidity ratio reached values between 2.7 and 3.0. Hence, the TSS to acidity ratio could also be considered as the reliable chemical index for harvest maturity. The results indicated that the fruits of both the cultivars took 115 days to reach full maturity and could attain harvest maturity in 110 days after fruit set.

Pandey *et al.* (2003) reported that field experiments were conducted in Anand, Gujarat, India during 1998-99 to 2000-01 to study the population

dynamics of hoppers infesting mango cv. Langado in relation to weather parameters. Results revealed that although mango hopper's initiation and buildup were closely associated with the reproductive stages of mango, the weather parameters were expediting the population growth and/or inhibited their further growth. Low mean temperatures (Tmean <22^{o}C) were unfavourable. The highest hopper population was associated with higher mean temperature (>28^{o} C). Fortnightly rainfalls of more than 100 mm had washing out effect although the temperatures were optimum. Correlations worked out on seasonal basis were higher than that obtained on annual basis. Wind speed, minimum temperature and vapour pressure had maximum association with hopper population (r=0.76 to 0.78**). Linear models could explain only 36 to 61% variation in mango hopper population but the nonlinear model such as power or exponential explained up to 78% of the variation in population.

Zhu *et al.* (2003) reported that the relationship between heat-induced chilling tolerance and changes in protein contents of 'Zihua' mango fruits was studied. Hot air treatment at 38^{o}C for 12 hours to 3 days significantly enhanced the chilling tolerance of mango fruits. Heat treatment increased the protein contents of the fruits even when during low temperature storage at 2^{o}C and ripening at 20^{o}C. Among the proteins that increased as a result of heat treatment, the heat-stable proteins made up a relatively high proportion. The results suggest that heat-induced proteins are related to chilling tolerance and that the production of heat-stable proteins under heat stress is one of the most important factors involved in the induction of chilling tolerance.

Nakamura *et al.* (2003) found that tree-ripe 'Irwin' mangoes grown under greenhouses in Japan have excellent quality. Unfortunately, their harvesting period is very limited and storability is very poor. Therefore, a method for preserving the fruit quality is highly required. Temperature and gas composition are the most important factors affecting the rate of respiration and ultimately the fruit quality attributes. Respiration rate is the necessary parameter for designing the storage conditions. In the present investigation, the effects of storage temperature (5, 15, or 25^{o}C) and gas composition on the

O2 consumption and the CO2 production have been studied by using the flow through system. The ratios of the respiration rate under controlled atmosphere conditions (1.6 to 20.7% O2, 0.2 to 10.2% CO2, balanced with N2) were calculated against the values under normal air condition. Data obtained on respiration rate and respiration quotient suggest that low temperature in combination with CA gas composition around 10% CO2 and 5% O2 will be effective to suppress the respiration rate of tree-ripe 'Irwin' mango.

Gurdeep and Pant (2003) reported that this review covers the etiology of mango malformation including the biotic and abiotic factors associated with the disease. Emphasis is given on the production of 'stress ethylene' by the plants as a factor contributing to the development of the disease. Notes are presented on the various approaches to control malformation in mangoes.

Kumar and Jaiswal (2003) reported that a trial was conducted to evaluate the performance of 11 cultivars (Baneshan, Bangalora, Mulgoa, Neelum, Swarnrekha, Alphonso, Kesar, Mankurad, Fernandin, Vanraj and Langra) in Bihar, India, on 12-year-old plants during 1991-93. Fruit set was highest in Mankurad and Bangalora (61.45 and 60.38, respectively) and lowest in Baneshan (9.57). Fruits matured from 88.17 to 119.50 days with specific gravity ranging from 1.034 to 1.067. Langra, Bangalora, Kesar, Neelum and Baneshan were the highest yielders. Neelum produced the highest number of fruits per tree (187.67), Bangalora recorded the highest fruit weight per tree (39.61 kg/tree), and Langra produced the highest pulp weight per tree (27.93 kg/tree).

Anila and Radha (2003) reported that studies on fruit set and fruit drop were carried out in Trichur, Kerala, India, on four cultivars (Alphonso, Prior, Muvandan and Neelum) and two hybrids (Ratna (Alphonso x Neelum) and H-151 (Kalapady x Neelum)) of mango during 2000-01. The season of flowering in majority of the genotypes was during December-January except in Neelum in which it was during April-May. The number of inflorescence per square metre ranged from 23.6 to 7.0 and was the maximum in Prior and minimum in Alphonso and Neelum. In the case of percentage of bisexual

flowers Alphonso had the maximum (44.39%) bisexual flowers and Muvandan had the minimum. Variation in length, breadth, colour and density of inflorescence was noticed among the genotypes. Initial fruit set ranged from 5.39 to 8.45 fruits per inflorescence. Fruit drop was 50% during the initial 15 days and continued for 45 days. The maximum drop was noted in Alphonso (89.93%) and the minimum in H-151 (79.6%).

Kannan and Rao (2003) found that a study was carried out in mango orchards in Tirupati, Chittoor, Andhra Pradesh, India, during October 2000-July 2001 to determine the effect of abiotic factors on the incidence of T. quadraria. The peak population of leaf and flower feeder was observed during the fifth week of December 2000 (9.0 larvae per 12 panicles). However, a gradual increase was observed from the first week of November 2000 (3.2 larvae per 12 panicles) to the first week of February 2001 (2.2 larvae per 12 panicles). The leaf and flower feeder population was negatively correlated with minimum and maximum temperatures (significant) as well as rainfall (non-significant), whereas with relative humidity the correlation was positive and significantly correlated. Rainfall showed no correlation.

Espinola Sobrinho *et al.* (2004) reported that a study was conducted at the MAISA S/A farm, in Mossoro County, Rio Grande do Norte, Brazil, to analyse the relationship between the global solar radiation-related air temperature and the yield of mango (cv. Tommy Atkins) tree, taken as reference the exhibition areas NW, SW, SE, and NE of the canopy. For production analysis, five plants were considered, one chosen for installation of the temperature sensor. Readings were taken with the help of a micrologger 21X, programmed for acquiring data every second. Portion SE of the canopy yield the highest production (59.11 kg/tree), followed by SW (55.82 kg/tree), NE (50.59 kg/tree), and NW (45.41 kg/tree). The most productive areas were the ones that received larger incidence of solar radiation and higher temperatures. Forty-one percent of the fruits presented export quality. The average weight of the fruits varied from 0.38 to 0.44 kg for sides SE and SW, respectively. The air temperature around the fruits presented an average of 30.7 and 24.7^{o}C for daily and night values, respectively, for all portions on the

canopy. A maximum value of 39.3^{o}C and a minimum value of 18.8^{o}C in the sides SW and NW were registered.

Kundan and Syamal (2004) found that the bisexual and male flowers of mango cv. Amrapali from healthy and malformed panicles were studied using an optical fibre microscope. The percentage of bisexual flowers in the healthy panicles was significantly higher than that in the malformed panicles. Bisexual flowers of healthy panicles showed well-developed superior ovary with receptive stigma and stamens with fertile anther; while those from malformed panicles showed poorly developed multi-locular ovaries, which were functionally male. Pollen viability in healthy and malformed panicles were 93 and 54%, respectively.

Godase *et al.* (2004) reported that a field experiment was conducted in Maharashtra, India during 1998, 1999 and 2001 to evaluate the yield loss in mango cv. Alfonso caused by the mango hopper (Idioscopus niveosparsus). Monocrotophos was applied at 1, 2 and 3 sprays as individual treatments, during panicle emergence stage and at subsequent 15-day intervals. The hopper population was 6.71 and 8.5/panicle in 2 and 3 sprays, respectively, which was significantly less than the untreated control. Approximately 46.30 and 41.09% increase in yield was observed over the control, with 2 and 3 sprays, respectively. Two sprays applied first at panicle emergence and second at 15 days after the first spray were effective.

Murti and Upreti (2004) found that both regular and irregular bearing mango cultivars showed extremely poor and delayed flowering in 1998 in Bangalore, Karnataka, India. The cultivars Totapuri and Alphonso showed predominantly vegetative growth in the second half of March 1998 with negligible flowering. The estimated period of peak flower bud differentiation in Bangalore was set at November to early December. The night temperature in Bangalore during the first week of December 1997 (17^{o}C) was far above the averages of 1994-97 (10^{o}C). Similar trends were observed with respect to mean and mean maximum temperatures, but at a lower magnitude. As temperatures of 18/10^{o}C (close to an average of 15^{o}C) are considered optimum for flower induction, the higher temperatures, especially night

temperatures (>17^{o}C), prevailing during the flower induction period in October to December seemed to have a detrimental effect on this parameter. Even cool temperatures induced a vegetative flush instead of inflorescence, when growth of the bud did not take place during this period. It was predominantly the effect of high temperature, especially night temperature, which prevailed during October to December during flower induction and differentiation periods, possibly accentuated by slightly higher rainfall in October-December, that culminated in poor flowering in mango.

Kumar and Jaiswal (2004) reported that the performance of mango cultivars from the south zone (Baneshan, Bangalora, Mulgoa, Neelum and Swarnrekha) and from the west zone (Alphonso, Kesar, Mankurad, Fernandin and Vanraj) of India was evaluated in an experiment conducted in 1991-93. Neelum recorded the highest pooled number of leaves (9.22) and total leaf area per shoot (383.57 cm), whereas Kesar recorded the highest pooled area per leaf (47.03/m 2). Langra recorded the highest plan height (461.67 cm), girth (87.33 cm) and canopy area (33.55/m2).

Muhammad *et al.* (2004 b) reported that an experiment was conducted to determine the physicochemical characteristics of Pakistani mango cultivars Sindhri, Almas, Langra, Chaunsa, Anwar Retaul, Malda, Desi, Dusehri, Totapuri, Fajri, Super Badam and Lahotia. Almas gave the highest pulp weight (79.12%) and reducing sugar content (5.760%). Langra, Fajri, Desri and Dusehri gave the highest peel weight (22.60%), fruit weight (501.4 g), stone weight (27.28%) and non-reducing sugars content (14.83%), respectively. Anwer Retaul gave the highest total soluble solids content (25.20%) and total sugar content (20.04%) while Super Badam gave the highest acidity (0.840%) and ascorbic acid content (310.1 mg/100 g). Comparative data on the ratio of various physical and chemical characteristic values of the mango cultivars tested are also tabulated.

Dhillon and Kumar (2004) reported that the pomegranate cultivars i.e, kandhari, Nabha, and Ganesh in fruit quality characteristic fruit volume, aril weight, juice percentage and organoleptic rating increased while percent rind weight decreased with advancement of maturity.

Kaushal *et al.* (2004) reported that the number of sepals and petals in some cultivar of plum and apricot. The average stamen length varied from 0.75cm. to 0.81cm. in plum and from 0.98cm. to 1.08cm. in apricot. The comparative pistil length of plum cultivars was much shorter than those of apricot cultivar.

Nilesh and Banik (2005) found that the yield and yield characters of 9 mango cultivars (Meghlanthan, Totapuri, Kishanbhog, Langra, Bombay Yellow, Bombay Green, Himsagar, Neelum and Alphonso) in the alluvial zone of West Bengal, India were evaluated during 2003. The parameters tested included: fruit length, fruit breadth, fruit weight, pulp percentage, peel percentage, stone percentage, pulp:peel, stone percentage, pulp:peel, pulp:stone, peel:stone, total soluble solids content (TSS), total sugars, reducing and non-reducing sugar contents, acidity, ascorbic acid content and TSS:acid ratio. Cultivars Himsagar, Langra and Kishanbhog showed better yield potential, and physical and chemical properties than the other cultivars.

Verma and Singh (2010) reported that the pest activity in the mango orchards began in the months of June and it remain active up to the December, beyond that the activity declined to zero level up to April. The pest completed several over lopping generation from june to December on mango tree. There was three distinct peaks observed in first fortnight of August (9.48 webbed mass/tree), September (23.10 webbed mass/tree) and October (25.00 webbed mass/tree) respectively. The pest's activity remains at high level from September to December (ranged from 20.00 to 25.00 webbed mass/tree).

CHAPTER- III
MATERIAL AND METHODS

The methods adopted and materials used during the course of present investigation are being presented in this chapter

3.1 Experimental site

The present investigation entitled “Study on flowering and fruiting behaviour of mango cultivars in relation to weather parameter. (Temperature humidity wind, sunshine)” was carried out at Fruit Research Station, Kuthulia, College of Agriculture, Rewa (M.P.) during December to June, 2011-12.

3.2 Climatic and weather conditions

Rewa is situated in the north- eastern part of Madhya Pradesh at latitude $24^0$31. N longitude $81^0$15’E and altitude of 365.7 meters above the mean sea level. Rewa enjoys the subtropical climate, hot and dry summer and cold winter are the main characteristics features of this region. Some times the winter temperature touches the freezing point. In general, the highest and lowest temperature goes above 43^0C and below 5^0c, respectively. The annual rainfall varies from 900 mm to 1150 mm which is received mainly from July to September and some times winter showers are also received.

3.3 Meteorological observations

The maximum and minimum temperature, percentage of relative humidity during day, wind and bright sun shining hours were recorded during December to June, 2011-12. The period of investigation and presented graphically in Fig. 3.1

Table- 3.1 Meteorological data

Week	Temperature^{0}c		Humidity %		Wind km/h	Sunshine cm/day	Rainfall mm.
	Max.	Min.	Max.	Min.			
49	25.31	7.68	79.00	60.14	0.41	6.68	0.00
50	24.37	5.31	78.42	60.42	0.50	6.28	0.00
51	23.28	3.54	82.00	50.57	0.28	0.22	0.00
52	23.77	3.70	80.00	52.57	0.14	5.37	0.00
1	22.25	11.74	80.85	32.71	0.42	3.20	4.62
2	22.71	4.31	74.71	24.28	0.57	6.20	0.00
3	24.31	6.91	77.57	15.28	0.44	6.20	0.00
4	21.91	5.45	74.00	22.00	0.42	7.00	0.00
5	21.54	7.4	76.71	27.00	0.41	5.60	0.00
6	22.71	6.75	74.57	32.42	0.41	4.62	0.00
7	25.11	5.91	75.85	38.00	0.65	6.97	0.00
8	25.51	9.8	58.00	39.57	0.85	7.48	0.00
9	27.97	11.17	70.14	46.00	0.85	6.34	0.00
10	30.40	11.34	80.14	47.57	0.65	6.34	0.00
11	28.14	15.17	68.42	48.71	0.78	5.08	0.00
12	33.77	18.40	77.28	41.42	0.64	6.42	0.00
13	35.14	18.74	80.71	40.41	0.67	8.34	0.00
14	38.51	18.51	83.42	29.85	0.94	8.65	0.00
15	38.02	15.88	83.42	30.71	0.75	7.20	0.00
16	37.54	18.48	74.71	33.85	0.80	8.57	0.00
17	38.77	18.91	70.71	34.71	0.70	8.91	0.00
18	39.62	20.6	79.57	34.28	0.78	9.02	0.00
19	41.28	22.22	83.28	34.28	0.97	9.34	0.00
20	42.02	22.77	79.14	34.85	1.27	9.14	0.00
21	43.22	24.25	68.00	34.00	0.97	8.28	0.00
22	44.45	25.51	80.42	31.28	0.90	8.91	0.00
23	43.51	25.82	75.14	33.85	0.82	9.71	0.00
24	42.57	25.28	75.28	33.57	2.10	9.80	0.00
25	41.05	24.80	70.71	33.57	0.90	7.82	0.00
26	38.31	23.80	75.14	33.14	0.74	8.20	0.68

3.4 Physico – chemical properties of the soil

The composite soil samples from different part of the experimental field were collected from 15-30 cm depth. The soil sample were analysed in Department of soil science, College of Agriculture, Rewa (M.P.).

The soil of the experimental site was mixed red black with clay loam texture and having depth of 4 meters. The land was slightly sloppy and drainage was normal. The results of the phycico- chemical analysis of soil are presented in

Table-3.2 Physico – chemical properties of the soil

S. No.	Soil components	Analytical value
1	Sand %	45.78
2	Silt %	28.22
3	Clay %	26.00
4	Organic carbon %	0.49
5	Soil Ph	5.70
6	Available nitrogen (kg/ha)	0.750
7	Available phosphorus (kg/ha)	14.33
8	Available Potash (kg/ha)	131.6
9	Water holding capacity (%)	42.48
10	Electric conductivity mmhos/cm^2	0.12

3.5 Experimental details

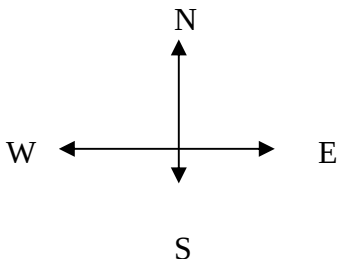
The details of the experiment are as follows:

1	Design	:	R B D
2	Replication	:	4
3	Treatments	:	5 (varieties of mango)
4	No. of plant per treatment	:	2
5	Spacing	:	10x10 m
6	Area required	:	0.40 ha
7	Total number of tree	:	40

The varieties evaluated were as follows

T_1	:	Dashehari
T_2	:	Mallika
T_3	:	Sundarja
T_4	:	Totapari
T_5	:	Langra

Figure : 3.2 Layout Plant of the Experiment



R I	R II	R III	RIV 10 m.	
T_1	T_5	T_4	T_2	**10 m.**
T_2	T_4	T_5	T_3	
T_3	T_2	T_1	T_5	
T_4	T_3	T_2	T_1	
T_5	T_1	T_3	T_4	

3.6 Observation

Weather parameter (Temperature e^0c, Humidity% wind km/h, Sunshine calorie cm /day) (Daily from panicle appearance to marketable fruits).

In this investigation, the observations were recorded on the following aspects.

1. **Growth of plant**
    a. Tree height (m)
    b. Tree spread (N-S) and (E-W) (m)
    c. Girth of root stock (m)
    d. Girth of scion (m)
    e. Canopy height (m)
    f. Volume of tree (m^3)
2. **Flowering**
    a. Date of first appearing flower
    b. Date of 50% flowering
    c. Date of 100% flowering
    d. Size of panicle (cm)
    e. Number of male flower (%)
    f. Number of hermaphrodite flower (%)
    g. Number of hermaphrodite flower in N.S.E.W. direction
    h. Total no. of flower
    i. Sex ratio
3. **Fruiting**

i. Date of fruit setting

    a. Mustard size of fruits / panicle
    b. Pea size of fruits / panicle
    c. Marble size of fruits / panicle
    d. Mature fruits / panicle
    e. Fruit drop (%)
    f. Harvesting period (days)

4. **Yield**
    a. Number of fruits per tree
    b. Weight of fruits per tree (kg)

5. **Disease (Malformation, Powdery mildew etc.)**
6. **Insect pest (Mango hopper, Mealy bug, leaf folder)**
7. **Fruit quality**

I. Physical quality

a. Physical quality
b. Fruit weight (gm)
c. Fruit breadth (cm)
d. peel (%)
e. pulp (%)
f. stone (%)

II. Chemical quality

a. TSS (^{0}brix)
b. Acidity (%)

III. Keeping quality at room temp days

The details of the observations recorded are given below

3.7 Growth of plant

The growth observations were recorded in the month of December, 2011.

a. Tree height : The height of the experimental trees was measured from the ground level to the tip of the top shoot by measuring tape with help of bamboo.

b. Tree spread (N-S) and (E-W) : The spread of the experimental trees was measured in the North- South and East –West directions with the help of measuring tape.

c. Girth of root stock : The girth of root stock was measured just below the graft union.

d. Girth of scion: The girth of scion was recorded just above the graft union.

e. Canopy height : The canopy height of the experimental tree was measured from the point of primary branching to the tip of the terminal shoots.

f. Volume of the tree: The total volume of the tree was calculated by the formula given below:

Volume = $лr^2h$

Where r = average radius

$$r = \frac{\text{spread N-S + E-W}}{4}$$

h = Canopy height

3.8. Flowering

a. Date of first appearing flower: The date from which the flower initiation was started was noted.

b. Date of 50% flowering: The date from which the 50% flower initiation was noted.

c. Date of 100% flowering: When the tree was in full bloom and the date was noted.

d. Size of panicle: The size of panicle was noted with help of the measuring scale .

e. Number of male flower : The total number of male flower were counted per panicle.

f. Number of hermaphrodite flower : The total numbers of hermaphrodite flower were counted per panicle.

g. Number of hermaphrodite flower in N.S.E.W. direction: The total number of hermaphrodite flowers were counted per panicle in direction.

h. Sex ratio : The total number of male and hermaphrodite flower were noted per panicle and percent of sex ratio was calculated.

3.9. Fruiting

(I) Date of fruit setting:

(a) Mustard size of fruits/ panicle: The number of fruit per panicle were observed in mustard size fruits and noted. Five panicle in each direction were randomly selected in each treatment.

(b) Pea size of fruits/ panicle: The number of fruit per panicle were observed in pea size fruits and noted. Five panicle in each direction were randomly selected in each treatment.

(c) Marble size of fruits/ panicle: The number of fruits per panicle were observed in marble size fruits and noted. Five panicle in each direction were randomly selected in each treatment.

(d) Mature fruits/ panicle: The number of fruit per panicle were observed in mature size fruits and noted. Five panicle in each direction were randomly selected in each treatment .

(e) Fruit drop (%) : Total number of fruits at pea stage was counted and the number of fruits retained at maturity stage was noted. The percentage fruit drop was calculated with the help of formula given below.

$$\text{Percentage of fruit drop} = \frac{\text{Total No. of fruits- Fruits retained at harvesting}}{\text{Total number of fruits}} \times 100$$

(f) Harvesting : The harvesting of fruits was done after reaching the maturity . It was decided by maturity index.

3.10. Yield

(a) No. of fruits per tree : Number of fruits per tree were counted and noted .

(b) Weight of fruits per tree (kg) : Mature fruits were weighted and weight was recorded in kg.

3.11. Disease (Malformation, Powdery mildew etc.) :

Malformation: The intensity of floral malformation was calculated by the formula given below.

$$\text{Percentage of fruit drop} = \frac{\text{Number of malformed panicle}}{\text{Total number of panicle}} \times 100$$

Powdery mildew: The intensity of powdery mildew was calculated by the formula given below.

$$\text{Percentage of powdery mildew} = \frac{\text{Number of powdery mildew panicle}}{\text{Total number of panicle}} \times 100$$

3.12. Insect – Pest

Mango hopper : Monthly mango hopper population were noted in the month of Jan. to April .

Mealy bug: Mealy bug population were noted in 15th day interval from Jan. to April.

Leaf folder : Webs of leaves due to leaf folder was noted in the month of October.

3.13. Fruit quality:

(i) Physical quality

(a) Fruit weight (gm) : Five randomly selected mature fruits were weighted and weight was recorded in grams.

(b) Fruit length (cm) : The length of five fruits randomly selected fruits was measured by Vernear calipers the average length per fruits was noted

(c) Fruit breadth (cm) : The breadth of the five randomly selected fruits was measured by vernear calipers and the average breadth per fruit was noted.

(d) Peel (%) : The five randomly selected fruits were peeled and the total weight of the peel was recorded. The peel percentage was calculated by the following equcation/formula.

$$\text{Peel percentage} = \frac{\text{Weight of peel}}{\text{Weight of fruit}} \times 100$$

(e) Pulp (%) : The pulp of five randomly selected fruits was removed with the help of stainless steel knife and the weight of the pulp was recorded. The pulp percentage was calculated as per the formula given below.

$$\text{Pulp percentage} = \frac{\text{Weight of pulp}}{\text{Weight of fruit}} \times 100$$

(f) Stone (%) : The weight of the stone of the some fruits was measured and the percentage was calculated as per the formula given below.

$$\text{Stone percentage} = \frac{\text{Weight of stone}}{\text{Weight of fruit}} \times 100$$

III Chemical quality

(a) TSS (^{0}brix) : The homogenized fruit sample was crushed and juice was extracted through muslin cloth and few drops of juice were placed on the surface of priso. The hinged part was placed black. The hand refroctometer was then placed against the sun and the reading were recorded by revolving the eye pices at room temperature (A.O.A.C., 1970).

(b) Acidity : Acidity was estimated by simple acid alkaline titration method as described in A.O.A.C (1970). Ten ml. of fruit solution was transferred into a 100 ml volumetric flask and the volume was made up to mark with distilled water. It was shaked well dissolve and 25 ml of diluted fruit juice was transferred in to a 250 ml beaker. Three drops of phenopthalein indicater was added to the solution. The juice was titrated with N/10 Naoth (Sodium hydroxide). The alkali was added drop by drop in the beaker with constant stirring till the pink and point is reached. Three to four readings were recorded and the percentage acidity was calculated by the formula given below.

$$\text{Total acidity} = \frac{\text{Titrated value normality of alkali x volume made up x 64 x 100}}{\text{Weight of sample taken}}$$

Where 64 = Eduivalent weight of an acid

Volume made up = Volume of titrated up

(iii) Keeping quality at room temp. (days) : Five mature fruits of each treatments were kept at room temperature for ripening with out deterioration of fruits was counted.

3.14. Statistical analysis variance

Analysis of variance of different variable was carried out to know the degree of variation among all the treatments with regard to various treatments. The data were analyzed by the method of analysis of variance as derived by R.A. fisher (D 54) . The analysis of variance table is give below.

Table :3 Skeleton of analysis of variance

S. No.	Source of variation	d.f.	S.S.	M.S.S.	F.cal	F. value 5%
1	Replication	(r-1)	R.S.S.	R.M.S.S.	R.m.S.S.	
2	Variety	(t-1)	Tr.S.S.	Tr. M.S.S.	E.M. S.S.	
3	Error	(r-1) (t-1)	E.S.S.	EM.S.S.	Tr. M.S.S.	
	Total	(Tr.-1)	T.S.S		E.M.S.S.	

The significance of treatments was estimated employing “F”Test. The significant difference between means were determined by using critical difference SEm ±(C.D.) which was calculated as follows. and C.D. of variety

$$S.E.m \pm = \sqrt{\frac{\text{Error of variance}}{\text{No. of replication}}}$$

$$\text{or} = \sqrt{\frac{M.S.E.}{\text{Replication}}}$$

$$S.E.M. \pm = \sqrt{\frac{\text{Error of variance}}{\text{Replication}}} \times 2$$

$$C.D. = S.E.m \pm \sqrt{2 \times \text{“t”}}\ (5\% \text{ for error d.f.})$$

3.15. Correlation studies

Cofficients of correlation between different characters were calculated as per the formula given by pane and sukhatme (1967)

$$R. = \frac{E\,x\,Y - E\,X.\,EY}{\sqrt{[\{ EX^2 - (E\,x)^2/n \} - \{ x^2 - (EY)^2 / n \}]}}$$

$$t = \frac{|r|}{\sqrt{1 - n^2}} \sqrt{n - 2}$$

Where

R = Coefficient of correlation

N = Number of treatments (varieties)

S.Y = Characters under study

3.16 Present of data

All the interpretation of the data in the chapter iv “Experimental finding” are based on “F” test C.D. (Critical difference). The results of various characters as influenced by different treatments (varieties) have been illustrated by bar diagrams and graphic curves.

CHAPTER-IV
RESULTS

The present investigation entitled “Study on flowering and fruiting behaviour of mango cultivars in relation to weather parameter. (Temp. Humidity, wind, Sunshine)” was conducted at Fruit Research Station Kuthulia, College of Agriculture, Rewa during the year 2011-12. The periodical observations are summarized in the form of table (Table 4.1 to table 4.9 illustrated through figures (Fig 4.1 to 4.19) wherever felt necessary. The data were statistically computed and the analysis of variance (ANOVA) tables for all the characters studies have been appended for reference in Appendices.

4.1 Growth Plant:

4.1.1. Tree height:

The observation on plant height of mango were recorded and the statistically commuted and presented in Table 4.1 and illustrated through Fig 4.1. The analysis of variance is given in Appendix - I. After persual of the results it is clear that the plant height of mango varieties differed significantly except Sundarja. The maximum height was recorded under Langra (6.91 m) followed by Mallika (6.82 m). Dashehari (6.79 m) and Totapari (6.13 m) where as the minimum height was noted under Sundarja (5.88 m).

4.1.2 Tree spread (N.S.) (m)

The plant spread (N –S) of mango was measured in each treatment and the data were subjected to statistical computation as shown in Anova (Appendix -II). The mean data of plant spread are shown in Table 4.1 and illustrated through diagram as in fig.4.2. Indicate that variety Dashehari gave significant higher spread (N-S) as compared to Sundarja and Totapari. Dashehari, Mallika and Langra did not differ significantly. The maximum spread of the tree (N-S) was recorded in Mallika (10.76 m) followed by Dashehari (10.71m) and Langra (10.36 m). The minimum spread was found under Totapari (7.83 m) and Sundarja (8.53 m.)

Table : 4.1 Growth of mango cultivars

S. No.	Variety	Tree height (m)	Tree spread (N-S) (m)	Tree spread (E-W) (m)	Girth of root stock (m)	Girth of scion (m)	Canopy height (m)	Volume of tree (m^3)
1	Dashehari	6.79	10.71	10.28	1.23	1.10	6.08	539.00
2	Mallika	6.82	10.76	10.32	1.31	1.14	6.24	545.36
3	Sundarja	5.88	8.53	7.95	1.09	0.90	5.35	286.90
4	Totapari	6.13	7.83	7.35	1.06	0.89	5.26	239.20
5	Langra	6.91	10.36	10.29	1.41	1.21	6.30	526.43
	SEM $\pm$	0.30	0..24	0.30	0.06	0.06	0.35	32.82
	C.D. at 5%	0.93	0.74	0.94	0.20	0.20	1.10	101.14

4.1.3 Tree spread (E-W) (m)

The plant spread (E- W) of mango was measured treatment wise and the data so obtained were subjected to statistical analysis (Appendix - III). The mean data are presented in Table 4.1 and exhibited through Fig. 4.2 Indicates that variety Dashehari, Mallika and Langra gave significant higher spead (E-W) as compared to Sundarja and Totapari. Dashehari, Mallika and Langra did not differ significantly. The maximum plant spread (E-W) was recorded in Mallika (10.32 m) followed by Langra (10.29 m) and Dashehari (10.28 m). The minimum spread was found under Totapari (7.35 m) followed by Sundarja (7.95 m)

4.1.4 Girth of root stock (m)

The girth of root stock of mango was measured in each treatment and the data so obtained were statistically computed (Appendix -IV). The mean data are exhibited in Table 4.1 and diagrammatically illustrated in Fig.4.3 . Indicates that variety Dashehari, Mallika and Langra gave significant higher girth of root stock as compared to Sundarja and Totapari. Dashehari, Mallika and Langra did not differ significantly.

The maximum girth was noted under Langra (1.41 m) followed by Mallika (1.31 m) and Dashehari (1.23). The minimum girth was noted under Totapari (1.06 m)followed by Sunarja (1.09m)

4.1.5 Girth of scion (m)

The girth of scion of mango was observed in each treatment and the data thus obtained were subjected to statistical analysis as shown in Anova (Appendix-V). The mean value are presented in Table 4.1 and diagrammatically exhibited through Fig.4.3. Indicates that variety Dashehari, Mallika and Langa gave significant higher girth of scion as compared to Sundarja and Totapari. Dashehari, Mallika and Langra did not differ significantly.

The maximum girth was noted under Langra (1.21 m) followed by Mallika (1.14 m) and Dashehari (1.10 m).Where as minimum was under Totapari (0.89 m) followed by Sundarja (0.90m).

4.1.6 Canopy height (m)

The data on canopy height recorded treatment wise were subjected to statistical analysis as shown in Appendix - VI. The mean data are highlighted in Table 4.3 and illustrated through Fig.4.3. Non significant differences was found in different varieties.

The maximum canopy height was recorded under Langra (6.30 m) followed by Mallika (6.24 m) and Dashehari (6.08 m). The minimum canopy height was recorded in Totapari (5.26 m) and Sundarja (5.35 m).

4.1.7 Volume of tree (m^3)

The volume of tree was also recorded in each treatment and the data thus noted were subjected to statistical analysis. The mean tree volume data are presented in Table 4.1 and digrammatically exhibited in Fig 4.2 is given Appendix VII Indicates variety Dashehari, Mallika and Langra gave significant higher volume

of tree as compared to Sundarja and Totapari. Dashehari, Mallika and Langra did not differ significant.

The maximum volume of tree was noted under Mallika (545.36m^3) followed by Dashehari (539.m^3) and Langra (5.26.43m^3). The minimum volume of tree was noted under Totapari (239.20m^3) and Sundarja (286.90m^3).

4.2. Flowering:

4.2.1. Date of first appearing flowers:

The dates of first appearance flowers were recorded in each treatment and the range of such dates is presented in Table 4.2, Appendix – VIII and Fig. 4.4 Indicates that variety Totapri and Langra gave significant higher first appearing of flowering as compared to Dashehari, Mallika and Sundarja did not differ significant in Totapari and Langra.

The earliest emergence of flower was observed under Sundarja (5th Jan.) followed by Mallika (8th Jan.) and Dasheri (10th Jan.) . Where as late emergence of flower was observed under Totapari (17th Jan.) and Langra (12th Jan.)

4.2.2 Date of 50% flowering

The date of 50% flowering were observed in each treatment and the range of such dates is presented in Table4.2 , Appendix -IX Fig .4.4 .Indicates that variety Totapari, Sundarja and Langa gave significant higher 50% of flowering as compared to Dashehari and Mallika. Totapari, Sundarja and Langra did not differ significant

The earliest flowering was observed under Dashehari (13th Feb.) and Mallika (15th Feb.) Late flowering was observed under Totapari (28th Feb. followed by Langra (23th Feb.) and Sundarja (20th Feb.).

Table :4.2 Flowering behaviour of mango cultivars

S. No	Variety	Date of first appearing flower	Date of 50% flowering	Date of 100% flowering	Size of panicle (cm)	No. of male flower	Number of hermaphrodite flower	Number of hermaphrodite flower/ panicle north direction	Number of hermaphrodite flower/ panicle south direction	Number of hermaphrodite flower/ panicle east direction	Number of hermaphrodite flower / panicle west direction	Total Number of flowers	Sex ratio
1	Dashehari	10 Jan	13 Feb.	4 March	20.24	543.88	233.40	343.63	209.75	158.13	222.00	777.19	30.12
2	Mallika	8 Jan	15 Feb	6 March	18.12	238.38	74.47	129.25	55.50	49.63	63.50	312.84	25.58
3	Sundarja	5 Jan	20 Feb	9 March	33.00	519.63	171.03	196.75	158.75	147.38	181.25	690.66	24.56
4	Totapari	17 Jan	28 Feb	13 March	17.21	262.25	74.03	105.88	66.00	58.00	68.00	362.28	20.47
5	Langra	12 Jan	23 Feb	10 March	15.41	254.38	503.59	656.13	498.50	394.38	465.00	757.97	68.30
	SEM $\pm$	2.29	2.91	1.29	1.71	54.42	20.67	33.38	19.68	17.89	20.51	70.46	3.29
	C.D. at 5%	7.07	8.99	3.99	5.29	167.70	63.72	102.88	60.65	55.15	63.23	217.14	10.15

4.2.3. Date of 100% flowering

The date of full bloom were recorded in each treatment and the range of such dates is highlighted in Table 4.2 , Appendix X and Fig. 4.4. Indicates that variety Totapari, Sundarja and Langa gave significant higher 100% of flowering as compared to Dashehari and Mallika. Totapari, Sundarja and Langra did not differ significantly.

The earliest flowering was observed under Dashehari (4th March) and Mallika (6th March). Late flowering was observed under Totapari (13th March) followed by Langra (10th March) and Sundarja (9th March).

4.2.4. Size of panicle (cm.)

The size of panicle of mango was measured in each treatment and the data were subjected to statistical computation as shown in (Appendix XI).The mean data of size of panicle are shown in Table 4.2 and illustrated through diagram as in Fig- 4.5 After persual of the result it is clear that the size of panicle in mango varieties did not differed significantly except Sundarja.

The maximum size of panicle was noted under Sundarja (33.00 cm). The minimum size of panicle was noted under Langra (15.41 cm) followed by Totapari (17.21 cm) Mallika (18.12 cm) and Dashehari (20.24 cm)

4.2.5. Number of male flower

The number of male flower was counted in each treatment and the data so obtained were subjected to statistical analysis as revealed from Anova (Appendix XII) The mean data are depicted in table 4.2 and illustrated through diagram as in fig.4.6 Indicates that variety Dashehari and Sundarja gave significantly higher male flower as compared to Mallika, Totapari, and Langra. Dashehari and Sundarja did not differ significantly.

The maximum number. of male flower was noted under Dashehari (543.88) and Sundarja (519.63). The minimum number of male flower was noted under Mallika (238.38) followed by Langra (254.38) and Totapari (262.25).

4.2.6. Number. of hermaphrodite flower

The number of hermaphrodite flower was counted in each treatment and data thus recorded were subjected to statistical computation (Appendix XIII). The mean values are highlighted in table 4.2 and illustrated through bar diagram as in fig 4.6. After persual of the result it is clear that hermaphrodite flower of mango varieties did not differed significantly except Langra.

The maximum number of hermaphrodite flower was noted under Langra (503.59). The minimum number of hermaphrodite flower was noted under Totapari (74.03) followed by Mallika (74.47), Sundarja (171.03) and Dashehari (233.40).

4.2.7.Total number of flower

The total number of flower was counted in each treatment and the data thus recorded were subjected to statistical computation (Appendix XIV). The mean values are highlighted in table 4.2 and illustrated through bar diagram as in fig 4.6. Indicates that variety Dashehari, Sundarja and Langra gave significant higher total number of flower as compared to Mallika, and Totapari. Dashehari, Sundarja and Langra did not differ significant.

The maximum total number of flower was noted under Dashehari (777.19) followed by Langra (757.97) and Sundarja (690.68). The minimum total number of flower was noted under Mallika (312.84) followed by Totapari (362.28).

4.2.8. Number of hermaphrodite flower in north direction

The number of hermaphrodite flower in north direction was counted in each treatment wise and the data so obtained were subjected to statistical analysis as reveled from Anova (Appendix- XV). The mean data are depicted in table 4.2 and illustrated through diagram as in fig 4.7.After persual of the result it is clear that the hermaphrodite flower in north direction of mango varieties did not differed significantly except Langra.

The maximum flower was noted under Langra (656.13). The minimum flower was noted under Totapari (105.88) followed by Mallika (129.25), Sundarja (196.75) and Dashehari (343.63).

4.2.9. Number of hermaphrodite flower in south direction

The number of hermaphrodite flower in south direction was counted in each treatment wise and the data so obtained were subjected to statistical analysis as shown in Anova (Appendix-XVI). The mean data are presented in table 4.2 and exhibited through diagram as in fig 4.7. After persual of the result it is clear that the hermaphrodite flower in south direction of mango varieties did not differed significantly except Langra.

The maximum flower was noted under Langra (498.50). The minimum flower was noted under Mallika (55.50) followed by Totapari, Sundarja (158.75) and Dashehari (209.75)

4.2.10. Number of hermaphrodite flower in east direction

The number of hermaphrodite flower in east direction was counted in each treatment and the data were subjected to statistical analysis as shown in Anova (Appendix-XVII). The mean data are presented in table 4.2 and exihibited through diagram as in fig 4.7. After persual of the result it is clear that the hermaphrodite flower in east direction of mango varieties did not differed significantly except Langra.

The maximum flower was noted under Langra (394.38). The minimum flower was noted under Mallika (49.63) followed by Totapari (58.00), Sundarja (147.38) and Dashehari (158.13).

4.2.11. Number of hermaphrodite flower in west direction

The number of hermaphrodite flower in west direction was counted in each treatment and the data thus recorded were subjected to statistical computation (Appendix- XVIII). The mean data value are highlighted in table 4.2 and illustrated through bar diagram as in fig 4.7. After persual of the result it is

clear that the hermaphrodite flower in west direction of mango varieties did not differed significantly except Langra.

The maximum number of flowers was noted under Langra (465.00). The minimum flower was noted under Mallika (63.50) followed by Totapari (68.00), Sundarja (181.25) and Dashehari (222.00).

4.2.12. Sex ratio

The sex ratio was counted treatment wise and the data so obtained were subjected to statistical analysis as revealed from Anova Appendix - XIX. The mean data are depicted in table 4.2 and illustrated through diagram as in fig 4.8. After persual of the result it is clear that the sex ratio of mango varieties did not differed significantly except Langra.

The maximum sex ratio was noted under Langra (68.30). The minimum sex ratio was noted under Totapari (20.47) followed by Sundarja (24.56), Mallika (25.58) and Dashehari (30.12).

4.3. Fruiting

4.3.1. Mustard size of fruits /panicle

The mustard size fruit was counted treatments wise and the data so obtained were subjected to statistical analysis as revealed from Anova - (Appendix XX). The mean data are depicted in table 4.3 and illustrated through diagram as fig 4.9 .Indicates that variety Dashehari, Sundarja and Langra gave significant higher mustard size of fruit as compared to Mallika and Totapari. Dashehari, Sundarja and Langra did not differ significantly.

The maximum mustard size of fruit was noted under Langra (171.25) followed by Sundarja (142.50) and Dashehari (102.25). The minimum fruit was noted under Mallika (46.25) and Totapari (70.00)

Table :4.3 Fruiting behaviour of mango cultivars

S. No.	Variety	Mustard size of fruits/ panicle	Pea size of fruits/ panicle	Marble size of fruits/ panicle	Mature fruits /panicle	Fruit drop (%)	Harvesting period (days)
1	Dashehari	102.25	23.88	6.00	2.63	52.96	29 May
2	Mallika	46.25	7.25	2.13	1.00	50.33	17 June
3	Sundarja	142.50	16.50	4.25	1.13	38.64	15 June
4	Totapari	70.00	7.13	1.25	0.75	53.20	15 June
5	Langra	171.25	6.25	1.75	0.88	87.05	5 June
	SEM $\pm$	22.81	1.46	0.55	0.22	6.99	0.29
	C.D. at 5%	70.31	4.51	1.72	0.69	21.54	0.89

4.3.2.Pea size of fruits/panicle

The pea size of fruit was counted in each treatment and the data thus recorded were subjected to statistical computation (Appendix -XXI). The mean values are highlighted in table 4.3 and illustrated through bar diagram as in fig 4.9 After persual of the result it is clear that the pea size of fruit in mango varieties did not differed significantly except Dashehari.

The maximum fruit was noted under Dashehari (23.88). The minimum fruit was noted under Langra (6.25) followed by Totapari (7.13), Mallika (7.25) and Sundarja (16.50).

4.3.3. Marble size of fruits/panicle

The number of marble size of fruit was counted treatment wise and the data so obtained were subjected to statistical analysis as revealed from Anova (Appendix XXII). The mean values are depicted in Table No. 4.3 and illustrated through diagram as in fig 4.9 After persual of the result it is clear that the marble size of fruit in mango varieties did not differed significantly except Dashehari.

The maximum fruit was noted under Dashehari (6.00). The minimum fruit was noted under Totapari (1.25) followed by Langrai (1.75), Mallika (2.13) and Sundarja (4.25).

4.3.4. Mature fruits/panicle

The mature fruit per panicle was counted in each treatment and the data were subjected to statistical analysis as shown in Anova (Appendix XXIII). The mean values are presented in table 4.3 and exhibited through diagram as in fig 4.9. After persual of the result it is clear that the mature fruit of mango varieties did not differed significantly except Dashehari.

The maximum fruit was noted under Dashehari (2.63). The minimum fruit was noted under Totapari (0.75) followed by Langra (0.88), Mallika (1.00) and Sundarja (1.13).

4.3.5. Fruit drop (%)

The number fruit drop was counted in each treatments and presented in percentage. The data were subjected to statistical computation (Appendix XXIV). The mean data are highlighted in table 4.3 and illustrated through diagram as in fig 4.10 After persual of the result it is clear that the fruit drop of mango varieties did not differed significantly except Langra.

The maximum fruit drop was recorded under Langra (87.05%). Where as minimum fruit drop was recorded under Sundarja (38.64%) followed by Mallika (50.33%), Dashehari (52.96%) and Totapari (53.20%).

4.3.6. Harvesting period (days)

The data of harvesting period were observed in each treatment and the range of such dates is presented in table 4.3, Appendix XXV and Fig No. 4.11 After persual of the result it is clear that the harvesting period of mango varieties did not differed significantly except Dashehari.

The earliest harvesting was observed under Dashehari (29th May). Late harvesting was observed under Totapari (15th July) followed by Mallika (17th June), Sundarja (15th June) and Langra (5th June).

4.4. Yield

4.4. 1. Number of fruits/tree

The total number fruits per tree was counted and the data thus obtained were subjected to statistical analysis (Appendix-XXVI). The mean data are exhibited in table 4.4 and illustrated through bar diagram as in fig.4.12.. After persual of the result it is clear that the No. of fruit in mango varieties did not differed significantly except Dashehari.

The maximum number of fruits was recorded under Dashehari (328.38) where as minimum number was found under Mallika (120.38) followed by Totapari (138.40), Sundarja (153.95) and Langra (170.58).

Table :4.4 Yield of mango cultivars

S. No.	Variety	Number of fruits per tree	Weight of fruits per tree (kg.)
1	Dashehari	328.38	87.01
2	Mallika	120.38	36.13
3	Sundarja	153.95	34.28
4	Totapari	138.40	38.50
5	Langra	170.58	41.78
	SEM $\pm$	26.43	4.40
	C.D. at 5%	81.46	13.57

4.4.2. Weight of fruits/tree (kg.)

The weight of fruits was recorded in each treatment and the values were subjected to statistical analysis as shown in Annova (Appendix- XXVII). The data are highlighted in table 4.4 and diagrammatically illustrated in fig.4.12 After persual of the result it is clear that the weight of fruit in mango varieties did not differed significantly except Dashehari.

The maximum weight of fruit was per tree was recorded under Dashehari (87.01) where as minimumweight of fruit per tree was recorded under Sundarja (34.28) followed by Mallika (36.13), Totapari (38.50) and Langra (41.78.

4.5. Disease

4.5.1. Malformation (%)

Malformation in mango trees was observed in percentage in each treatment and the data so obtained were subjected to statistical analysis (Appendix- XXVIII). The mean data are presented in table 4.5 and exhibited through suitable diagram as in fig.4.13 Indicates that variety Sundarja and Langra gave significant higher malformation as compared to Totapari followed by Dashehari and Mallika. Sundarja and Langra did not differ significant.

The maximum incidence was observed under Langra (47.79%) and Sundarja (42.56%) where as minimum incidence was noted under Totapari (2.99%) followed by Dashehari (7.32) and Mallika (21.14%).

Table: 4.5 Disease of mango cultivers

S. No.	Variety	Malformation	Powdery mildew
1	Dashehari	7.32 (2.70)	-
2	Mallika	21.14 (4.59)	-
3	Sundarja	42.56 (6.52)	-
4	Totapari	2.99 (1.72)	-
5	Langra	47.79 (6.91)	-
	SEM $\pm$	5.35	-
	C.D. at 5%	16.51	-

( ) Root transformation value

4.5.2. Powdery mildew

The powdery mildew was not recorded in this location

4.6. Insect pest

4.6.1.Mango hopper/ panicle (January)

The number of mango hopper per panicle was counted in each treatment and the data were subjected to statistical analysis as shown in Anova (Appendix-XXIX). The mean data are presented in table 4.6 and exhibited through diagram as in fig-4.14. Indicates that variety Dashehari, Mallika and Langra gave significant higher mango hopper, as compared to Sundarja and Totapari. Dashehari and Langra did not differ significant.

The maximum incidence was observed under Langra (1.67) followed by Mallika (1.29) and Dashehari (1.18). The minimum incidence was observed under Totapari (0.38) followed by Sunderja (0.50).

4.6.2. Mango hopper/panicle (February)

The number of mango hopper per panicle was counted in each treatment and the data thus recorded were subjected to statistical computation (Appendix-XXX) The mean values are highlighted in table 4.6 and illustrated through bar diagram as in fig 4.14 Indicates that variety Dashehari, Mallika and Langra gave significant higher mango hopper, as compared to Sundarja and Totapari. Dashehari , Mallika and Langra did not differ significantly.

The maximum incidence was observed under Langra (6.45) followed by Mallika (6.13) and Dashehari (6.00). The minimum incidence was observed under Totapari (1.45) and Sundarja (1.69).

Table :4.6 Insect pest of mango cultivers

S. No.	Variety	Mango hopper				Mealy bug	Leaf folder (0ct.)
		Jan.	Feb.	March	April		
1	Dashehari	1.18	6.00	19.85	11.88	-	19.79
2	Mallika	1.29	6.13	20.14	12.25	-	18.83
3	Sundarja	0.50	1.69	9.23	11.16	-	13.71
4	Totapari	0.38	1.45	8.25	9.88	-	11.95
5	Langra	1.67	6.45	20.73	13.13	-	25.45
	SEM ±	0.17	0.20	0.33	0.44	-	0.51
	C.D. at 5%	0.53	0.62	1.02	1.36	-	1.59

4.6.3. Mango hopper/panicle (March)

The number of mango hopper per panicle was counted in each treatment and the data obtained were subjected to statistical as revealed from Anova (Appendix- XXXI) The mean data are depicted in table 4.6 and illustrated through diagram as in fig 4.14 Indicates that variety Dashehari, Mallika and Langra gave significant higher mango hopper, as compared to Sundarja and Totapari. Dashehari, Mallika and Langra did not differ significantly.

The maximum incidence was observed under Langra (20.73) followed by Mallika (20.14) and Dashehari (19.85). The minimum incidence was observed under Totapari (8.25) followed by Sundarja (9.23).

4.6.4. Mango hopper/panicle (April)

The number of mango hopper was counted in each treatment and the data thus recorded were subjected to statistical computation (AppendixXXXII) The mean values are highlighted in table 4.6 and illustrated through bar diagram as in fig4.14 Indicates that variety Dashehari, Mallika and Langra gave significant higher mango hopper, as compared to Sundarja and Totapari. Dashehari, Mallika and Langra did not differ significantly.

The maximum incidence was noted under Langra (3.13) followed by Mallika (12.25) and Dashehari (11.88). The minimum incidence was noted under Totapari (9.88) and Sundarja (11.16).

4.6.5. Mealy bug

The mealy bug was not recorded in this location

4.6.6. Leaf folder (web mass /tree) (October)

The number of web mass per tree was counted in each treatment and the data thus recorded were subjected to statistical computation (Appendix-XXXIII) The mean values are highlighted in table 4.6 and illustrated through bar diagram as in fig4.15After persual of the result it is clear that the leaf folder of mango varieties did not differed significantly except Langra.

The maximum web mass was noted under Langra (25.45mass). The minimum web mass noted under Totapari (11.95 mass) followed by Sundarja (13.71 mass), Mallika (18.83 mass) and Dashehari (19.79 mass).

4.7. Fruit quality

4.7.1.Fruit weight (gm)

The weight of fruits was recorded in each treatment and the values were subjected to statistical analysis as shown in Anova (Appendix-XXXIV) The average data are highlighted in table4.7 and diagrammatically illustrated in fig 4.16 Indicates that variety Dashehari, Mallika and Totapari gave significant higher fruit weight as compared to Sundarja and Langa. Dashehari and Totapari did not differ significantly.

The maximum weight per fruit was recorded under Mallika (299.50 gm) followed by Totapari (278.43 gm) and Dashehari (268.75 gm). The minimum weight per fruit was recorded under sundarja (223.53 gm) and Langra (245.44 gm).

4.7.2. Fruit length (cm)

The length of fruits was measured in each treatment and the data so obtained were computed statistically as shown in Anova (Appendix-XXXV). The average values are exhibited in table 4.7 and illustrated diagrammatically in fig 4.16 After persual of the result it is clear that the fruit length of mango varieties did not differed significantly except Totapari.

The maximum length of fruit was recorded under Totapari (14.35 cm). The minimum length of fruit was recorded under Langra (10.12 cm) followed by Sundarja (10.42 cm) Mallika (12.54 cm) and Dashehari (13.06 cm)

Table : 4.7 Physical qualities of mango cultivars

S. No.	Variety	Fruit weight (gm)	Fruit length (cm)	Fruit breadth (cm)	Peel (%)	Pulp (%)	Stone (%)
1	Dashehari	268.75	13.06	6.88	16.96	73.54	9.50
2	Mallika	299.50	12.54	7.63	12.63	76.15	11.23
3	Sundarja	223.53	10.42	7.79	14.67	72.82	12.52
4	Totapari	278.43	14.35	7.32	15.00	72.75	12.25
5	Langra	245.44	10.12	6.63	12.11	74.39	13.50
	SEM $\pm$	13.24	0.38	0.22	0.70	0.47	0.42
	C.D. at 5%	40.82	1.19	0.67	2.10	1.47	1.31

4.7.3. Fruit breadth (cm)

The breadth of fruits was measured in each treatment wise and the data so obtained were subjected to statistical analysis (Appendix-XXXVI). The data are presented in table 4.7 and diagrammatically exhibited through fig4.16 Indicates that variety Sundarja, Mallika and Totapari gave significant higher fruit breadth as compared to Dashehari and Langra.. Sundarja, Mallika and Totapari did not differ significantly.

The maximum breadth of fruit was recorded under Sundarja (7.79 cm). followed by Mallika (7.63 cm) and Totapari (7.32 cm). The minimum breadth of fruit was recorded under Langra (6.63 cm) and Dashehari (6.88 cm).

4.7.4. Peel (%)

The peel weight was recorded in percentage under each treatment and the data so received were subjected to statistical analysis (Appendix-XXXVII). The average values are presented in table 4.7 and diagrammatically illustrated in fig4.17 Indicates that variety Dashehari, and Totapari gave significant higher peel % as compared to Mallika, Sundarja and Langra. Dashehari and Totapari did not differ significantly.

The maximum peel was noted under Dashehari (16.96%) and Totapari (15.00%). The minimum peel was noted under Langra (12.11%) followed by Mallika (12.63%) and Sundarja (14.67%).

4.7.5. Pulp (%)

The pulp weight of mango fruit was recorded in percentage under each treatment wise and the data so obtained were subjected to statistical analysis as shown in (Appendix-XXXVIII). The mean data on pulp weight are exhibited in table 4.7and illustrated through bar diagram as in fig. 4.17 After persual of the result it is clear that the pulp % of mango varieties did not differed significantly except Mallika.

The maximum pulp was noted under Mallika (76.15%) . The minimum pulp was noted under Totapari (72.75%) followed by Sundarja (72.82 %). Dashehari (72.54 %) and Langra (74.39%).

4.7.6. Stone (%)

The stone weight of mango fruit was recorded in percentage in each treatment and data were subjected to statistical computation (Appendix –XXXIX) The average data are presented in table 4.7 and illustrated through bar diagram as in fig4.17 Indicates that variety Sundarja, Totapari and Langra gave

significant higher stone% as compared to Dashehari and Mallika . Sundarja, Totapari and Langra did not differ significantly.

The maximum stone was noted under Langra (13.50%) followed by Sundarja (12.52%) and Totapari (12.25%). The minimum stone was noted under Dashehari (9.50%) and Mallika (11.23%).

4.8. II. Chemical quality

4.8.1. (TSS^0 Brix)

The TSS of mango fruits was determined chemically in each treatment and the data so obtained were subjected to statistical analysis (Appendix-XXXX). The mean data are produced in Table 4.8 and illustrated through bar diagram as in fig.4.18 Indicates that variety Sundarja and Langra gave significant higher TSS as compared to Dashehari, Mallika and Totapari. Sundarja and Langra did not differ significantly.

The maximum TSS of fruit was recorded under Langra (23.74 ^{0}brix) and Sundarja (22.73^0 brix) followed by Mallika (21.59^{0}brix) and Dashehari (21.80^0 brix). The minimum TSS of fruit was recorded under Totapari (15.23^0 brix) followed by Mallika (21.59^{0}brix) and Dashehari (21.80^0 brix)

Table :4.8 Chemical quality of mango cultivars

S. No.	Variety	TSS (^{0}brix)	Acidity (%)
1	Dashehari	21.80	0.39
2	Mallika	21.59	0.28
3	Sundarja	22.73	0.32
4	Totapari	15.23	0.27
5	Langra	23.74	0.26
	SEM $\pm$	0.57	0.002
	C.D. at 5%	1.78	0.006

4.8.2. Acidity (%)

The acidity of mango fruits was worked out treatment wise in percentage. The values so obtained wee subjected to statistical calculation as shown in Appendix-XXXXI The mean values are highlighted in table 4.8 and illustrated through suitable diagram as in fig 4.18 After persual of the result it is clear that the acidity of mango varieties did not differe significantly except Dashehari.

The maximum acidity was recorded under Dashehari (0.39%). The minimum acidity was recorded under Langra (0.26%) followed by Totapari (0.27 %), Mallika (0.28%) and Sundarja (0.32%).

4.9. III. Keeping quality at room temp (day)

The keeping quality of mango fruits after maturity were observed in days at room temperature and the data thus obtained were subjected to statistical analysis (Appendix-XXXXII) The mean data are exhibited in table 4.9 and illustrated through diagram as in fig4.19 Indicates that variety Sundarja and Totapari gave significant higher keeping quality as compared to Dashehari, Mallika and Langa. Sundarja and Totapari did not differ significantly.

The maximum keeping quality was recorded under Totapari (11 days) and Sundarja (10.63 days). The minimum keeping quality was recorded under Langra (6.00 days) followed by Mallika (6.75 days) and Dashehari (8.50 days).

Table:4.9 Keeping quality of mango cultivars at room temp. (day)

S. No.	Variety	Days
1	Dashehari	8.50
2	Mallika	6.75
3	Sundarja	10.63
4	Totapari	11.00
5	Langra	6.00
	SEM ±	0.32
	C.D. at 5%	1.00

Correlation Studies

Correlation among various morphological, flowering, fruiting and yield contributed characters:-

The data on correlation (R) in various correlation table 4.10 indicate that the Tree height was positively and significantly correlated with tree spread (N-S) (0.910), Tree spread (E-W) (0.939), Girth of root stock (0.904), Girth of scion (0.961), Canopy height (0. 966), Volume of tree (0.945), Sex ratio (0.575) and fruit drop (0.643). How ever it has negative correlated with Size of panicle (-0.718), Number of male flower (-0.318), Mustard size of fruit (-0.029), Pea size of fruit (-0.098), and Marble size of fruit (-0.013). The Temperature range max. 25.31^{o}C and min. 7.68^{o}C, humidity (%) max. 79.00 and min. 60.17, wind 0.41 km/h and sunshine 6.68 cm/day.

The plant spread (N-S) was positively and significantly correlated with Tree spread (E-S) (0.993), Girth of root stock (0.849), Girth of scion (0.917), canopy height (0.960) and volume of tree (0.994). How ever it has negative correlated with size of panicle (-0.378) and number of male flower (-0.018). The temp. range max 25.31^{o}C and min. 7.68^{o}C, humidity (%) max 79.00 and min 60.14 wind 0.41 km/h and sunshine 6.68 cm/day.

Tree spread (E-W) was positively and significantly correlated with Girth of root stock (0.900), Girth of scion (0.955) canopy height (0.983) and volume of tree (0.998). How ever it has negative correlated with size of panicle (-0.438). and No. of male flower (-0.080). The temp. range max. 25.31^{o}C and min 7.68^{o}C, Humidity max. 79% and min. 60.14%, wind 0.41 km/h and sunshine 6.68 cm./day.

Girth of root stock was positively and significantly correlated with girth of scion (0.983), canopy height (0.955), volume of tree (0.886), No. of hermaphrodite flower (0.677), sex ratio (0.789) and fruit drop (0.755). How ever it was negative correlated with size of panicle (-0.550), no of male flower (-0.378), Pea size of fruit (-0.264) and marble size of fruit (-0.143). The temp. range between max. 25.31^{o}C and min. 7.68^{o}C, humidity max. 79.00% and min. 60.14%, wind 0.41 km/h and sunshine 6.68cm./day.

Table No. 4.10. Correlation among various morphological, flowering, fruiting and yield contributed characters:-

	Tree height (m)	Tree spread (N-S) (m)	Tree spread (E-W) (m)	Girth of root stock(m)	Girth of scion (m)	Canopy height (m)	Volume of tree (m^3)	Size of panicle (cm)	No. of male flower	No. of hermaphrodite flower	Sex ratio	Mustard size of fruit/panicle	Pea size of fruit/panicle	Marble size of fruit/panicle	Mature size of fruit/panicle	Fruit drop (%)	No. of fruit/ tree	Weight of fruit/ tree (kg)
Tree height (m)		0.910**	0.939**	0.904**	0.961**	0.966**	0.945**	-0.718	-0.318	0.478	0.575**	-0.029	-0.098	-0.013	0.296	0.643**	0.329	0.408
Tree spread (N-S) (m)			0.993**	0.849**	0.917**	0.960**	0.994**	-0.378	-0.018	0.388	0.431	0.002	0.167	0.286	0.469	0.375	0.415	0.465
Tree spread (E-W) (m)				0.900**	0.955**	0.983**	0.998**	-0.438	-0.080	0.476	0.528	0.070	0.100	0.219	0.416	0.480	0.391	0.436
Girth of root stock (m)					0.983**	0.955**	0.886**	-0.550	-0.378	0.677**	0.789**	0.265	-0.264	-0.143	0.036	0.755**	0.088	0.110
Girth of scion (m)						0.989**	0.948**	-0.583	-0.301	0.618**	0.713**	0.173	-0.143	-0.030	0.191	0.699**	0.229	0.267
Canopy height (m)							0.980**	-0.548	-0.251	0.518	0.610**	0.073	-0.076	0.040	0.261	0.593**	0.261	0.313
Volume of tree (m^3)								-0.458	-0.089	0.437	0.493	0.020	0.1.2	0.217	0.427	0.459	0.396	0.450
Size of panicle (cm)									0.713**	-0.244	-0.411	0.267	0.501	0.514**	0.102	-0.690	-0.017	-0143
No. of male flower										-0.029	-0.289	0.286	0.955**	0.943**	0.744**	-0.506	0.686**	0.585**
No. of hermaphrodite flower											0.962**	0.846**	-0.051	0.006	0.055	0.847**	0.260	0.160
Sex ratio												0.723**	-0.295	-0.225	-0.133	0.934**	0.063	-0.004
Mustard size of fruit/ panicle													0.128	0.165	-0.005	0.496	0.171	-0.0001
Pea size of fruit / panicle														0.986**	0.904**	-0.449	0.840**	0.783**
Marble size of fruit/ panicle															0.902**	-0.414	0.820**	0.759**
Mature size of fruit / panicle																-0.194	0.958**	0.958**
Fruit drop (%)																	0.026	0.013
No. of fruit/tree																		0.981**

** significant at 5%

Girth of scion was positively and significantly correlated with canopy height (0.989), volume of tree (0.948), No. of hermaphrodite flower (0.618), Sex ratio (0.713), and fruit drop (0.699). How ever it was negative correlated with size of panicle (-0.583), No. of male flower (-0.301) and pea size of fruit (-0.143). The temp. range between max. 25.31^{o}C and min 7.68^{o}C, Humidity max. 79% and min. 60.14%, wind 0.41 km/h and sunshine 6.68 cm./day.

Canopy height was positively and Significantly correlated with volume of tree (0.980), sex ratio (0.610) and fruit drop (0.593). How ever it was negative correlated with size of panicle (-0.548), No. of male flower (-0.251) and Pea size of fruit (-0.076). The temp. range between max. 25.31^{o}C and min 7.68^{o}C, Humidity max. 79% and min. 60.14%, wind 0.41 km/h and sunshine 6.68 cm./day.

Volume of tree was negative correlated with size of panicle (-0.458) and No. of male flower (-0.089). The temp. range between max. 25.31^{o}C and min 7.68^{o}C, Humidity max. 79% and min. 60.14%, wind 0.41 km/h and sunshine 6.68 cm./day.

Size of panicle was positively and significantly correlated with No. of male flower (0.713). How ever it was negative correlated with No. of hermaphrodite flower (-0.244), sex ratio (-0.411), fruit drop (-0.690), no. of fruit tree (-0.017) and weight of fruit/tree (-0.143). The temp range between max. 33.77^{o}C and min 18.40^{o}C, Humidity max. 77.28% and min. 41.42%, wind 0.64 km/h and sunshine 6.42 cm./day.

No. of male flower was positively and significantly correlated with Pea size of fruit (0.955), marble size of fruit (0.943), mature size of fruit (0.744), No. of fruit/tree (0.686) and weight of fruit/tree (0.585). How ever it was negative correlated with No. of hermaphrodite flower (-0.029), sex ratio (-0.289) and fruit drop (-0.506). The temp. range between max. 35.14^{o}C and min 18.74^{o}C, Humidity max. 80.71% and min. 40.41%, wind 0.67 km/h and sunshine 8.34 cm./day.

No. of hermaphrodite flower was positively and significantly correlated with sex ratio (0.962), mustard size of fruit (0.846) and fruit drop (0.847). How ever it was negative correlated with pea size of fruit (-0.051). The temp. range between

max. 35.14^{o}C and min 18.74^{o}C, Humidity max. 80.71% and min. 40.41%, wind 0.67 km/h and sunshine 8.34 cm./day.

Sex ratio was positively and significantly correlated with mustard size of fruit (0.723) and fruit drop (0.934). How ever it was negative correlated with Pea size of fruit (-0.295), marble size of fruit (-0.225), mature size of fruit (-0.133) and weight of fruit/tree (-0.004). The temp. range between max. 35.14^{o}C and min 18.74^{o}C, Humidity max. 80.71% and min. 40.41%, wind 0.67 km/h and sunshine 8.34 cm./day.

Mustard size of fruit was negative correlated with mature size of fruit (-0.005) and weight of fruit /tree(-0.0001). The temp range between max. 25.51^{o}C and min 9.8^{o}C, Humidity max. 58% and min. 39.57%, wind 0.85 km/h and sunshine 7.48 cm./day.

Pea size of fruit was positively and significantly correlated with marble size of fruit (0.986), mature size of fruit (0.904), No. of fruit/tree (0.840) and weight of fruit/tree (0.783). How ever it was negative correlated with fruit drop (-0.449). The temp. range between max. 30.40^{o}C and min 11.34^{o}C, Humidity max. 80.14% and min. 47.57%, wind 0.65 km/h and sunshine 6.34 cm./day.

Marble size of fruit was positively and significantly correlated with mature size of fruit (0.902). Number of fruit per tree (0.820). weight of fruit per tree (kg.) (0.759). How ever it was negative correlated with fruit drop (-0.416). The temp. range between max. 38.51^{o}C and min 18.51^{o}C, Humidity max. 83.42% and min. 25.85%, wind 0.94 km/h and sunshine 8.65 cm./day.

Mature size of fruit was positively and significantly correlated with No. of fruit/tree (0.958) and weight of fruit/tree (0.958). How ever it was negative correlated with fruit drop (-0.194). The temp. range between max. 40.2^{o}C and min 22.77^{o}C, Humidity max. 79.14% and min. 34.85%, wind 1.27 km/h and sunshine 9.14 cm./day.

No. of fruit/tree was positively and significantly correlated with weight of fruit/tree (0.981). The temp range between max. 41.05^{o}C and min 24.80^{o}C, Humidity max. 70.71% and min. 33.57%, wind 0.90 km/h and sunshine 7.82 cm./day.

CHAPTER – V

DISCUSSION

In this chapter an attempt has been made to elucidate the findings of the present investigation entitled "**Study on flowering and fruiting behaviour of mango cultivars in relation to weather parameter. (Temperature, Humidity , wind , sunshine)"** have been discussed critically in the light of recent review of literature. The whole findings have been discussed in the appropriate headings viz. Growth of plant, flowering, fruiting, yield, Disease, Insect, pest, fruit quality, keeping quality and correlation.

5.1 Growth of plant

Maximum growth parameters viz. tree height, tree spread (N-S) and (E-W), girth of root stock, girth of scion, canopy height, volume of tree, was recorded in Langra and Mallika. The remaining varieties exhibited lower in all characteristics.

The growth and development of a variety having a definite genetic character in particular set of environmental conditions shows positive relation. The variation in vegetative growth characters among mango varieties might be due to variation in genetic make up. High variability in vegetative growth amongst the mango varieties have also been reported that Shrivastava *et al*. (1987), Singh *et al.* (1998) and Murti and Upreti (2004).

5.2 Flowering behaviours

The earliest emergence of flower and maximum size of panicle was observed in Sundarja. On the other hand the 50% and 100% of flowering was earliest in Dashehari. The maximum number of hermaphrodite flower was noted in Langra followed by Dashahari. Maximum hermaphrodite flowers was obtained in temperature 33.47^{o}C (Max) 35.4^{o}C and minimum in 18.4^{o}C and 18.7^{o}C respectively and other weather parameters that increased the fruit set in all variety studied. It is really interesting to note that the percentage of hermaphrodite flower increase with advance of age of the trees. Significant variations in percentage of hermaphrodite flower were also observed in different

sides of the tree. Lowest percentage of hermaphrodite flower was found in east side and highest in the north. It seems probable that he differences in percentage of hermaphrodite flowers on different sides of the tree, may be due to photoperiodism. The mechanism of variation in the percentage of hermaphrodite flowers in the first and second flush and those given out from secondary or tertiary branches are situated in side of the tree where light is less intease to retain higher percentage of mature fruits. These results carrobarate with those of Thimmappaiah and Suman (1987), Tsai *et al*. (1996), Avilan *et al*. (1998), Singh et al. (1998), Liv et al. (1998), Dod et al. (1999), Sukhvibul et al. (1999), Shu (1999) and Chang and Cho (2001).

5.3 Fruiting behaviours

The maximum mustard size of fruits and fruit drop was obtained from Langra. The maximum pea size, marble size, mature fruit and earliest harvesting was observed in Dashehari.

The variations observed in fruiting behaviours may be attributed to the genetic nature of varieties and weather parameter. Fruit drop in mango during initial stages is reported to vary with growth of fruitlets. It is more on number basis at mustard stage and on weight basis at marble stage (active fruiting growth phase). This reveals that the drop of larger fruitlets (those at marble stage) is more associated to ethylene evolution than those of smaller fruitlets. These finding similar with those of Shrivastava *et al*. (1987), Jana and Sharangi (1998), Muhammad *et al*. (2002a) and Kumar and Jaiswal (2003).

5.4 Insect pest and disease

The maximum incidence of malformation, mango hopper and leaf folder was observed in Langra and the remaining varieties exhibited less than the these varieties. The variation in the incidence of malformation amongst the varieties may probably be related to the genetic characters of the variety.

The variations in the incidence of mango hppper and leaf folder may be related the temperature, humidity, wind and sunshine. Maximum incidence of mango hopper was noted in the month of March in Langra variety. It might be due to dark space and soil moisture in the periferi of the variety. These similar

findings with those of Kumar (1999), Singh (2002), Pandey *et al*. (2003) Kundan and Syamal (2004).

5.5 Yield and fruit quality

The maximum number of fruits, weight of fruits, peel percentage and acidity was recorded in Dashehari and the maximum weight per fruit and pulp percentage was found in Mallika. The maximum stone percentage and TSS was found Langra and the maximum length of fruits and keeping quality was recorded in Totapari. The maximum breadth per fruit was recorded in Sundarja. It is really interesting to note that variety Dashahair gave higher yield than other variety may be due to “off year” season in last year and they reserves the carbohydrate synthesis that increase higher yield. These similar findings those of (Rajput and Panday (1997), Ghosh and Chattopadhyay (1995), Shinde *et al*. (2001), Kumar and Jaiswal (2003), Anila and Radha (2003) and Muhammad *et al*. (2004).

5.6 Correlation studies on growth, yield and fruit quality-

It is clear from the table 4.10, fruit yield positively correlated with plant height, canopy height, spread (N-S and E-W), average fruit weight, quality parameter. Mature fruit was positively and significantly correlated with number of fruit/tree and weight of fruit/tree. However, it was negative correlated with fruit drop. Similar correlation along with various parameters of mango was observed by Oppenheimer (1960), Pongsomboon *et al.* (1997), Chakrabarti *et al.* (1997), Chakrawar and Jature (1980) reported that correlation was positive between the yield and number of fruit plant. Prasad (1987) reported that positive significant association between the number of fruits, their size with T.S.S., fruit weight.

CHAPTER-VI

SUMMARY CONCLUSION AND SUGGESTION FOR FURTHER WORK

Summary

The present investigation "**Study on flowering and fruiting behavior of mango cultivars in relation to weather parameter. (Temperature, Humidity, Wind, Sunshine)"** was carried out in the orchard at Fruit Research Station , Kuthulia, College of Agriculture, Rewa (M.P.) during the year 2011-12.

The experiment consisted of five commercial varieties viz. Dashehari, Mallika, Sundarja, Totapari and Langra.

The grafted plants of these varieties were planted at the recommended distance of 10 x 10m. The experiment was conducted in the randomized block design consisting of four replications. Two plants were planted per replication. The remarkable result obtained from this investigation are below.

1. Maximum plant growth were noted in Langra followed by Mallika and Dashehari.
2. Maximum volume of tree was noted in Mallika (545.36m^3) followed by Dashehari (539.0 m^3) and Langra (526.4 m^3).
3. The earliest emergence of flower was observed in Sunderja.
4 The maximum volume of tree was noted under Mallika (545. 36 m^3) followed by Dashehari (539.00 m^3) and Langra (526..43 m^3). Where as the minimum volume of tree was noted under Totapari (239.20 m^3) and Sundarja (286.90m^3 m).
5 The earliest emergence of flower was observed under Sundarja (5th Jan.) followed by Mallika (8th Jan.) and Dashehari (10th Jan.). Where as late emergence of flower was observed under Totapari (17 Jan.) and Langra (12 Jan.)
6 The earliest 50% of flowering was observed under Dashehari (13th Feb.) and Mallika (15th Feb.). Late flowering was observed under Totapari (28th Feb.) followed by Langra (23th Feb.) and Sundarja (20th Feb.)

7 The earliest 100% of flowering was observed under Dashehari (4th March.) and Mallika (6th March.). Late flowering was observed under Totapari (13th March.) followed by Langra (10th March.) and Sundarja (9th March)

8 The maximum size of panicle was noted under Sundarja (33.00 cm) and minimum size Langra (15.41 cm) followed by Totapari (17.21 cm) Mallika (18.12 cm) and Dashehari (20.24 cm).

9 The maximum no. of male flower was noted under Dashehari (543.88) and Sundarja (519.63). The minimum no. of male flower was noted under Mallika (238.38) followed by Langra (254.38) and Totapari (262.25).

10 The maximum no. of hermaphrodite flower was noted under Langra (503.59). The minimum no. of hermaphrodite flower was noted under Totapari (74.03), Sundarja (171.03) and Dashehari (233.40).

11 The maximum total no. of flower was noted under Dashehari (777.19) followed by Langra (757.97) and Sundarja (690. 68). The minimum total no. of flower was noted under Mallika (312.84) and Totapari (362.28).

12 The maximum no. of hermaphrodite flower in north direction was noted under Langra (656.13) The minimum flower was noted under Totapari (105.88) followed by Mallika (129.25). Sundarja (196.75) and Dashehari (343.63)

13 The maximum no. of hermaphrodite flower in south direction was noted under Langra (498.50) The minimum flower was noted under Mallika (55.50) followed by Totapari (66.00), Sundarja (158.75) and Dashehari (209.75)

14 The maximum no. of hermaphrodite flower in east direction was noted under Langra (394.38) The minimum flower was noted under Mallika (49.63) followed by Totapari (58.00,). Sundarja (147.38) and Dashehari (158.13).

15 The maximum no. of hermaphrodite flower in west direction was noted under Langra (465.00). The minimum flower was noted under Mallika (63.50) followed by Totapari (68.00). Sundarja (181.25) and Dashehari (222.00).

16 The maximum sex ratio was noted under Langra (68.30) The minimum sex ratio was noted under Totapari (20.47) followed by Sundarja (24.56),

Mallika (25.58) and Dashehari (30.12)

17 The maximum mustard size of fruit was noted under Langra (171.25) followed by Sundarja (142.50) and Dashehari (102.25). The minimum fruit was noted under Mallika (46.25) and Totapari (70.00).

18 The maximum pea size fruit was noted under Dashehari (23.88). The minimum fruit was noted under Langra (6.25) followed by Totapari (7.13), Mallika (7.25) and Sundarja (16.50).

19 The maximum marble size of fruit was noted under Dashehari (6.00). The minimum fruit was noted under Totapari (1.25) followed by Langra 91.75), Mallika (2.13) and Sundarja (4.25).

20 The maximum mature fruit was noted under Dashehari (2.63). The minimum fruit was noted under Totapari (0.75) followed by Langra (0.88) Mallika (1.00) and Sundarja (1.13).

21 The maximum fruit drop was recorded under Langra (87.05%). Where as minimum fruit drop was recorded under Sundarja (38.64%) followed by Mallika (50.33%), Dashehari (52.96%) and Totapari (53.20%)

22 The earliest harvesting was observed under Dashehari (29th May). Late harvesting was observed under Totapari (15th July followed by Mallika (17th June), Sundarja (15th June) and Langra (5th June).

23 The maximum number fruits was recorded under Dashehari (328.38) Where as minimum number was found under Mallika (120.38) followed by Totapari (138.40), Sundarja (153.95) and Langra (170.58).

24 The maximum weight of fruit per tree was recorded under Dashehari (87.01kg) . Where as minimum weight of fruit per tree was recorded under Sundarja (34.28 kg) followed by Mallika (36.13 kg), Totapari (38.50 kg) and Langra (41.78 kg).

25 The maximum incidence of malformation was observed under Langra (47.79%) followed by Sundarja (42.56%). Where as minimum incidence was noted under Totapari (2.99%) followed by Dashehari (7.32 %) and Mallika (21.14%)

26 The maximum incidence of mango hopper in January was observed under Langra (1.67) followed by Mallika (1.29) and Dashehari (1.18). The minimum incidence was observed under Totapari (0.38) followed by

Sundarja (0.50)

27 The maximum incidence of mango hopper in February was observed under Langra (6.45) followed by Mallika (6.13) and Dashehari (6.00). The minimum incidence was observed under Totapari (1.45) and Sundarja (1.69).

28 The maximum incidence of mango hopper in March was observed under Langra (20.73) followed by Mallika (20.14) and Dashehari (19.85). The minimum incidence was observed under Totapari (8.25) and Sundarja (9.23)

29 The incidence of mango hopper in April was noted under Langra (13.13) followed by Mallika (12.29) and Dashehari (11.88). The minimum incidence was noted Totapari (9.88) followed by Sundarja (11.16).

30 The maximum web. mass was noted under Langra (25.45 mass). The minimum web mass noted under Totapari (11.95mass) followed by Sundarja (13.71 mass), Mallika (18.83) and Dashehari (19.79).

31 The maximum weight of fruit was recorded under Mallika (299.50 gm) followed by Totapari (278.43 gm) and Dashehari (268 gm). The minimum weight per fruit was recorded under Sundarja (223.53 gm) and Langra (245.44 gm)

32 The maximum length of fruit was recorded under Totapari (14.35 cm). The minimum length of fruit was recorded under Langra (10.12 cm) followed by Sundarja (10.42 cm), Mallika (12.54 cm) and Dashehari (13.06 cm)

33 The maximum breadth of fruit was recorded under Sundarja (7.79 cm).followed by Mallika (7.63 cm) and Totapari (7.32 cm). The minimum breadth of fruit was recorded under Langra (6.63cm) and Dashehari (6.88 cm).

34 The maximum peel was noted under Dashehari (16.96%) and Totapari (15.00 %). The minimum peel was noted under Langra (12.11%) followed by Mallika (12.63%) and Sundarja (14.67%).

35 The maximum pulp was noted under Mallika (76.15%). The minimum pulp was noted under Totapari (72.75 %) followed by Sundarja (72.82%). Dashehari (73.54%) and Langra (74.39%)

36 The maximum stone was noted under Langra (13.50%) followed by

Sundarja (12.52%) and Totapari (12.25%). The minimum stone was noted under Dashehari (9.50%) and Mallika (11.23%).

37 The maximum TSS of fruit was recorded under Langra (23.74 ^{0}brix) and Sundarja (22.73 ^{0}brix). The minimum TSS of fruit was recorded under Totapari (15.23 ^{0}brix) followed by Mallika (21.59 ^{0}brix) and Dashehari (21.80 ^{0}brix).

38 The maximum acidity was recorded under Dashehari (0.39%). The minimum acidity was recorded under Langra (0.26%) followed by Totapari (0.27%), Mallika (0.28%) and Sundarja (0.32%).

39 The maximum keeping quality was recorded under Totapari (11.00 day) and Sundarja (10.63 day). The minimum keeping quality was recorded under Langra (6.00 day) followed by Mallika (6.75 day) and Dashehari (8.50 day).

CONCLUSION

As per the findings of the present investigation variety Dashehari was found to be the highest yielding (87.01 kg/tree). Mallika, Sundarja, Dashehari, Langra, were found better in fruit quality (physio-chemical properties). However totapari gave maximum keeping quality.

SUGGESTION FOR FURTHER WORK

1. The experiment should be repeated to confirm the finding of the present investigation.
2. Floral biology of these varieties should be studied in detail
3. Maturity index of these varieties should be studied to find out early , mid and late varieties
4. Chemical analysis of the fruits should also be done to find out the suitable varieties of better quality.
5. East to West direction for row to row, wider than 10 X 10m, within row spacing of 5 to 8 m may be studied for the fore said characters of mango varieties under study.

BIBLIOGRAPHY

A.O.A.C. (1970) Methods of analysis of association of official agricultural chemist , washington , D.C.

Anila, R. and Radha, T. (2003). Physico- chemical analysis of mango varieties under kerala conditions. *Journal of tropical Agriculture* **41** : 20-22.

Anila, R. Radha,T. (2003). Studies on fruit drop in mango varieties. *Journal of tropical – Agriculture,* **41** (1/2): 30-32.

Aonymous (2010) Horticulture division ministry of agriculture (2010). http.// dacent. net in /eands/ At Glance (2010)/ S./ %. xis.

Avilan, L. Darantes, I., Rodriguez, M., Arellano, J. (1998).Characterization and flowering behavior of several mango cultivars. *Agronomia-Tropical – Maracay*. **48** (1):69-82.

Chakarbarti, D.K., Kumar, R. and Ali,s (1997). Mango malformation seasonal variation in Fusarium moniliforme , population in relation to environmental factors, Mangiferin content and flushings in *mangifera indica*(L.). *Indian – Journal of Plant protection,* **25** (2) : 146-148.

Chakrawar, V.R. and Jature, S.D. (1980). Correlation studies on Kazilime strantns. *Punjab Hort. J.* **20**: 39-40.

Chang, Jerway and Chao-Chengnan (2001). Effects of air temperature and rainfall on flower and fruit drop in mango . *Chinese Journal of Agrometerlogy,* **7** (4) : 33-41.

Dag, A. Eisenstem, D. and Gazit, S. (2000). Effect of temperature regine an pollen and the effective pallination of ‘kent’ mango in Isreal. *Scientia Horticulture,* **86** (1) : 1- 11.

Dhillon, W.S. and Kumar Ashwinder (2004). Some physio-biochemical changes during fruit development in pomegranate. *Indian J. Hort.,* **61** (3) : 219-222.

Dod, V.N., Bharad, S.G. and Jadhao, B. J. (1999). Flowering and fruiting behaviour of different varieties of mango (*Mangifera indica* L.) under hot and dry climatic condition of Akola. *Crop Resarch Hisar*, **17** (3) : 329-332.

Espinola, Sobrinho, J., Menezes, J.B., Souza, T.H., Melo, F.C., Leitao, M.M. V.B.R., Machado, F.L.C. (2004). Effect of air temperature on mango tree yield and fruit quality. *Acta Horticulture*, **645** : 189-194.

Galvis, J.A., Arjona, H., Fischer, G. Landwehr, T. Martinez, R. (2002). Influence of temperature and storage time on quality of mango fruit (*Mangifera indica* L.) variety vandyke . *Agronomic colombiana* **19** (1/2) : 23-35.

Ghosh, S.N., and Chattopadhyay, N. (1995). Performance of some mango cultivars in rainfed semi-arid region of West Bengal. Proceeding national symposium on sustainable agriculture in sub humid zone, 173-176.

Godase, S.K., Bhole, S.R., Shivpuje, P.R., Patil, B.P. (2004). Assessment of yield less in mango (*Mangifera indica*) due to mango hopper. *Indian Journal of Agricultural Sciences,* **71** (7) : 370-372.

Gurdeep, Bains and Pant, R.C. (2003). Mango malformation etiology and preventive measures. *Physiology and malecular Biology of Plants*, **9** (1) : 41-61.

Jacobi, K.K. Macrae, E.A and Hetherington, S.E. (2001b). Effect of fruit maturity on the response of ‘kensington’ mango fruit to heat treatment. *Australion Journal of Experimental Agriculture*, **41** (6) : 793-803.

Jacobi, K.K. Macrae, E.A. and Hetherington, S.E. (2001a). Loss of heat tolerance in kensington mango fruit following heat treatments. *Postharvest Biology and technology,* **21** (3) : 321-330.

Jana, A and Sharangi, A.B. (1998). Fruit drop in different varieties of mango (*Mangifera indica*L.). *Environment and Ecology*, **16** (1) : 127-131.

Kannan, M. and Rao, N.N. (2003). Effect of meteorological parameters on the population dynamics of leaf and flower feeder on mango (*Mangifera indica* L.). *Insect Environment,* **9** (2) : 88.

Kaushal, R., Parmar, R. , Sharma, S.D. and Bist, H.S. (2004). Floral morphological and flowering studies in some plum and apricot cultivar. *Indian J. Hort.,* **61** (2) : 276-277.

Kudachikar, V.B., Kulkarni, S.G. , Aradhya , S.M., Prasad, B.A. and Ramana, K.V.R. (2003). Physico-chemical changes in mango (*Mangifera indica* L.) varieties. Alphonso and Raspuri during fruit development and maturation. *Journal of food science and technology Mysore*, **40** (3) : 285-289.

Kumar, Naresh and Jaiswal U.S. (2003). Bearing behaviour of some west and south indian mangoes. *Haryana Journal Horticultural Sciences,* **32** (3/4) : 154-158.

Kumar, R. and Chakarabarti, D.K. (1997). Assessment of loss in yield of mango (*Mangifera indica*) caused by malformation . *Indian J. Agrice Sci.* **67** (3): 130-131.

kumar, Rajendra (1999). Associations and their partition for mango malformation. *Annals of Biology Ludhiana*, **15** (2) : 167- 172.

Kumar,N. and Jaiswal, U.S.(2004).Bearing behavior of some south and west Indian mangoes.1.vegetative growth. *Haryana Journal of Horticultural Sciences*, **33** (1/2):9-10

Kundan, Kishore and Syamal, M.M. (2004). Studies on the floral biology of healthy and malformaed panicles of mango (*Mangifera indica* L.) cv. Amrapali*, Advances in plant Sciences*, **17** (1) : 279-281.

Lad, B.L., Pujari, K.H. and Magdum, M.B. (1999). Effect of thermoperiodic changes on flowering behavior in mango under coastal climate of Maharashtra. *Annals of plant physiology*, **13** (1) : 38 – 46.

Liv- zhition, Luo- Guanxing, Yan, Yu (1998). Effect of frost one the flowering of mango . South china fruits, **27** (2) : 32.

Muhammad Asif, Muhammad Usman, Muhammad Jafar Jaskani and Muhammad Mumtaj Khan (2004). Comparative study of flower sex ratio in different cultiavars of mango . *International J. Agriculture and Biology,* **04** (2) : 220-222.

Muhmmad, Asif, Muhammad, Usman, Fatima, B., Jaskani, M.J. and Khan, M.M. (2002a). Fruit set and drop behaviour of three commercial cultivar of mango . *Pakistan J. Agric. Sci*., **39** (2) : 129 – 131.

Muhmmad, Nadeem, Muhmmad, Arshad, Umar, Iqbal and Zia, M.A. (2004 b). Physico-chemical analysis of some Pakistani mango varieties. *Indus Journal of Biological Sciences*, **1** (3) : 175 – 182.

Mukunda, G.K., Thimmaraju, K.R. and Bojapa, K.M. (1988). Effect of direction and position of the tree on open pollination in mango . *Acta Horticulture* **231** : 138 – 141.

Murti, G.S.R. and Upreti, K.K. (2004). An analysis of possible causes for poor flowering in mango under Bangalore conditions. *Indian J. Hort*. **61** (4) : 289-291.

Muzaffar A., Talpur, Rabdino, Khuhro and Intiaz A. Nizamani (2002). Phenological relationship between mango hoppers Indoscopes spp. and mango inflorescence fruit . *Pakistan J. Applied Sciences*, **2** (5): 533-536.

Nakamura, N., Rao, D.V.S., Shina, T. and Nuwa, Y. (2003). Effects of temperature and gas composition on respiratory behavior of tree ripe. Irwin, Mango *, Acta Horticulture* **600** : 425-429.

Nilesh, Bhowmick and Banik, B.C. (2005). Yield and physico chemical properties of some mango cultivars in new alluvial zone of west Bengal. *Environment and Ecology*, **23** (3) : 503-506.

Oppenheimer, E. (1960). The relationship between tree size and yield of mango (*Mangifera indica* L.) and avocado (*Persea americdana milli*.) *Hort. Adv*. **4**: 6-15.

Pandey, V., Patel., M.G., Chaudhari, G.B. , Patel, J.R. Bhatt, B.K., Vadodaria, R.P. and Shekh, A.M. (2003). Influence of weather parameters on the population dynamics of mango hopper. *Journal of Agro-meteorology*, **5** (13 : 51-59).

Pongsomboon, W. Subhadrabandhu, S. and Stephenson, R.A. (1997). Some aspects of the ecophysiology of flowering intensity of mango *(Mangifera indica* L.) cv. Nam Dokimai in a semi tropical monsoon asian climate. *Scientia Horticulture*, **70** (1) : 45-56.

Prasad, A. (1987). Correlation studies on growth behaviour and fruit characters with yield components in mango *Indian J. Hort*. **44** (3 & 4): 176-183.

Rajput, S.S. and Pandey, S.D. (1997). Studies on physico-chemical characteristics of some mango cultivars under chhattisgarh region of Madhya Pradesh . *Horticultural Journal ,* **10** (1) : 9 – 14.

Selvaraj, Y., pal, D.K., Edwaral Raja, M. and Rawal, R.D. (1999). Change in chemical composition of guava fruits during growth and development. *Indian J. Hort.,* **56** (1) : 10-18.

Shinde, A.K. Burondkar, M.M., Bhingarde, R.T., Waghmare, G.M., Rangwala, A.D. and Wagh, R.G. (2001). Heat unit requirement for fruit maturity

in mango varieties. *Indian Journal of Plant Physiology*, **6** (2) : 194-196.

Shrivastava, S.S., Asati , M.K., Patel, M.P., Tiwari, B.L. and Bhadauria, U.P.S. (1987). Evaluation of mango varietis in M.P. *Indian J. Hort.* **44** (3/4) 97-201.

Shu, Z.H. (1999). Effect of temperature on the flowering biology and fertilization of mango (*Mangifera indica L.). Journal of Applied Horticulture Lucknow,* **1** (2) : 79-83.

Singh, Bhawna and Arora , R.L. (2000). Changes in biochemical constituents in developing peach fruits. *Indian J. Hort*. **57** (1) : 35 – 38.

Singh, C. and Bhagat, B.K. (1988). Comparative studies on the floral biology of early and late cultivars of mango. *Acta Horticulture*, **231** : 152 – 154.

Singh, R.S., Vashishtha, B.B. and Prasad, R.N. (1998). Micro meteorology of ber (*Zizyphus mauritiona* (L.)). orchard grown under rainfed arid condition . *Indian J. Hort*., **55** (2) : 97-107.

Singh, Rajesh, Mishra, K.K. and Jaiswal, H.R. (2000). Studies on physio-chemical character of fruit of Beal genotypes. *Indian J. Hort.*, **57** (4) : 314-317.

Singh, Sanjay (2002) Studies on intensity and suseptibility of floral malformation in different mango genotypes. *New Botanist,* **29** (1/4) : 121-128.

Singh, V.K., Saini, J.P. and Mishra, A.K. (1998). Mango malformation in relation to physiological parameters under elevated temperature. *Indian Journal of Plant Physiology*, **3** (3) : 231-233.

Sukhvibul, N., Hetherington , S.E., vithanage, V., Whiley, A.W. and Smith, M.K. (2000). Effect of temperature on infloresensce development

and floral biology of mago (*Mangifera indica* L.). *Acta Horticulture* **(509)** : 601- 607.

Sukhvibul, N., Whiley, A.W., Smith, M.K., Hetherington, S.E. and vithanage, V. (1999). Effect of temperature on inflorescence development and sex expression of mono and poly embryanic mango cultivar . *Journal of Horticultural Science and biotechnology* **74** (1) : 64-68.

Thimmappaiah and Suman , C.L. (1987). Sex in relation to fruit set and fruit yield in mango . *Punjab Hort*., **27** (1-2) : 8-11.

Tsai Jinchuan, Yao Minghwi, ChikungShy, Liang Shing (1996). Studies on the relation ships between climatic element and the yield of mango in yuching area. *Journal of Agriculture Resarch of China* , **45** (2) : 186-191.

Verma, Rajesh and Singh Swati (2010), Seasonal activity of the mango leaf webber arthaga euadrusalis walker. *Insect Environment*, **16** (1) : 22.

Zhu shijiang, Jizuoliang, Zhang Zhaodi and Luwang jin (2003). The relationship between heat induced chilling tolerance and the changes in protein contents. *Acta Horticulture Sinica*, **30** (2) : 198-200.

APPENDIX –I

Analysis of variance table Tree height (m)

ANOVA TABLE					
source	df	ss	ms	fcal	f. tab at 5%
rep	3	2.504	0.835	2.284	3.88
treatment	4	3.517	0.879	2.406	3.26
error	12	4.385	0.365		
total	19				

APPENDIX –II

Analysis of variance table Tree spread (N-S) (m)

ANOVA TABLE					
source	df	ss	ms	fcal	f. tab at 5%
rep	3	3.263	1.088	4.693	3.88
treatment	4	29.706	7.426	32.044	3.26
error	12	2.781	0.232		
total	19				

APPENDIX –III

Analysis of variance table Tree spread (E-W) (m)

ANOVA TABLE					
source	df	ss	ms	fcal	f. tab at 5%
rep	3	1.186	0.395	1.041	3.88
treatment	4	34.347	8.587	22.616	3.26
error	12	4.556	0.380		
total	19				

APPENDIX –IV

Analysis of variance table Girth of root stock (m)

ANOVA TABLE					
source	df	ss	ms	fcal	f. tab at 5%
rep	3	0.250	0.083	4.863	3.88
treatment	4	0.353	0.088	5.150	3.26
error	12	0.205	0.017		
total	19				

APPENDIX –V

Analysis of variance table Girth of Scion (m)

ANOVA TABLE					
source	df	ss	ms	fcal	f. tab at 5%
rep	3	0.254	0.085	4.809	3.88
treatment	4	0.343	0.086	4.877	3.26
error	12	0.211	0.018		
total	19				

APPENDIX –VI

Analysis of variance table Canopy height (m)

ANOVA TABLE					
source	df	ss	ms	fcal	f. tab at 5%
rep	3	1.782	0.594	1.153	3.88
treatment	4	4.021	1.005	1.951	3.26
error	12	6.184	0.515		
total	19				

APPENDIX –VII

Analysis of variance table Volume of tree (m3)

ANOVA TABLE					
source	df	ss	ms	fcal	f. tab at 5%
rep	3	30056.949	10018.983	2.325	3.88
treatment	4	365343.282	91335.820	21.194	3.26
error	12	51715.280	4309.607		
total	19				

APPENDIX –VIII

Analysis of variance table Date of first appearing flower

ANOVA TABLE					
source	df	ss	ms	fcal	f. tab at 5%
rep	3	154.850	51.617	2.450	3.88
treatment	4	313.425	78.356	3.720	3.26
error	12	252.775	21.065		
total	19				

APPENDIX –IX

Analysis of variance table Date of 50 % flowering

ANOVA TABLE					
source	df	ss	ms	fcal	f. tab at 5%
rep	3	38.837	12.946	0.380	3.88
treatment	4	579.575	144.894	4.249	3.26
error	12	409.225	34.102		
total	19				

APPENDIX –X

Analysis of variance table Date of 100 % flowering

ANOVA TABLE					
source	df	ss	ms	fcal	f. tab at 5%
rep	3	27.037	9.012	1.339	3.88
treatment	4	175.925	43.981	6.534	3.26
error	12	80.775	6.731		
total	19				

APPENDIX –XI

Analysis of variance table Size of Panicle (cm)

ANOVA TABLE					
source	df	ss	ms	fcal	f. tab at 5%
rep	3	36.963	12.321	1.042	3.88
treatment	4	792.588	198.147	16.754	3.26
error	12	141.922	11.827		
total	19				

APPENDIX –XII

Analysis of variance table No. of male flower

ANOVA TABLE					
source	df	ss	ms	fcal	f. tab at 5%
rep	3	16006.000	5335.333	0.450	3.88
treatment	4	378904.200	94726.050	7.996	3.26
error	12	142167.000	11847.250		
total	19				

APPENDIX –XIII

Analysis of variance table No. of hermaphrodite flower

ANOVA TABLE					
source	df	ss	ms	fcal	f. tab at 5%
rep	3	11185.463	3728.488	2.180	3.88
treatment	4	500447.885	125111.971	73.145	3.26
error	12	20525.704	1710.475		
total	19				

APPENDIX –XIV

Analysis of variance table No. of hermaphrodite flower in north direction

ANOVA TABLE					
source	df	ss	ms	fcal	f. tab at 5%
rep	3	23598.137	7866.046	1.764	3.88
treatment	4	821175.075	205293.769	46.042	3.26
error	12	53505.925	4458.827		
total	19				

APPENDIX –XV

Analysis of variance table No. of hermaphrodite flower in south direction

ANOVA TABLE					
source	df	ss	ms	fcal	f. tab at 5%
rep	3	11593.200	3864.400	2.493	3.88
treatment	4	518834.700	129708.675	83.686	3.26
error	12	18599.300	1549.942		
total	19				

APPENDIX –XVI

Analysis of variance table No. of hermaphrodite flower in East direction

ANOVA TABLE					
source	df	ss	ms	fcal	f. tab at 5%
rep	3	14095.100	4698.367	3.667	3.88
treatment	4	310679.750	77669.938	60.620	3.26
error	12	15375.150	1281.263		
total	19				

APPENDIX –XVII

Analysis of variance table No. of hermaphrodite flower in Wast direction

ANOVA TABLE					
source	df	ss	ms	fcal	f. tab at 5%
rep	3	3987.450	1329.150	0.789	3.88
treatment	4	428467.200	107116.800	63.603	3.26
error	12	20209.800	1684.150		
total	19				

APPENDIX –XVIII

Analysis of variance table Total No. of flower

ANOVA TABLE					
source	df	ss	ms	fcal	f. tab at 5%
rep	3	48477.621	16159.207	0.814	3.88
treatment	4	806299.716	201574.929	10.149	3.26
error	12	238348.747	19862.396		
total	19				

APPENDIX –XIX

Analysis of variance table Total No. of flower

ANOVA TABLE					
source	df	ss	ms	fcal	f. tab at 5%
rep	3	21.745	7.248	0.167	3.88
treatment	4	6135.988	1533.997	35.345	3.26
error	12	520.815	43.401		
total	19				

APPENDIX –XX

Analysis of variance table Mustard size of fruits /panical

ANOVA TABLE					
source	df	ss	ms	fcal	f. tab at 5%
rep	3	6982.150	2327.383	1.117	3.88
treatment	4	41875.700	10468.925	5.026	3.26
error	12	24993.600	2082.800		
total	19				

APPENDIX –XXI

Analysis of variance table Pea size of fruits /panical

ANOVA TABLE					
source	df	ss	ms	fcal	f. tab at 5%
rep	3	27.800	9.267	1.079	3.88
treatment	4	961.825	240.456	27.994	3.26
error	12	103.075	8.590		
total	19				

APPENDIX –XXII

Analysis of variance table Marble size fruits /panical

ANOVA TABLE					
source	df	ss	ms	fcal	f. tab at 5%
rep	3	0.938	0.313	0.250	3.88
treatment	4	63.700	15.925	12.740	3.26
error	12	15.000	1.250		
total	19				

APPENDIX –XXIII

Analysis of variance table Mature size of fruits /panical

ANOVA TABLE					
source	df	ss	ms	fcal	f. tab at 5%
rep	3	0.337	0.113	0.545	3.88
treatment	4	9.425	2.356	11.424	3.26
error	12	2.475	0.206		
total	19				

APPENDIX –XXIV

Analysis of variance table Fruits Drop (%)

ANOVA TABLE					
source	df	ss	ms	fcal	f. tab at 5%
rep	3	235.303	78.434	0.401	3.88
treatment	4	5255.295	1313.824	6.718	3.26
error	12	2346.674	195.556		
total	19				

APPENDIX –XXV

Analysis of variance table Harvesting Period (Days)

ANOVA TABLE					
source	df	ss	ms	fcal	f. tab at 5%
rep	3	3.238	1.079	3.178	3.88
treatment	4	1142.425	285.606	841.049	3.26
error	12	4.075	0.340		
total	19				

APPENDIX –XXVI

Analysis of variance table No. of fruits / tree

ANOVA TABLE					
source	df	ss	ms	fcal	f. tab at 5%
rep	3	1518.393	506.131	0.181	3.88
treatment	4	112164.053	28041.013	10.030	3.26
error	12	33548.319	2795.693		
total	19				

APPENDIX –XXVII

Analysis of variance table Weight of fruits / tree (kg.)

ANOVA TABLE					
source	df	ss	ms	fcal	f. tab at 5%
rep	3	88.324	29.441	0.379	3.88
treatment	4	7914.822	1978.705	25.475	3.26
error	12	932.059	77.672		
total	19				

APPENDIX –XXVIII

Analysis of variance table Mango hopper per panicle (January)

ANOVA TABLE					
source	df	ss	ms	fcal	f. tab at 5%
rep	3	0.374	0.125	1.022	3.88
treatment	4	4.798	1.199	9.830	3.26
error	12	1.464	0.122		
total	19				

APPENDIX –XXIX

Analysis of variance table Mango hopper per panicle (February)

ANOVA TABLE					
source	df	ss	ms	fcal	f. tab at 5%
rep	3	0.553	0.184	1.132	3.88
treatment	4	102.997	25.749	158.294	3.26
error	12	1.952	0.163		
total	19				

APPENDIX –XXX

Analysis of variance table Mango hopper per panicle (March)

ANOVA TABLE					
source	df	ss	ms	fcal	f. tab at 5%
rep	3	18.003	6.001	13.612	3.88
treatment	4	638.496	159.624	362.080	3.26
error	12	5.290	0.441		
total	19				

APPENDIX –XXXI

Analysis of variance table Mango hopper per panicle (April)

ANOVA TABLE					
source	df	ss	ms	fcal	f. tab at 5%
rep	3	1.768	0.589	0.747	3.88
treatment	4	23.927	5.982	7.578	3.26
error	12	9.473	0.789		
total	19				

APPENDIX –XXXII

Analysis of variance table Leaf folder (Webmass/tree) October

ANOVA TABLE					
source	df	ss	ms	fcal	f. tab at 5%
rep	3	13.852	4.617	4.307	3.88
treatment	4	457.563	114.391	106.704	3.26
error	12	12.864	1.072		
total	19				

APPENDIX –XXXIV

Analysis of variance table Fruit Weight (gm)

ANOVA TABLE					
source	df	ss	ms	fcal	f. tab at 5%
rep	3	1900.064	633.355	0.902	3.88
treatment	4	13877.493	3469.373	4.942	3.26
error	12	8424.788	702.066		
total	19				

APPENDIX –XXXV

Analysis of variance table Fruit Length (cm)

ANOVA TABLE					
source	df	ss	ms	fcal	f. tab at 5%
rep	3	0.394	0.131	0.217	3.88
treatment	4	51.783	12.946	21.436	3.26
error	12	7.247	0.604		
total	19				

APPENDIX –XXXVI

Analysis of variance table Fruit Breadth (cm.)

ANOVA TABLE					
source	df	ss	ms	fcal	f. tab at 5%
rep	3	0.143	0.048	0.246	3.88
treatment	4	3.881	0.970	4.992	3.26
error	12	2.332	0.194		
total	19				

APPENDIX –XXXVII

Analysis of variance table Peel %

ANOVA TABLE					
source	df	ss	ms	fcal	f. tab at 5%
rep	3	2.397	0.799	0.406	3.88
treatment	4	61.131	15.283	7.768	3.26
error	12	23.609	1.967		
total	19				

APPENDIX –XXXVIII

Analysis of variance table Pulp %

ANOVA TABLE					
source	df	ss	ms	fcal	f. tab at 5%
rep	3	1.584	0.528	0.575	3.88
treatment	4	31.598	7.900	8.598	3.26
error	12	11.025	0.919		
total	19				

APPENDIX –XXXIX

Analysis of variance table Stone %

ANOVA TABLE					
source	df	ss	ms	fcal	f. tab at 5%
rep	3	0.502	0.167	0.229	3.88
treatment	4	36.912	9.228	12.642	3.26
error	12	8.759	0.730		
total	19				

APPENDIX –XXXX

Analysis of variance table T.S.S. (^{0}Brix) %

ANOVA TABLE					
source	df	ss	ms	fcal	f. tab at 5%
rep	3	1.595	0.532	0.397	3.88
treatment	4	179.217	44.804	33.469	3.26
error	12	16.064	1.339		
total	19				

APPENDIX –XXXXI

Analysis of variance table Acidity (%)

ANOVA TABLE					
source	df	ss	ms	fcal	f. tab at 5%
rep	3	0.004	0.001	72.667	3.88
treatment	4	0.045	0.011	566.000	3.26
error	12	0.000	0.000		
total	19				

APPENDIX –XXXXII

Analysis of variance table Keeping quality at room temp. (days)

ANOVA TABLE					
source	df	ss	ms	fcal	f. tab at 5%
rep	3	0.338	0.113	0.265	3.88
treatment	4	80.200	20.050	47.176	3.26
error	12	5.100	0.425		
total	19				