"Evaluation Of Twenty Commercial Varieties Of Mango (Mangifera indica Linn.)"

THESIS

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MASTER OF SCIENCE
IN
AGRICULTURE
(HORTICULTURE)

By

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2003

Dedicated to

My Respected Parents

Father Shri Dashrath Prasad Ji

and

Mother (Smt.) Moonga Bai

CERTIFICATE-I

This is to certify that the thesis entitled, **"Evaluation of twenty commercial varieties of mango (*Mangifera indica* L.)"** submitted in partial fulfillment of the requirements for the degree of **"Master of Science in Agriculture (Horticulture)"** of the Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur, is a record of the bonafide research work carried out by **Shri Ram Abhilash Saket** under my guidance and supervision. The subject of the thesis has been approved by the Student's Advisory Committee and the 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.

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Chairman of the Advisory Committee

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CERTIFICATE-II

This is to certify that the thesis entitled, **"Evaluation of twenty commercial varieties of mango (*Mangifera indica* L.)"** submitted by **Shri Ram Abhilash Saket** to J.N. Krishi Vishwa Vidyalaya, Jabalpur in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE IN AGRICULTURE in the **Department of Horticulture,** College of Agriculture, Rewa (M.P.) has after evaluation been approved by the Student's Advisory Committee after an oral examination of the same.

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Place: Rewa

Date: 3.09.03

(RAM ABHILASH SAKET)
3.9.03

LIST OF ABBREVIATIONS

Words	Abbreviations
at the rate of	@
Centimeter	cm
Co-workers	et al.
Critical difference	C.D.
Cultivar	cv.
Days after sowing	DAS
Degree of centigrade	°C
Days of sowing	D
Figure	Fig.
Fisher's value	"F" value
Gram(s)	g
Kilogram(s)	kg
Metre	m
Mean sum of square	M.S.S.
Nitrogen	N
Non-significant	N.S.
Number	No.
Per hectare	/ ha
Per cent	%
Phosphorus	P
Quintal	q
Significant at 5%	*
Standard error of means	S.Em±
Sum of square	S.S.
Varieties	V

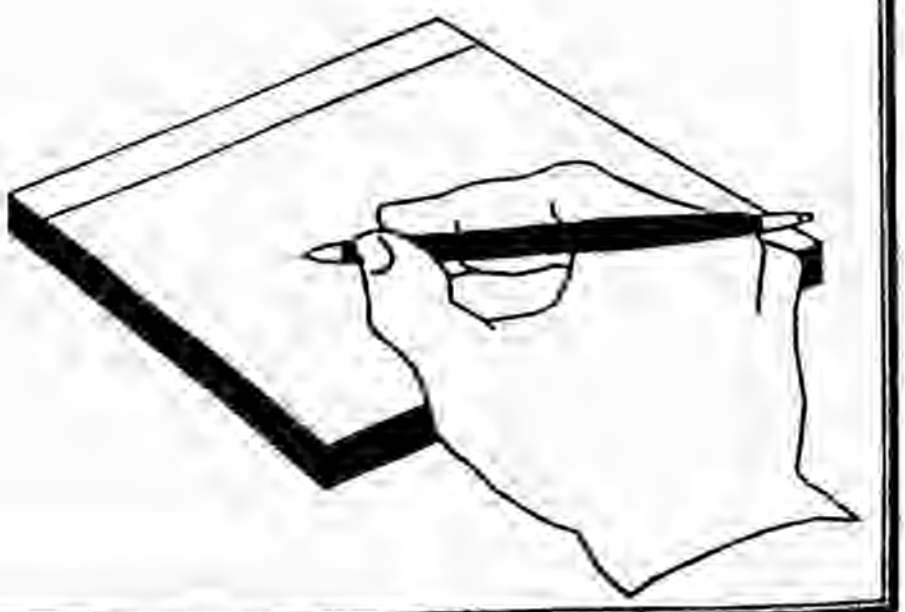
CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER- I

INTRODUCTION



CHAPTER –I

INTRODUCTION

The mango (*Mangifera indica* L.) belongs to the family Anacardiaceae . It is one of the most important commercial fruits of India which is being grown in the country since ancient times. It has great adoptability and thrives under wide range of climatic and soil conditions. Mango undoubtedly deserves to be the national fruit of India. In area, production, nutritive value and popularity of appeal, no other fruit can compete with it.

The mango is indigenous to North-East India and North Burma region (De Candolle, 1884; Popenoe, 1920; Mukherjee, 1953).

Systematic survey on area, production and productivity of mango in the country has not been conducted at regular intervals. However, according to recent statistics available, it occupies about 12,83,030 hectares area with an annual production of 108,10,957 metric tones which contribute about 42.80 per cent of the total area and 52.00 per cent of the total production under fruits in India (Research in Agriculture, 1997-98).

In Madhya Pradesh, it is grown in 18,249 hectares area and the average production/ha is 8.99 tonnes (National Horti. Board 1995-96). It occupies about 4032 hectares and 2004 hectares in Rewa division and Rewa district respectively.

In India, mango is distributed throughout the country except in hilly regions above 915 metres from the sea level. Mango is the choicest fruit of the tropics and is grown in about 87 countries. The total production in the world is estimated to be 19.22 million tones (F.A.O, 1996), out of which the production in India is 10.81 million tonnes which is over 52 per cent of the world's production (National Horticulture Board, 1995-96). Philippines, Indonesia, Thailand, Burma, Malaya, Srilanka, Egypt, South-East Africa, Israel, Tropical Australia, U.S.A, (Hawai and Florida), Mexico, Burma and Cuba are the other countries, where mango is grown extensively.

In India mango is extensively grown in U.P., Bihar and Andhra Pradesh. Other states where mango is an important crop are Madhya Pradesh, West Bengal and Maharashtra. Mango is grown in all the districts of M.P. but the acreage is more in Jabalpur, Raipur, Rewa, Bastar, Durg, Rajnandgaon and Satna (Shrivastava, 1983).

All the cultivated mangoes belong to the single species-*Mangifera indica* Linn. A few other edible species of Mangifera grown in the malaysian region are M. odorta, M. foetida and M.caesia. However , fruits of these species are not as good in quality as those of *Mangifera indica* Linn.

The tree is hardy in nature and has comparatively low cost of culture and maintenance. The tree is perennial, evergreen spreading type and attains good height. Leaves are alternate, flowers small and fruit is a drupe, having a skin or the epicarp, the flesh or the mesocarp and the hard covering of the seed or stone known as the endocarp. Flowering period is January to March under subtropical conditions and fruits are obtained from May to August.

Mango is ancient most popular among Hindus due to it's religious importance in Vedic literature since time. The fruits are utilized in several ways at all the stages of its development. The unripe mango fruits are consumed for domestic uses as chatni, pickles and drinks. The squashes, syrups, jam, jellies are the main products of ripe fruits besides It's other important derivatives of ripe mango fruits which are common in north India during summer. It is also a good source of sucrose, vitamin A, B and C.

Mango leather is prepared from fruits which is used during off season. Dried and roasted kernels of mango are consumed as food by marginal and tribal people.

The consumption of mango in India has increased in recent years. Several small scale industries have come up due to increased consumption of wide variety of mango products. There is also a good scope for the export of mango fruits and their products such as chutney, pickles, juice, nector and mango slices in brine to many countries of the world (DGC15 Ministry of commerce 1997-98). India is exporting about 42, 894 tonnes of fresh fruits and 45,875 tonnes of

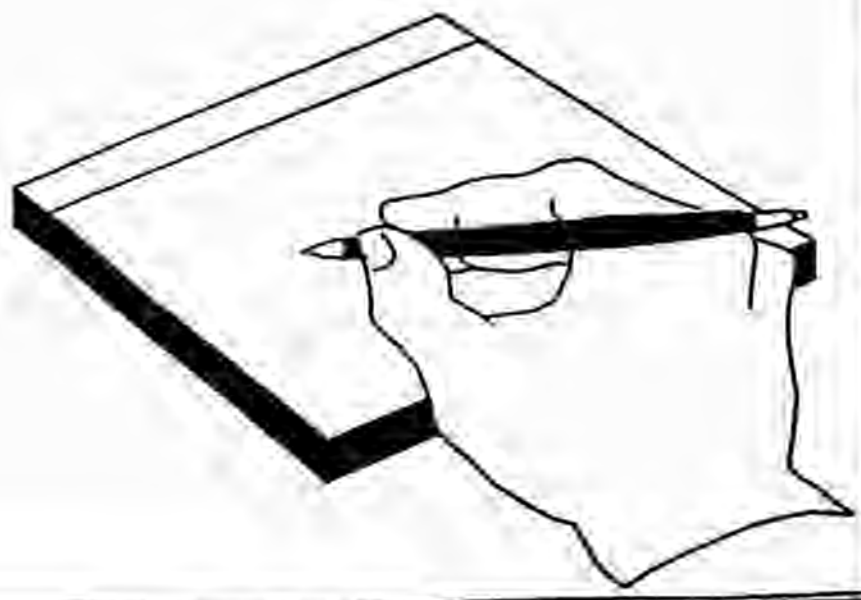
mango pulp to the countries such as U.K., U.S.A., Kuwait, U.S.S.R. and all the middle east and west European counties. Considering the importance and bright scope in near future, an attempt should be made to develop/identify the high yielding and nutritionally superior varieties of mango.

Very little systematic work has so for been done on mango in Madha Pradesh. Therefore an experiment entitled **"Evaluation of twenty commercial varieties of mango (*Mangifera indica* Linn.)"** was undertaken in the year 2002-2003 at Fruit Research Station, Kuthulia, College of Agriculture, Rewa with the following objectives.

1. To assess the flowering and fruiting behaviour and fruit drop in each variety.
2. To observe the intensity of malformation in different varieties under study.
3. To select the high yielding variety/varieties for Rewa region.
4. To select the variety/ varieties on the basis of quality characters.

CHAPTER- II

REVIEW OF LITERATURE



CHAPTER-II

REVIEW OF LITERATURE

A concise research work carried out on the performance of commercial varieties of mango in India and abroad is briefly reviewed in this chapter under the following heads:

2.1 Vegetative growth

2.2 Flowering

2.3 Malformation

2.4 Fruit drop

2.5 Fruiting behaviour and yield

2.6 Quality characters

2.7 Correlation studies

2.1 Vegetative growth

Krisahnamurthi *et al.* (1961) conducted the growth studies in mango under Delhi (sub-tropical) conditions and found that the growth season started by the middle of March and ceased by first week of November. Five cycles of shoot growth were observed in Dashehari and Chausa. The maximum growth was found in March growth cycle which extended up to May. Dashehari and Chausa produced the maximum extension growth in April.

Simao (1966) recorded the seasonal variation in vegetative growth in ten mango varieties in Brazil. Vegetative activity began with maximum vigour in August and least in February, with short resting period from November to January.

Teaotia *et al.*. (1970) studied the growth period in three mango varieties i.e. Dashehari, Langra and Nisar Pasand. The main growth period were March, July and October-November respectively, with a peak in June of Dashehari and May for Langra. Nisar Pasand shown no such peak.

Sharma *et al.* (2001) evaluated twenty mango cultivars of different regions for growth, yield and quality characters. The perusal of the data showed that north zone varieties viz., S.B. Chausa, Langra, Mallika and Fajri were significantly superior in growth and vigorous than other varieties whereas the cvs. Neelum, Kesar, Bombay green, Mankurad, Fernandin and Suvarnarekha were significantly inferior in morphological characters.

2.2 Flowering

Randhava and Damodaran (1961) studied the flowering season and panicle development in three mango varieties – Chausa, Dashehari and Krishnabhog and found the period and emergence of panicles to be from January to March. Dashehari has the largest panicle and took twenty days for bud burst till the growth of the panicle was completed.

Sen and Guha (1963) noticed the fruit bud differentiation in Langra and Himsagar varieties and found that fruit bud differentiation takes place after mid November. Langra being a week earlier than Himsagar. Differentiation reached its peak by mid December in Himsagar and by the end of December in Langra.

Simo (1966) reported that the flowers were produced in June, August and late September or October in mango, the major flowering being in August under Brazil conditions.

Moi and Gangwar (1972) reported wide varietal variation for the start of panicle emergence as well as flowering.

Zaidan *et al.*. (1975) found that in the variety Zabada about 25.00 % of flower induction was completed by late December and 78.00 % before 21st January, the remaining occurred in February. In the variety – Taimkur 17.00 % occurred before 21st December and 79.00 % by 31st December.

Ravishankar (1978) studied the fruit bud-differentiation and flowering in Alphonso and Totapari varieties and found that fruit bud differentiation of both varieties in October and attained a peak in mid November. By mid December the buds were well developed and the panicle emerged in early January.

Shuzeng and Zangwal (1981) studied the flower bud differentiation in Oingpi variety in the Nada district of Island and reported that differentiation starts during the second half of November and reaches a peak in the first half of December. Variety Oiumang starts to differentiate in mid December and reach a peak in mid January. They also found that the greatest number of flowers are produced on vigorous tree and on the south and south east sides.

Reddy (1983) conducted an experiment on vegetative growth and flowering in Beganpalli and reported that shoots produced blossoms irrespective of the time of their emergence and cessation of growth in the previous year. Single and double flush shoots were most fruitful, the majority of the triple flush shoots did not flower.

Shrivastava *et al.*. (1987) found that the varieties – Suvaranrekha, Vanraj, Langra, Kesar and Fernandin were early and Neelum, Fajri, Bangalora and Mulgoa were late in flowering.

Baghel *et al.* (1998) conducted a trial on ten cultivars of mango. The earliest panicle emergence was noticed in Dashehari followed by Himsagar. For 100 panicle emergence as well as fruit set (Mustard stage) Himsagar was the earliest. Maximum number of branches/panicle and the longest panicle were recorded in Sunderja. However, the highest number of panicle/m^2 and the lowest ratio of Hermaphrodite to male flowers was observed in Langra. The number of fruits/panicle were highest in Malda but the total number of fruits/tree was highest in Langra.

Hoda *et al.* (1999) evaluated various morphological and yield characters of different varieties. The perusal data showed that maximum emergence of panicle was emerged in middle of February in majority of the cultivars. Earliest peak flowering was in cv. Fajri and latest in cv. Dashehari. Fruit set was observed from 2^{nd} week to last week of March. Fruits of cultivars Fajri, Chausa and Neelum reached maturity in the 2^{nd} week of July and rest of June.

2.3 Malformation

Khan and Khan (1960) studied the malformation of mango inflorescence in west Pakistan and observed that Langra, Karela, Neelum and Krishnabhog were least infected but other varieties were highly susceptible.

Singh and Jawanda (1961) reported that the most popular varieties Langra and Dashehari are least affected but another commercial variety – Bombay green is most affected. Varieties like Alphonso and Pairee were also affected.

Verma *et al.*. (1974) noticed that *Fiusarium moniliforme* fungi is responsible for mango malformation.

Prasad (1977) stated that the least incidence of malformation was found in Alphonso, Neelum, Peddarasam, Janardan-Pasand and Vanraj as compared to other varieties.

Dang and Daulta (1982) found none of the varieties free from malformation. Only cultivar Langra was found to be tolerant and cultivars – Fajri, Dashehari, Hasanara were moderately susceptible and varieties Bombay green, S.B. Chausa and Khas-ul-Khas were susceptible. Saroli was observed to be the highly susceptible cultivar under Hissar conditions.

Singh and Pathak (1985) studied the intensity of malformation in 10 varieties at Saharanpur and found that all the varieties of *M. indica* and *M. zeylanica* were affected with the malformation. The severity varied from variety to variety ranging from 2.2 to 37.3 %. The highest percentage of malformation was observed in the Raska Jahan, while it was least in Panjab-Pasand variety. They also reported that the most popular varieties of northern India viz., Langra and Dashehari were observed to have the incidence of the malady below 10 %, whereas Bombay green, Chousa and Fajri the other commercial varieties, were highly susceptible and showed 28.29 and 33.00 % malformation, respectively.

Dahshan (1988) reported that the activity of endogenous auxins and gibberellins was considerably higher in malformed panicle and the accumulation of hormones in malformed panicles is associated with an ineffective translocation of hormones from the panicles to the shoots.

Khader *et al.*. (1988) examined the shoots and noticed that sixty six per cent of shoots gave malformed panicle which arose from auxiliary buds and wherever malformed panicles emerged, they were more numerous than the healthy panicle.

Sant-Ram *et al.*. (1992) standardized the com (maize) root curvature test for estimating malformin activity in various mango tissues. Malformin A and mango malformins also induced a typical curvature in pea roots similar to that in maize and induced a flap like growth in wheat roots could not be induced with other plant growth regulators. These tests could, therefore, be used to identify malformin,. Bioassays showed that healthy mango panicle and shoots did not contain any malformin, but it was isolated from malformed panicles and shoots. Data indicated a strong positive correlation between the degree of malformation and malformin activity. Some malformin-like substances were common to malformed vegetative and floral tissues but additional malformins were found in the former.

Singh *et al.*. (1992) surveyed the malformed mangos in the Varanasi district of Uttar Pradesh. Malformed plants were shorter and had shallower root system than healthy plants and younger plants were more affected by the disease than older trees. It is suggested that pollution may be an important factor.

Singh *et al.*. (1994) did an assessment of floral malformation in 20 mango cultivars in 1989 and 1990. The malformation was categorized as light, medium or heavy. All the cultivars suffered from malformation in both the years, but the worst was recorded with Neelum (29.24 and 17.39 %) in 1989 and 1990, respectively. Bangalora (19.45 and 18.13 %, respectively) and Kesar (18.49 and 15.36 %, respectively) and the least in Krishnabhog (10.23 and 9.60 %, respectively).

Singh and Singh (1996) recorded the incidence of floral malformation in 10 and 20 year old trees of 10 mango cultivars during 1987-88 and 1988-89. All cultivars except Bhadauran were susceptible. The highest incidence in Khasulkhas (34.51 %) followed by Gulabkhas (29.58 %), Dashehari (20.50 %) and Chausa (16.39 %). Percentage malformation was significantly lower in

Safeda Malihabad, Rataul, Bombay green and Langra, averaging 8.19 -11.65 %. Average percentage of malformation was higher in the older trees than in the younger ones (13.92 – 11.81 %), but the older trees produced more normal panicles than the younger trees (839.20 vs. 752.50/tree) as well as more malformed one (133.85 vs. 98.24/tree). Among the cultivars, Safeda Malihabad produced the maximum panicles (an average 1198.83 /tree, 1101.00 of which were normal), while Bhadauran had the highest normal panicles (1127.00/trees).

Kumar and Chakrabarti (1997) reported 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 Neelum. The relationship between frequency of malformed panicles and yield losses was determined by lineer regression. Fruit yield in Dashehari 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 Neelum, 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 Neelum, respectively. For the regular bearer, Neelum, 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.

2.4 Fruit drop

Naidu (1953) reported that varieties-Willard, Pulihora and Olour had a lower percentage of drop while Cherukuresam, Himayuddin and Jehangir registered a high percentage of shedding. They also found that certain varieties of mango with strong fruit stalks such as "Hamlet", "Trichur" are less liable to fruit shedding than others.

Chadha and Singh (1964) reported that Langra, Dashehari and Fajri varieties last about 89, 95 and 99 % fruits, respectively in all the three waves of fruit drop leaving only about 2, 5 and 1 % fruits, respectively to be finally

harvested during the 'on' year. They also found that Dashehari variety was less susceptible to drop as compared to Langra. The fruit drop during day time was nearly double of that occurring during night hours. Low rate of fruit drop during night time may be attributed to low prevailing temperature, comparatively calm weather and more satisfactory internal water relations of trees.

Singh and Chadha (1967) reported that in general, eastern and western sides of the tree exposed to comparatively medium isolation proceed to be more congenial for fruit retention than the northern or southern sides.

Desai *et al.* (1985) reported that in Alphonso, Gaomankurd and Kesar varieties average number of fruit set per panicle was 8.23, 2.73 and 10.73 respectively and the maximum drop of fruits was 75.77, 90.51 and 93.06 per cent during the first, fifth, sixth and seventh weeks from anthesis, respectively. They also reported that the loss of fruits was maximum during the early drop but later drop was more serious in terms of loss by weight.

Shrivastava *et al.* (1987) observed the fruit drop in fifteen commercial varieties and found maximum drop in Langra and least in Dasheahri.

Sanyal and Maity (1992) carried out a study on the initial fruit set, subsequent fruit drop and its relationship with fruit growth in 10 year old grafted plants of mango cultivars Bombay green, Bombay yellow, Gulabkhas, Himsagar, Langra and Safderpasand. Initial fruit set varied from 51.80 fruits/ panicle in Himsagar to 107.79 fruits/panicle in Langra. Fruit drop was high in all cultivars (96.87 – 99.69 %) with no significant differences between cultivars. Fruit drop was found to be positively correlated with fruit growth (length and breadth). Fruit drop was generally higher during April.

Guzman *et al.* (1996-1997) investigated fruit drop and yields over 3 years in 5 mango cultivars (Manila, Tommy Atkins, Haden, Dent and Keitt) growing in a 15-year-old commercial grove in Villa union, Mazatlan, Sinaloa (Mexico). The climate in the area is hot and sub-humid with a summer rainy season and the soil is an cutric fluvisol. Dropped fruits/tree were registered weekly starting 20 days after fruit set up to fruit maturity, and the number of fruits harvested and fruit yield were also recorded. The number of dropped fruits/tree for Manila, Tommy

Atkins, Haden, Kent and Keit were 4293, 12133, 3194, 2817 and 2258, respectively. The number of fruits harvested/tree for same order cultivars were 2317, 427, 649, 380 and 264. Except for cultivar Kent, dropped fruit values were statistically different among cultivars in every year except for Haden, the number of fruits harvested and yield were also different among cultivars. Most fruit drop occurred 25-50 days after fruit set in all the cultivars.

Jana and Sharangi (1998) conducted a study to assess the nature and extent of fruit drop in mango with 16 popular cultivars in West Bengal, India. The study revealed that irrespective of years 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, the 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. This variation was considered due to cultivar and the environment.

2.5 Fruiting behaviour and yield

Gangwar and Moti (1973) studied the fruiting behaviour and yield of twelve popular late mango varieties of northern India. They found that setting of fruits in all the varieties stretched over last three weeks of March. Peak maturity period spread over above seventy days starting from last week of June till end of August. The yield per plant ranged from as high as 335 kg to a minimum of 45 kg.

Gunjate *et al.* (1983) reported that the percentage of hermaphrodite flowers and fruit set was more in late flushes than early flushes and fruit retention was increased by cross pollination with the cvs. Pairi, Totapari and Vanraj.

Kalra and Tandon (1983) reported that the fruits of Dashehari mango picked 85 days after fruit set could be stored best with the lowest fruit loss , less fungal damage and superior quality.

Desai *et al.* (1985) studied the fruit set in Alphonso, Goamankurd and Kesar varieties and reported that the average number of fruit set per panicle was 8.23, 2.73 and 10.73 %, respectively. The mean final number of fruits retained per panicle were 0.40, 0.13 and 0.59, respectively.

Hoda and Yadav (1987) reported that per plant yield was maximum in Neelum and largest fruits were obtained in Fajri and Mallika.

Shrivastava *et al.* (1987) reported that Neelum, Langra and Bangalora are high yielding varieties under Rewa condition.

Singh and Maurya (1988) reported that the average yield per tree was highest in the cv Sukul (212.80 kg) followed by Safeda Lucknow (208.20 kg) and S.B.Chausa (175.90 kg) and lowest in Neelum (71.40 kg) but on the basis of m^2 of space covered by tree canopy and gross returns/ha Neelum scored highest, followed by Sukul, Safeda Lucknow and S.B. Chausa.

Sharma *et al.* (1997) recorded the highest yield per plant in Langra followed by Bangalora and S.B. Chausa while it was the lowest in Alphanso followed Kesar, Suvaranrekha and Vanraj on a four bearing year mean yield basis. Bangalora gave the highest production followed Langra, Neelum and Mallika. The lowest mean yield was observed in Mulgoa followed by Fernandin, Alphanso and Kesar.

Avilan *et al.* (1998) classified the panicles of 21 cultivars for the mango collection of the centro National de investigaciones Agra-pecuarias (CENTAP) Maracay, Venezuela 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 4 %. The potential fruit 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 later part of January with maximum flowering intensity in the 3rd and 4th weeks of January.

Sharma *et al.* (2001) evaluated twenty cultivars of different regions. The perusal data revealed that during 2000, the flowering and fruiting was poor and most of the cultivars did not come into bearing. However, during 1999, significant differences were recorded with regards to yield. Highest yield was found in cv. Bangalora closely followed by Dashehari being minimum in cv. Alphonso. In the

year 2000 also, maximum yield was recorded in cv. Bangalora followed by Langra, Mallika and Fajri.

2.6 Quality character

Jouhari *et al* (1969) studied the morphological and physicochemical characters of some important varieties of mango. They found maximum T.S.S. 20.28%, sugar 16.20 and vitamin 'C' 32 gm/100gm in the fruits of Safeda Malihabad. In addition its taste and flavour were also excellent. Mitwa and Malda Garakhpur were found to be the poorest in chemical composition.

Teaotia and Singh (1971) described the physico –chemical properties of Neelum, Bride of Russia, Katikibahar, Anupam, Nisarpasand, Langra, Dudhia and Kesar varieties. Taking in to consideration all general character as size, taste pulp-content and appearance, Langra, Dudhia was the best as it contains extraordinary high value of vitamin 'C' and attractive milkish shade on it's fruits. However, Nisar pasand was riche T.S.S. and sugar content.

Mann and Singh (1973) conducted an experiment on changes in physical characters of Dashehari and Langra fruits during growth and maturity periods in order to correlate them with the maturity of fruits. They found the specific gravity of Dashehari and Langra mangoes increased continuously as the picking season advanced change in colour from pea green to straw colour of the flesh indicated maturity of fruits in both the cultivars.

Lodhi *et al* (1974) observed the yield and physical properties of the fruits of some commercial varieties of mango and reported that Totapari was superior followed by Mulgoa and Baganpalli in yield. Baganpalli, Langra and Totapari had higher pulp content as compared to other varieties studied. Mulgoa and Bombay green had the highest dry-matter content. Langra was sweetest variety followed by Baganpalli, Paire and Alphonso.

Samad and Faruque (1976) studied the physical characters of mango varieties- Fajr, Langra, Gopalbhog, Mohanbhog, Missribhog, Kapahari, Dasheahri, Aswania and Ranibhog. Fruits of the variety-Fajri were the largest, contained the highest percentage of pulp and showed the optimum ratios of peel to pulp and nonedible to edible portions.

Sharma and Biswas (1981) analysed vitamin 'C', T.S.S., sugars and titrable acidity of thirty mango varieties. Highest vitamin 'C' content was noted in the Aswania and Himsagar, Bhabani chawras. Misarikant and Ranibhog had higher T.S.S. content and Chakraborty Khas gave maximum sugars.

Katrodia *et al.* (1985) studied the performance of sixty cultivars of mango under south Gujrat conditions. They found the highest fruit yield per tree in Bangalora , highest T.S.S. in Alphanso and maximum total sugar in cultivar Pachhotia.

Pandey and Dayal (1985) reported that variety Ceylon produced maximum number of fruits and yield per tree, biggest fruit size was observed in Mallika and Bathuwa had more pulp with smaller stone and thin peel. Ceylon and Mitwa Gazipur contained less acidity and T.S.S. was highest in Ceylon.

Shyamal and Mishra (1987) observed maximum fruit weight in Farji followed by Langra and Paharpur Sinduri and the lowest fruit weight in Mitwa variety. Fajli and Langra had higher pulp content. however, maximum pulp-stone ratio as recorded in Langra. Maximum ascorbic acid, T.S.S., reducing sugar and non-reducing sugar were recorded in Langra.

Bhuyan *et al.* (1988) studied the fruit weight, fruit size and thickness proportion of different parts, T.S.S. content and stone size of 13 varieties. Considerable variations were observed in most traits. Fruit weight varied from 202.8 to 1014.4 g, being highest in cv. Fajri. The edible portion ranged from 64.94 to 81.49 % being highest in cv. Krishnachura. T.S.S. content ranged from 15.00 to 21.44 % being highest in Gopalbhog.

Rajput and Pandey (1997) studied the physio-chemical properties of six cultivars of mango viz., Langra, Dashehari, Sunderja, Amrapali and Neeleswari in Raipur (M.P.). They found that the cv. Mallika was superior to other cultivars with regard to fruit size, fruit weight and pulp weight, with low stone and peel percentage. Langra and Sunderja also produced fruits of good weight and size, with high pulp and low stone percentage. T.S.S. 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 in Dashehari and Sunderja. Organoleptic quality of Dashehari was best and the cultivar was closely followed by Langra on the basis of quality parameters taste and general acceptance Dashehari and Langra were superior to other cultivars.

Sharma *et al.* (1997) found that Dashehari, S.B. Chousa, Langra, Alphanso and Mallika had the higher T.S.S., reducing and non-reducing sugar and lesser acidity.

Roy Chowdhary *et al.* (2000) studied the morphological and quality characters of varietal trial. The results showed that maximum T.S.S. and total sugar content were observed in cv. Bombai while minimum in cv. Vanraj. The acidity content was found maximum in cv. Mulgoa and minimum in cv. Chausa.

Hoda *et al* (2001) evaluated various morphological and yield characters of different cultivars. The results revealed that the quality characters viz. T.S.S. was found maximum in cv. Mallika whereas acidity was minimum in cv. Mankurad, Fernandin, Bangalora, Chausa and Mankurad.

Sharma *et al.* (2001) evaluated the physico-chemical characters of different cultivars. The results showed that the maximum pulp percentage (78.01), peel and stone percentage (20.95 and 19.75 %), T.S.S. (25.75 ^{0}B) and lowest acidity (0.22 %) were recorded in cvs. Alphonso, Neelum and Dashehari, respectively.

2.7 Correlation studies

Suman *et al.* (1985) carried out correlation studies in fruit characters of eighty four mango varieties and found that the fruit weight was positively associated with fruit length, width, stone length, stone width, pulp and peel weight. High positive correlation was observed between the pulp weight and the fruit weight.

Singh *et al.* (1985) studied the interrelationship between the chemical constituents in mango. They found that the vitamin 'C' and pulp pH were cultivar specific. Total sugar showed a significant positive correlation with sucrose and T.S.S., total sugar was associated with sucrose values.

Prasad (1987) carried out correlation studied in growth behaviours, fruit characters and components of forty varieties of mango and noted positive significant correlations in number of fruits. The size with T.S.S., ascorbic acid, fruit weight and fruit volume, plant spread in N-S and E-W had positive indirect effect through different aspects of growth behaviours of the plants. Direct and indirect positive effects of plant characters with number of fruits, their different aspects and yield were also found in the relationship observations.

Baghel et al. (1988), carried out correlation studies of 15 different characters in the cultivar Langra and noted that, the number of fruits/m^2 could be considered the most effective parameter for predicting the yield (Total number of fruits per tree), followed by yield of secondary branches (fruit number), number of fruits per panicle and number of panicles/m^2. The number of secondary branches considered an important factor for yield for casting.

Kokadwar *et al* (1992) collected forty superior local mango (*Mangifera indica*) types from 35 locations in the Kalamnuri district and recorded data for 12 fruit quality characters. Variability was highest for total sugar content followed by edible to non-edible ratio (E/N), pulp weight , fruit volume, size and percentage of acidity, pulp and total soluble solids (T.S.S.). Significant correlation between characters as the traits indicated good scope for yield and fruit quality improvement. Out of 10 selected cultivars, KMN 11, KMN 5 and KMN 23 were promising for most traits, in particular for reducing and total sugar, pulp percentage, fruit size and weight, T.S.S. and E/N. Niranjan, BTR 27 and Neelum were not recommended.

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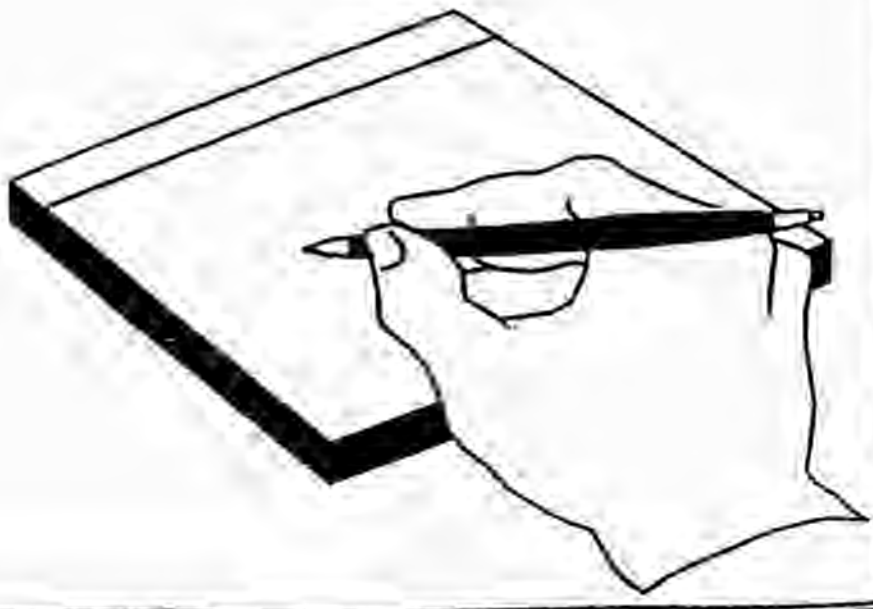
CHAPTER- III

MATERIALS AND METHODS



CHAPTER-III

MATERIAL AND METHODS

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

3.1 Experimental Site

The present investigation entitled **"Evaluation of twenty commercial varieties of mango (*Mangifera indica* Linn.)"** was carried out at Fruit Research Station, Kuthulia, College of Agriculture, Rewa (M.P.) under the All India co-ordinated Research Project on Sub-Tropical Fruits and the chemical analysis of the fruits was done in the laboratory of the Department of Food Science, College of Agriculture, Rewa during the year 2002-03.

3.2 Climatic and weather conditions

Rewa is situated in the North-Eastern part of Madhya Pradesh at latitude 24.31'N, longitude 81.15' E and altitude of 365.7 metres above the mean sea level. Rewa enjoys the sub.-tropical climate, hot and dry summer and cold winter are the main characteristics features of this region. Sometimes the winter temperature touches the freezing point. In general, the highest and lowest temperature goes above 43.3^{0}C and below 5^{0}C, respectively. The annual rainfall varies from 900 mm to 1150 mm which is received mainly from July to September and some times winter rains are also received.

The rainfall, maximum and minimum temperature, percentage humidity, wind velocity and sun shining hours were recorded and are presented graphically in Fig. 1(a) and 1(b) and given in Table-1.

Table 1. Meteorological data for the study period (From July 2002 to June 2003)

	Month	Temperature (°C)		Sunshine (hours)	Rainfall (mm)	No. of rainy days	Humidity %		Wind velocity km/hour
		Max.	Min.				High	Low	
2002	July	35.9	28.1	4.2	63.4	5	72	53	8.0
	Aug.	30.5	25.2	3.5	449.8	19	94	79	4.9
	Sep.	30.8	24.1	6.7	250.8	6	93	68	3.9
	Oct.	31.6	17.9	8.1	66.4	2	94	49	1.7
	Nov.	28.7	11.5	8.2	00.0	0	92	36	1.7
	Dec.	25.5	9.8	7.5	3.0	0	86	38	1.6
2003	Jan.	20.9	5.0	6.9	7.4	1	88	46	2.2
	Feb.	25.0	11.4	7.2	74.8	7	90	54	2.8
	March	31.0	13.4	9.5	3.2	1	81	33	2.7
	April	38.5	19.9	10.1	9.8	2	67	26	2.4
	May	40.8	23.5	8.4	2.4	0	57	21	1.7
	June	39.5	27.4	6.7	100.4	9	69	45	5.3

Source: Meteorological observatory, Kuthulia farm, College of Agriculture, Rewa (M.P.)

3.3 Soil

3.3.1 Chemical properties of the soil

The composite soil samples from different part of the experimental field was collected from 30 cm depth. The soil sample was analysed in the soil testing laboratory Rewa and the results of the analysis are presented in Table –2.

Table 2. Chemical analysis of experimental soil

S. No.	Factor	Analytical value	Rating
1.	Available nitrogen	285 26 kg/ha	Medium
2.	Available phosphorus	49.71 kg/ha	Medium
3.	Available potash	574.02 kg/ha	High
4.	Organic carbon	0.62 Per cent	Medium
5.	Soil pH	6.84 N "	Normal
6.	Electrical conductivity	0.32 mmhos/cm^2	Normal

3.3.2 Physical properties of the soil

The soil of the experimental field had 27.5 % clay, 38.6 % silt and 32.7 % sand. The data showed that the soil of the experimental field was clay loam in texture with a depth of more than 2 m and light black in colour.

3.4 Experimental details

The experiment was conducted on twenty commercial varieties of mango. These varieties were collected from various parts of India. Planting material was raised on the root stock grown from the stones of a single seedling tree and the scion wood was obtained from Vengurla, Sanga reddy, Sabour and Lucknow centres in the year 1981. Field plantation was done in Augut-September, 1982. Total eight plants of each variety were planted comprising of four replications i.e., two plants per replication. Planting was done in Randomized Block Design at 10 x 10 m distance. Total area of the experimental field is 1.2 hectares.

The varieties evaluated under this trial are as follows:

Fig.No.7(a): Meteorological data for the year 2002-2003 (From July to June)

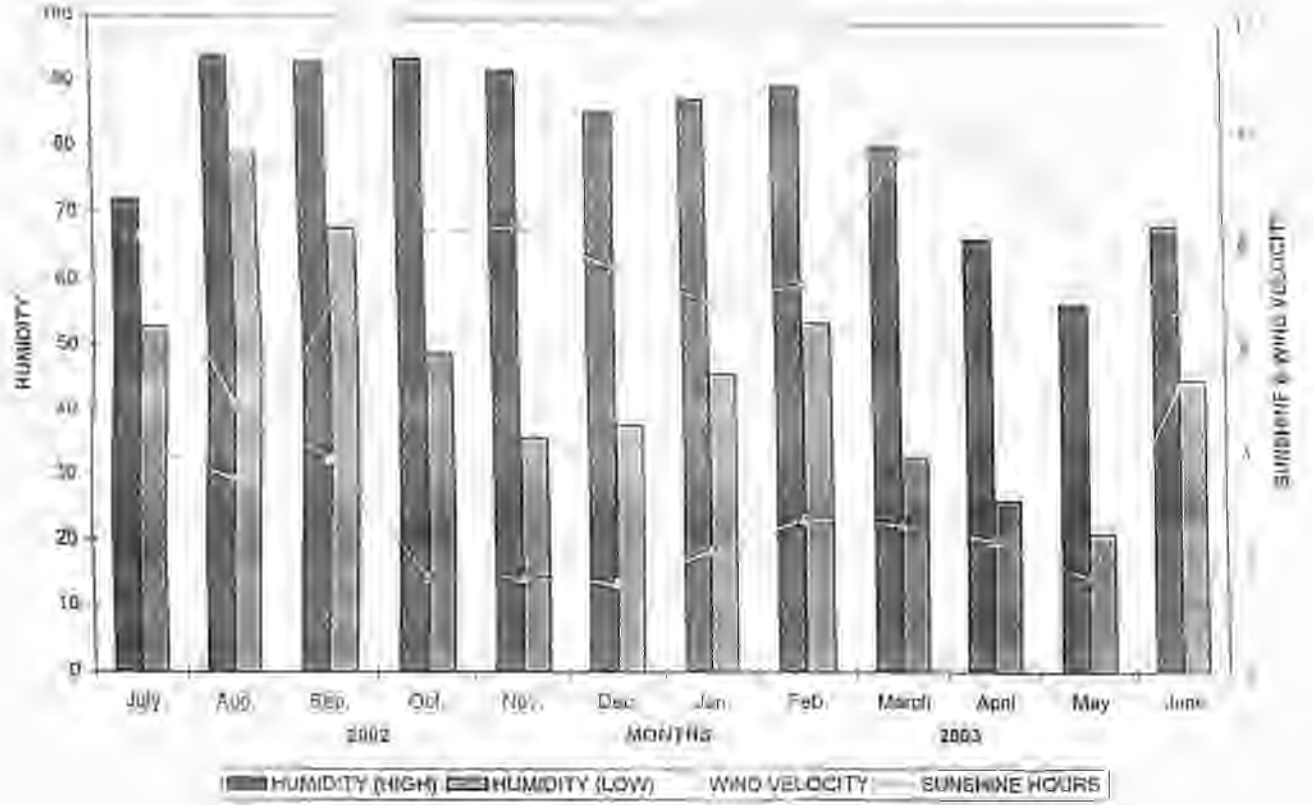
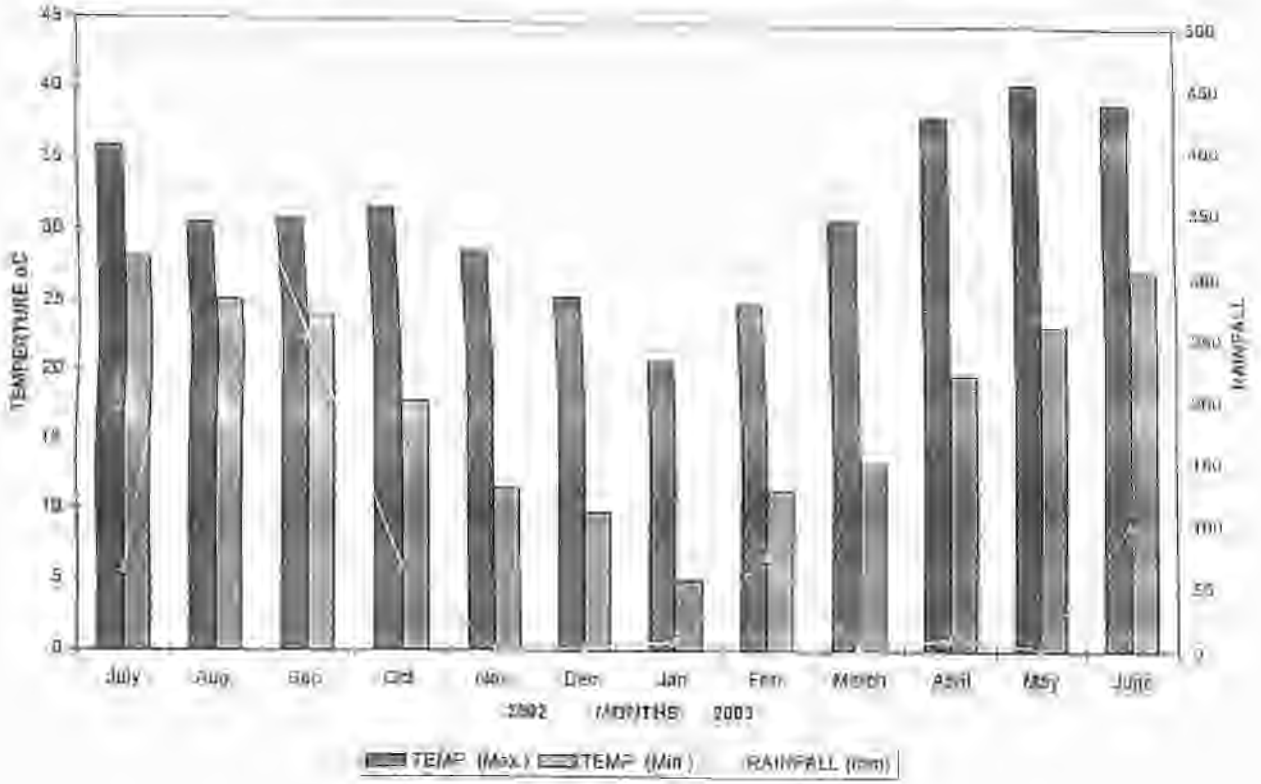


Fig.No.1 (B) Meteorological data for the year 2002-2003 (From July to June)



B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	B
	9	14	7	8	1	14	17	20	
O	10	18	12	20	3	5	16	18	O
	3	1	2	13	8	15	8	13	
R	8	17	14	4	2	13	11	10	R
	4	12	5	19	16	20	4	19	
D	16	2	1	3	9	10	7	5	D
	7	5	16	9	7	19	2	12	
E	6	15	17	11	4	18	9	15	E
	19	13	18	10	6	11	6	3	
	11	20	15	6	17	12	1	14	R

RI → RII → RIII → RIV

Index

1.	Dashehari	6.	Alphonso	11.	Banesban	16.	Zardalu
2.	Langra	7.	Kesar	12.	Bangalora	17.	Bombai
3.	Fajri	8.	Mankurad	13.	Mulgoa	18.	Bombay green
4.	S.B.Chausa	9.	Fernandin	14.	Neelum	19.	Himsagar
5.	Mallika	10.	Vanraj	15.	Suvarnarekha	20.	Krishnabhog

Fig.2: Layout Plan of the Experiment

S.No.	Name of the varieties	S.No.	Name of the varieties
1.	Dashehari	11.	Baneshan
2.	Langra	12.	Bangalora
3.	Fajri	13.	Mulgoa
4.	S.B.Chausa	14.	Neelum
5.	Mallika	15.	Suvarnarekha
6.	Alphonso	16.	Zardalu
7.	Kesar	17.	Bombai
8.	Mankurad	18.	Bombay green
9.	Fernandin	19.	Himsagar
10.	Vanraj	20.	Krishna bhog

3.5 Care and maintenance

3.5.1 Application of fertilizer

Fertilizer doses were given in a uniform manner in all the trees under trial as incremental doses of 100 g N, 100 g P_2O_5 and 50 g K_20 per plant. Full doses of super phosphate, muriate of potash and half quantity of urea was applied in the first week of July 2002. The remaining half quantity of urea was applied in the month of March, 2003 after the fruit set.

3.5.2 Irrigation, weeding and hoeing

The trees were irrigated at fortnightly during summer and at monthly interval during winter. Four hand hoeings were also done to pulverize the soil for better growth of the plants. Basins were prepared in the month of October, 2002 for irrigating the trees.

3.6 Picking and ripening of fruits

The picking of fruits was done after reaching the maturity index. After picking, the fruits were placed in a single layer over palash leaves on the floor and also covered with the same for ripening.

3.7 Observations

The observations were recorded on the following aspects:

3.7.1 Vegetative characters

(a) Tree height

(b) Canopy height

(c) Spread N-S and E-W

(d) Circumference of root stock

(e) Circumference of scion

(f) Volume of plants (calculated)

3.7.2 Flowering

(a) Date of flower bud initiation

(b) Date of start of flowering

(c) Date of full bloom

(d) Date of fruit setting

3.7.3 Malformation

(a) Total number of panicle

(b) Total number of malformed panicles

(c) Percentage of malformation

3.7.4 Fruit drop

3.7.5 Yield

(a) Total number of fruits/tree

(b) Total weight of fruits/tree

3.7.6 Physical properties

(a) Length of fruit

(b) Width of fruit

(c) Specific gravity

(d) Fruit shape

(e) Fruit colour (f) Colour of pulp

(g) Flavour (h) Taste

(i) Texture (j) Fibre content on stone

(k) Peel weight (l) Pulp weight

(m) Stone weight

3.7.7 Chemical qualities

(a) Reducing sugar (b) Non-reducing sugar

(c) Acidity (d) T.S.S.

(e) Total sugar

The details of the observations recorded are as follows:

3.7.1 Vegetative characters

The growth observations were recorded during the month of January , 2002.

3.7.1(a) Tree height: The height of the experimental trees was measured from ground level to the tip shoot with the help of measuring tape and bamboo.

3.7.1(b) Canopy height: The canopy height of the experimental trees was measured from the point of secondary branching to tip of the top shoot.

3.7.1(c) Spread of the tree: The spread of the experimental trees was recorded from North to South and East to West directions with the help of measuring tape.

3.7.1(d) Circumference of the root stock: The circumference of root stock was measured just below the graft union with the help of measuring tape.

3.7.1(e) **Circumference of the scion:** The circumference of the scion was measured just above the graft union with the help of measuring tape.

3.7.1(f) **Volume of the plant:** The total volume of the tree was calculated by the formula given below:

Volume = $\pi r^2 h$

Where ,

$\pi = 22/7 = 3.14$

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

h = canopy height

3.7.2 **Flowering observation**

Flowering observations were recorded at four stages which are as follows:

3.7.2(a) **Date of flower bud initiation :** The date on which the first flower bud appeared was recorded.

3.7.2(b) **Date of start of flowering:** The date from which the flower opening started was noted.

3.7.2(c) **Date of full bloom :** In the third stage of flowering, when the trees were in full bloom and all the flowers of each panicle have opened, the date was noted.

3.7.2(d) **Date of fruit setting:** The date was noted on fruit setting.

3.7.3 **Malformation:**

3.7.3(a) **Total number of panicles:** All the panicles which emerged on the trees were counted and recorded.

3.7.3(b) **Total number of malformed panicles:** In the month of March all the malformed panicles of each tree were cut with the help of tree pruner and total number of malformed panicles was recorded.

3.7.3(c) **Percentage of malformation:** The intensity of floral malformation was calculated by the formula given below:

$$\text{Percentage of malformation} = \frac{\text{Number of malformed panicles}}{\text{Total number of panicles}} \times 100$$

3.7.4 **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:

$$\text{Percentage of fruit drop} = \frac{\text{Total Number of fruits- Fruits retained at harvesting}}{\text{Total number of fruits}} \times 100$$

3.7.5 **Yield**

Following observations were recorded after picking of the fruits:

(a) Total number of fruits/tree

(b) Total weight of fruits/tree

(c) Average weight per fruit was calculated by dividing the total weight with the lotal number of fruits

3.7.6 Five fruits were selected randomly from each tree at the time of harvesting for testing lhe physical properties. The fruits were kept for ripening separately for one week and the observations recorded are given below:

3.7.6(a) **Average length of fruit:** The length of the five randomly selected fruits was measured and the average length per fruit was calculated.

3.7.6(b) **Average width of fruit:** The width of five randomly selected fruits was measured and average width per fruit was calculated.

3.7.6(c) Specific gravity: The weight of five randomly selected fruits was recorded. These fruits were placed in a glass jar full of water and the volume of replaced water was measured with the help of measuring cylinder. The specific gravity was calculated as per the formula given below:

$$\text{Specific gravity} = \frac{\text{Total weight of five fruits}}{\text{Total volume of replaced water by five fruits}}$$

3.7.6(d) Fruit shape: The fruits of the varieties were categorized as per their shape in the following groups:

(i) Complete round
(ii) Round
(iii) Oblong

3.7.6(e) Fruit colour: The colour of fruits after ripening the fruits was noted as : Light green, light yellow, deep yellow, golden yellow and redish yellow.

3.7.6(f) Pulp colour: The colour of the pulp of the ripe fruits was noted as – Lemon yellow, light yellow and deep yellow.

3.7.6(g) Flavour: The flavour of the fruits was categorized as –Excellent, pleasant, good and satisfactory.

3.7.6(h) Taste: The taste of the fruits was observed as moderately sweet, sweet and very sweet.

3.7.6(i) Texture of pulp: The fruits were categorized as juicy soft (melting) and firm as per the texture of the pulp.

3.7.6(j) Fibre content: The varieties were grouped as fibrous, less fibrous and fibre-less as per the fibre content of the fruit.

3.7.6(k) Peel weight: Five randomly selected ripe fruits were peeled and the total weight of the peel was recorded. The peel percentage was calculated by the following equation:

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

3.7.6(l) Pulp percentage: 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:

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

3.7.6(m)

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

3.6.6(n) Pulp:peel ratio: The pulp:peel ratio was calculated by the formula given below:

$$\text{Pulp /peel} = \frac{\text{Weight of pulp}}{\text{Weight of peel}}$$

3.7.6(o) Peel:stone ratio: The peel:stone ratio was calculated as per the following formula:

$$\text{Peel/stone ratio} = \frac{\text{Weight of peel}}{\text{Weight of stone}}$$

3.7.6(p) Pulp/stone ratio:

$$\text{Pulp/stone ratio} = \frac{\text{Weight of pulp}}{\text{Weight of stone}}$$

3.7.7 Chemical properties: Five fruits were selected randomly from each tree after ripening for ascertainment of the chemical quality. The fruits were washed thoroughly before analyzing the following contents:

(a) Reducing sugar

(b) Non-reducing sugar

(c) Acidity

(d) Total sugar

(e) T.S.S. (Total soluble solids)

Method of estimation of sugar in fruit juice

(A) Method of preparation of fruit solution

A homogenous sample of pulp was prepared after crushing the fruits for chemical analysis. Twenty ml of juice sample was diluted to 100 ml and this solution was used for estimating the following parameters:

I. Sugar
   (a) Reducing sugar
   (b) Non-reducing sugar

II. Acidity

(B) Method of preparation of Fehling's solution

1. Fehling's solution "A"

Transferred 34.639 g of copper sulphate (A.R.) to a clean and dry 500 ml volumetric flask. In this flask added 0.5 ml of concentrated sulphuric acid and dissolved copper sulphate by adding 200 ml of distilled water. Made the volume to the mark.

2. Fehling's solution "B"

Dissolved 173.0 g of pure sodium potassium tartrate (Rochelle salt) and 50 g of sodium hydroxide in distilled water and made the volume to 500 ml in volumetric flask.

(C) **Glucose solution (0.5%)**

Dissolved 2.5 g of glucose (A.R. anhydrous) in distilled water and made the volume to 500 ml.

Procedure

Ten ml of fehling's solution (5 ml each of Fehling "A" and Fehling "B" solution and mixed together) was taken in a conical flask and 10 ml of distilled water was added. It was heated on a burner and glucose solution was added gradually 2 ml at a time while keeping the flask on the burner. The glucose solution was added till the bluish colour of fehlings solution discharged and radish colour appeared. Three drops of methylene blue was added and titrated with the glucose solution till the blue colour of the indicator is completely discharged and a permanent brick red colour persists. The reading was recorded and was used as preliminary reading. To get an exact reading, 10 ml of Fehling's solution equal volumes of Fehling "A" & "B" was taken in a conical flask and glucose solution was added with the help of a burette 2 ml less the appropriate volume used in the preliminary titration. The conical flask was heated and allowed to boil for 2 minutes. If the colour was not brick red then more amount of glucose solution was added till no more blue colour is visible. Now two drops of methylene blue indicator was added and the glucose solution was added drop by drop till the colour of the indicator was discharged. One drop of methylene blue was added to test the complete reduction.

I. **Sugar**

(a) Reducing sugars in the fruit juice were estimated by the methods as suggested by Nelson (1944).

5 ml each of Fehling's 'A' and 'B' solutions were taken in a 300 ml conical flask and diluted with 40 ml of distilled water. The fruit solution taken in a burette, was added slowly in hot (boiling) Fehling's solution, till

the sligh: red colour appeared. Now three drops of methylene blue indicator was added and titration was continued till a brick red precipitate appeared vanishing the blue colouration.

(b) **Non reducing sugars**

Hydrolysis was done by taking 20 ml of the extract prepared for the estimation of reducing sugar. 5 ml of concentrated Hcl was added in it and boiled on water bath for 30 minutes at $70^0C - 90°C$. The solution was cooled and excess of Hcl was neutralized by adding sodium carbonate (Na_2Co_3) solution. The solution was transferred in a 100 ml volumetric flask and volume was made up to mark with distilled water. This solution was taken in a burette and titrated with the Fehling's solution similar as reducing sugar. The reading obtained would represent the total sugar (Reducing and non-reducing) in the fruit juice. Hence, reducing sugar content was substracted from the total sugar for calculating the non-reducing sugar in the fruit juice.

II. **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 10 ml volumetric flask and the volume was made up to mark with distilled water. It was shacked well dissolve and 25 ml of diluted fruit juice was transferred in to a 250 ml beaker. Three drops of phenolphthalein indicator was added to the solution. The juice was titrated with N/10 NaoH (sodium hydroxide). The alkali was added drop by drop in the beaker with constant stirring till the pink end point is reached. Three to four readings were recorded and the percentage acidity was calculated by the formula given below:

$$\text{Total acidity percentage} = \frac{\text{Titrated value x Normality of alkali X Volume made up x 64}}{\text{Weight of sample taken x 100}} \times 100$$

Where , 64 = Equivalent weight of an acid

Volume made up = Volume of titrated made up

Total soluble solids (T.S.S.)

The homogenized fruit sample was crushed and juice was extracted through muslin cloth. The extract was used for determination of 'O' brix by hand refractometer. Few drops of juice were place on the surface of prism The hinged part was placed black. The refractometer was then placed against the sun and the readings were recorded by revaluating the eye pieces at room temperature (A.O.A.C., 1970).

Statistical analysis

(a) analysis of variance: Analysis of different variables was carried out to know the degree of variation amongst all the treatments with regard to various treatments. The data were analysed by the method of analysis of variance as derived by R.A. Fisher (1954). The analysis of variance table is given below:

Table 3. Skeleton analysis of variance

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

The significance of treatments was estimated employing 'F' test. The significant difference between means were determined by using critical difference (C.D.) which was calculated as follows:

SEm ± and C.D. of variety

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

or

$$= \pm \sqrt{\frac{\text{M.S.E.}}{\text{Rep.}}}$$

$$S.Ed\pm = \sqrt{\frac{\text{Error variance}}{\text{No. of replication}} \times 2}$$

$$= \pm \sqrt{\frac{\text{M.S.E.}}{\text{Rep.}}}$$

C.D = S.Ed. x t value of 5% d.f. (Error degree of freedom)

t value of 5% d.f	1% d.f.
2.189	2.699
2.019	

(b) Correlation studies:

Coefficients of correlation between different characters were calculated as per the formula given by Panse and Sukhatme (1967).

$$r = \frac{\sum xy - \frac{\sum x . \sum y}{N}}{\sqrt{[\sum x^2 - (\sum x)^2/n] - \{\sum y^2 - (\sum y)^2/n\}}}$$

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

where,

r = coefficient of correlation

n =Number of treatments (varieties)

x, y = characters under study

Presentation of data

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

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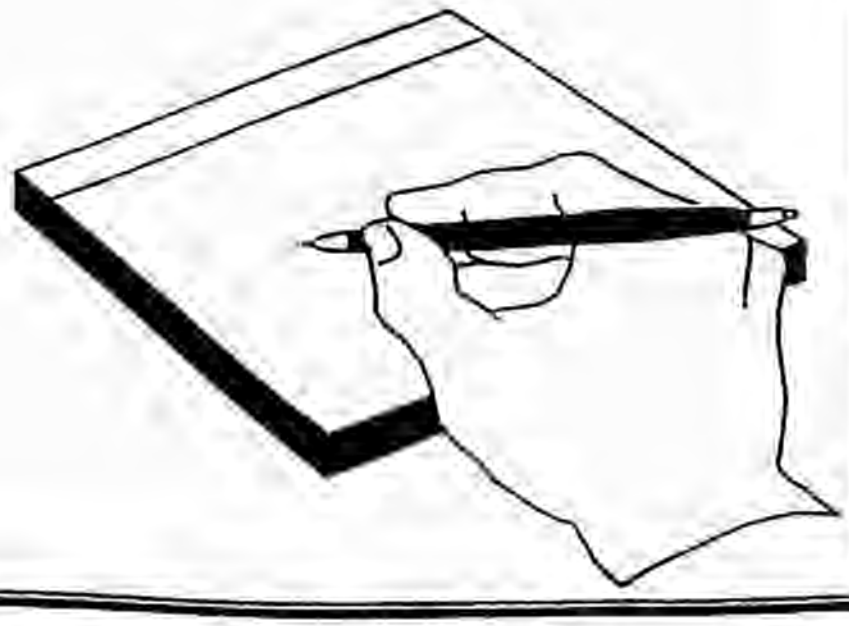
CHAPTER- IV

RESULTS



CHAPTER –IV

RESULTS

The present investigation entitled "**Evaluation of twenty commercial varieties of mango (*Mangifera indica* L.)**" was conducted at Fruit Research Station, Kuthulia, College of Agriculture, Rewa (M.P.) during the year 2002-2003. The observations on different aspects of vegetative growth, flowering, malformation, fruit-drop, yield and physico-chemical properties of the fruits were recorded. The observations were recorded replicationwise and statistically analysed. The analysis of variance table is given in Appendices. The findings of this investigation are presented in this chapter in tabular form and illustrated with suitable diagrams.

4.1 Vegetative growth characters

The observations on vegetative growth characters such as height of the tree, canopy height, circumference of root stock and scion, spread (North to South & East to West) were recorded during December, 2002 and the average volume per tree was calculated and presented in Table-4.

4.1.1 Average height per tree

The average height per tree varied significantly with the varieties (Table-4). The maximum height (8.07 m) was noted in S.B.Chausa closely followed by Langra (7.05 m) and both were significantly superior to other varieties (Table-4). Minimum height (4.39 m) was recorded in Neelum followed by Suvarnarekha (4.76 m), Bombay green and Himsagar (4.87 m). The height of other varieties ranged between 4.92 to 6.43 m.

4.1.2 Average canopy height per tree

It is evident from the data given in Table-4 that the average canopy height per tree of different varieties ranged between 3.45 to 7.36 m. S.B. Chausa recorded maximum canopy height (7.36 m) followed by Mallika (5.86 m) and Langra (5.84 m), whereas minimum canopy height was noted in Neelum (3.45 m) followed by Mulgoa

(4.10) and Suvarnarekha (4.11 m) which were inferior in canopy height than other varieties. The canopy height of other varieties ranged between 4.32 to 5.71 metres.

Table 4. Vegetative growth characters

S. No.	Treatment	Height per tree (m)	Canopy height per tree (m)	circumference		Spread per tree		Volume per tree (m^3)
				Root stock (cm)	Scion (cm)	N-S (m)	E-W (m)	
1.	Dashehari	5.72	5.08	96.50	84.88	7.47	7.19	213.87
2.	Langra	7.05	5.84	119.00	107.38	9.55	9.60	421.86
3.	Fajri	6.43	5.58	116.00	96.63	7.93	8.29	292.37
4.	S.B.Chausa	8.07	7.36	143.00	124.25	10.42	9.78	589.85
5.	Mallika	6.38	5.86	113.13	94.63	9.02	9.09	380.00
6.	Alphonso	6.39	5.46	99.38	83.56	6.46	6.48	181.29
7	Kesar	5.14	4.41	82.13	65.38	5.38	5.42	101.87
8.	Mankurad	4.92	4.32	83.50	69.50	5.54	5.88	113.63
9.	Fernandin	5.43	4.44	76.37	61.50	6.01	5.85	122.38
10	Vanraj	5.37	4.72	83.63	72.63	6.88	6.93	172.33
11	Baneshan	6.35	5.71	103.50	89.63	7.94	8.15	290.37
12.	Bangalora	5.60	4.58	90.62	78.25	6.90	7.19	178.30
13.	Mulgoa	5.09	4.10	86.75	72.00	6.09	6.13	121.39
14.	Neelum	4.39	3.45	73.13	59.75	5.06	5.18	72.04
15.	Suvarnarekha	4.76	4.11	81.13	69.13	6.11	6.15	121.00
16.	Zardalu	5.83	5.23	95.00	80.75	8.14	7.96	269.75
17.	Bombai	5.76	4.98	101.00	84.38	8.15	8.40	267.76
18.	Bombay green	4.87	4.35	84.88	76.50	5.83	5.81	115.07
19	Himsagar	4.87	4.69	85.38	71.38	5.90	6.02	132.41
20	Krishnabhog	5.60	5.24	93.13	73.13	6.83	7.02	199.48
	Mean	5.701	4.975	95.358	90.767	7.081	7.12	217.851
	S.Em±	0.197	0.252	4.186	3.482	0.406	0.344	22.257
	C.D at 5%	0.558	0.714	11.84	9.848	1.148	0.974	62.954

Fig. 4.3: Average height and canopy height per tree

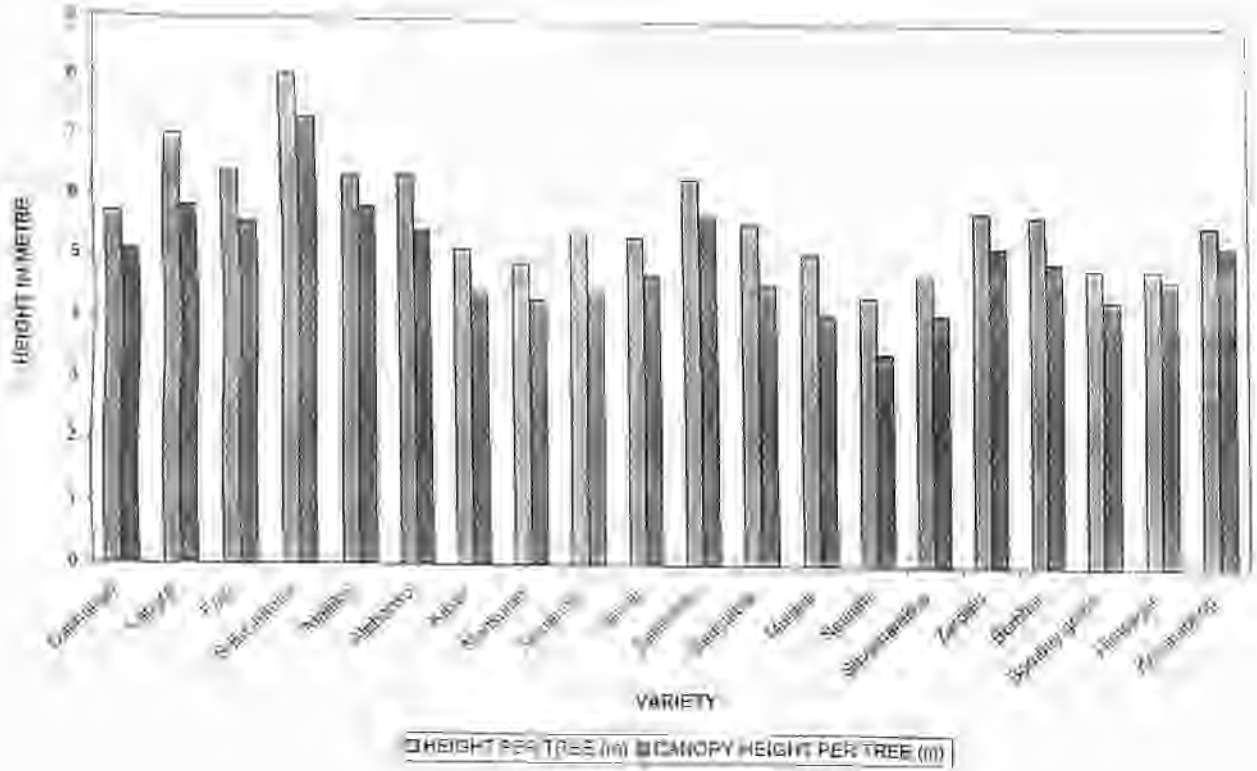


Fig.No.4:Circumference of root stock and scion

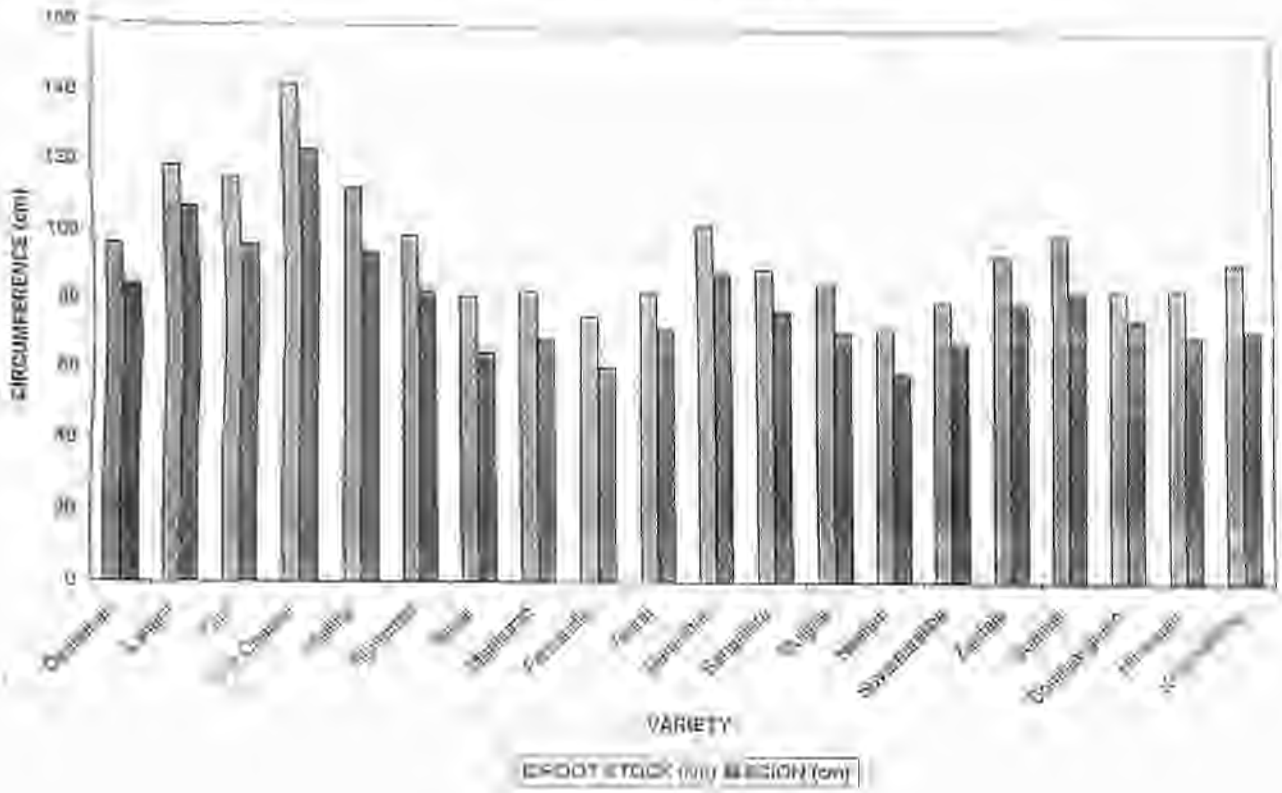


Fig No.5: Average spread North to South and East to West per tree

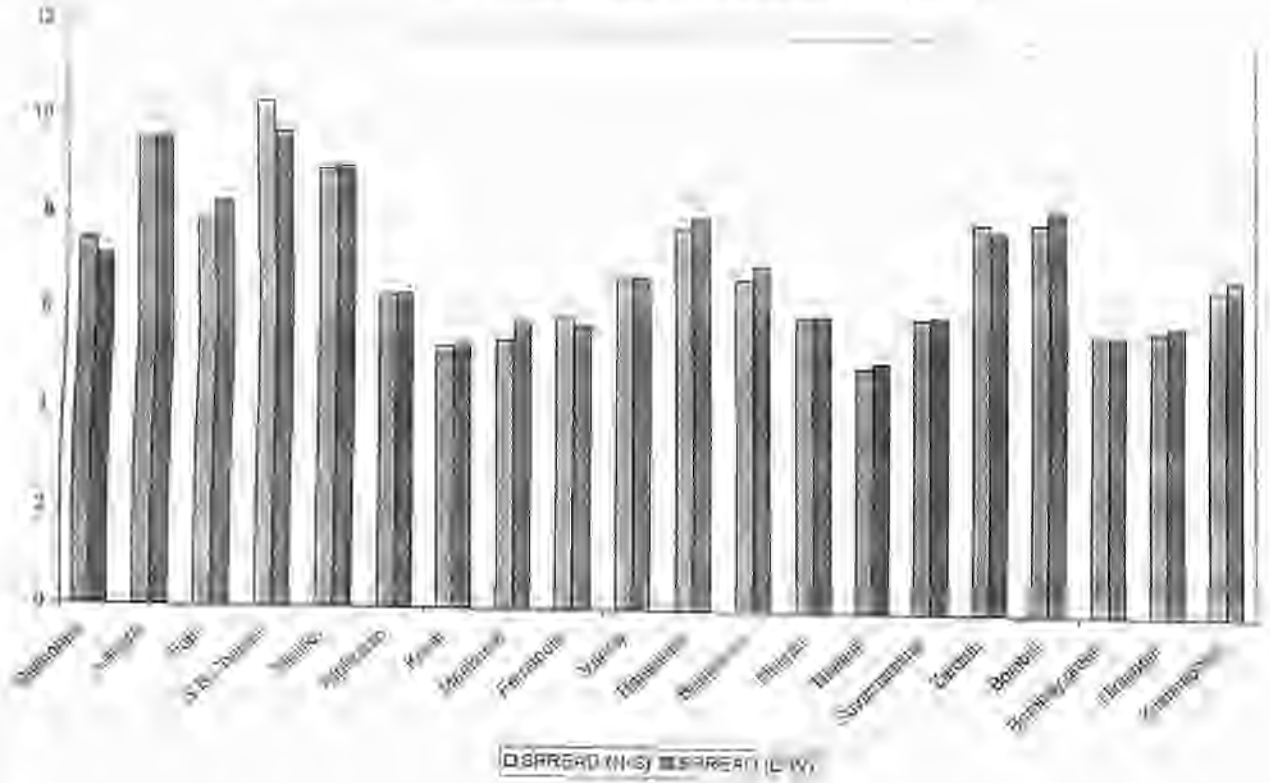
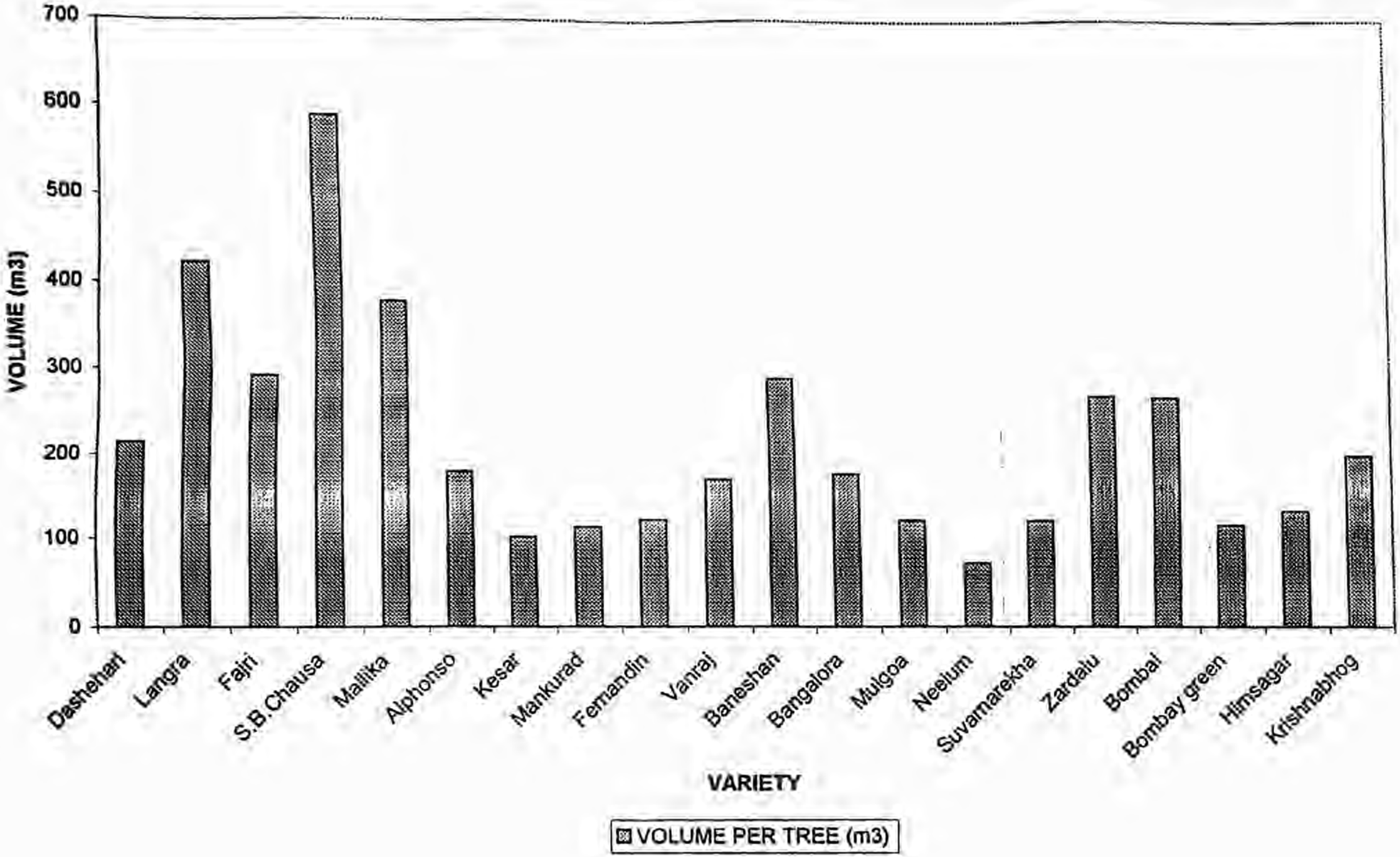


Fig.No.6; Average volume per tree



4.1.3 Average circumference of root stock

The average circumference of root stock varied significantly and it ranged between 73.13 to 143.00 cm. The highest circumference was noted under S.B. Chausa (143.00 cm) followed by Langra (119.00 cm) and Fajri (116.00 cm). lowest circumference was recorded under Neelum (73.13 cm) closely followed by Fernandin (76.37 cm) and Suvarnarekha (81.13 cm). The average circumference of root stock ranged between 82.13 to 113.00 cm in other cultivars.

4.1.4 Average circumference of scion

Similar variations were observed in the average circumference of scion which varied from 59.75 to 124.25 cm. The maximum circumference was noted in S.B.Chausa (124.25 cm) followed by Langra (107.38 cm) and both were significantly superior to other varieties. Minimum circumference was recorded in Neelum (59.75 cm) followed by Fernandin (61.50 cm) and Kesar (65.38 cm). The circumference of in other varieties ranged between 69.13 to 96.63 cm.

4.1.5 Average spread of the tree

The significant variations in the spread (N-S and E-W) were also noted amongst the varieties. The average spread of the tree (N-S and E-W) was recorded highest in S.B. Chausa (10.42 m and 9.78 m) followed by Langra (9.55 m and 9.60 m) whereas, the lowest spread was observed under Neelum (5.06 m and 5.18 m). The spread of the other varieties ranged between 5.38 to 9.02 m (N-S) and 5.42 to 9.09 m (E-W).

4.1.6 Average volume per tree

The significant variations in the average volume per tree were also found amongst the varieties. The average volume varied from 72.04 to 589.85 m^3. Cultivar S.B.Chausa gave the maximum volume (589.85 m^3) followed by Langra (421.86 m^3) and Mallika (380 m^3) which were significantly superior to other varieties. Minimum volume was noted under Neelum (72.04 m^3) followed by Kesar (101.87 m^3) and Mankurad (113.63 m^3). The volume of other varieties was in between 115.07 to 292.37 m^3.

4.2 Flowering behaviour

The observations on flowering were recorded at the four stages viz., date of flower bud initiation , date of start of flowering, date of full bloom and date of fruit setting. The results are presented in table-5.

Table 5. Flowering behaviour

S. No.	Varieties	Date of flower bud initiation	Date of start of flowering	Date of full bloom	Date of fruit setting
1.	Dashehari	19 J	10 F	23 F	3 M
2.	Langra	8 F	24 F	6 M	14 M
3.	Fajri	20 J	17 F	3 M	11 M
4.	S.B.Chausa	21 J	19 F	3 M	11 M
5.	Mallika	21 J	15 F	26 F	9 M
6.	Alphonso	9 F	27 F	7 M	16 M
7.	Kesar	22 J	14 F	25 F	7 M
8.	Mankurad	22 J	13 F	24 F	8 M
9.	Fernandin	17 J	12 F	25 F	6 M
10	Vanraj	15 J	7 F	17 F	26 F
11	Baneshan	16 F	7 M	17 M	24 M
12.	Bangalora	6 F	28 F	11 M	18 M
13.	Mulgoa	20 J	9 F	22 F	2 M
14.	Neelum	15 F	4 M	15 M	21 M
15.	Suvarnarekha	21 J	12F	24 F	5 M
16.	Zardalu	16 J	10 F	22 F	5 M
17.	Bombai	21 J	12 F	27 F	9 M
18.	Bombay green	8 F	25 F	6 M	14 M
19	Himsagar	8 F	28 F	9 M	17 M
20.	Krishnabhog	7 F	28 F	11 M	19 M

J = January, F = February and M = March

4.2.1 Date of flower bud initiation

The date of flower bud initiation varied from 15th Jan. to 16th Feb. The earliest flower bud initiation was observed in Vanraj (15th Jan.) followed by Zardalu (16th Jan.). The latest flower bud initiation was noted in Baneshan (16th Feb.) followed by Neelum (15th Feb.).

4.2.2 Date of start of flowering

The date of start of flowering was observed from 7th Feb. to 7th March in different varieties. Earliest flowering was observed in Vanraj (7th Feb.) followed by Mulgao (9th Feb.), Dashehari and Zardalu (10th Feb.). Latest start of flowering was observed under Baneshan (7th March) and Neelum (4th March). The start of flowering of other varieties was noted in between 12th February and 28th February.

4.2.3 Date of full bloom

The date of full bloom of the cultivars was in between 17th Feb. to 17th March. The earliest full bloom was observed in Vanraj (17th Feb.) followed Zardalu, Mulgao (22nd Feb.) and Dashehari (23rd Feb.). Latest full bloom was observed under Baneshan (17th March) followed by Neelum (15th March). Full bloom stage of other varieties was observed from 24th Feb. to 11th March.

4.2.4 Date of fruit setting

The date of fruit setting of the varieties was noted between 26th Feb. to 24th March. The earliest fruit setting was observed in Vanraj (26th Feb.) followed by Mulgoa (2nd March) and Dashehari (3rd March). Late fruit setting was observed under Baneshan (24th March) followed by Neelum(21st March). Fruit setting stage of other varieties was observed from 5th March to 19th March.

4.3 Percentage of malformation:

The total number of malformed panicles was recorded and percentage was calculated. The percentage of malformation given in Table-6 varied from 2.37 to 65.23 %. The maximum incidence was observed under Alphonso (65.23 %) followed by Fernandin (55.91 %) and Vanraj (46.45 %) whereas, minimum incidence

was noted under Baneshan (2.37 %) followed by Bangalora (7.61 %). The incidence in other varieties was in between 12.98 to 42.28 %.

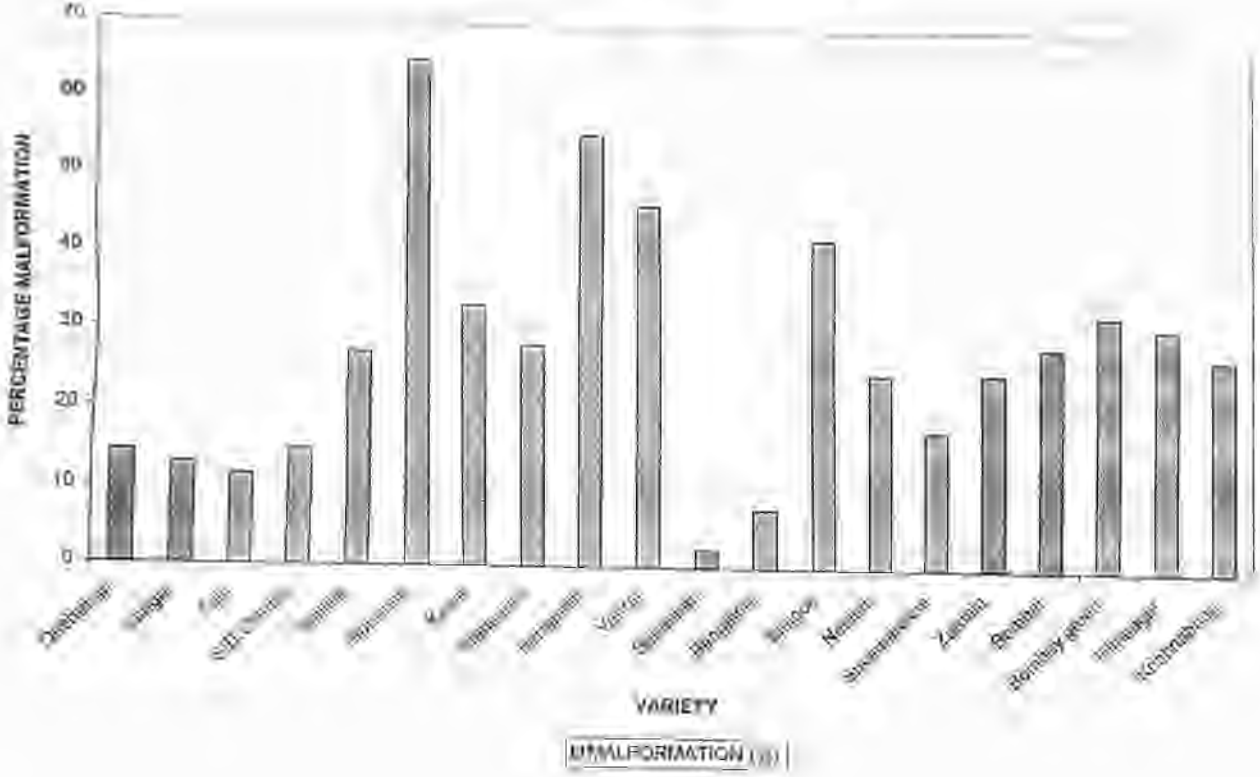
Table 6. Percentage of malformation

S. No.	Varieties	Malformation %
1.	Dashehari	14.43
2.	Langra	12.98
3.	Fajri	11.52
4.	S.B.Chausa	14.80
5.	Mallika	27.15
6.	Alphonso	65.23
7.	Kesar	33.26
8.	Mankurad	28.21
9.	Fernandin	55.91
10	Vanraj	46.45
11	Baneshan	2.37
12.	Bangalora	7.61
13.	Mulgoa	42.28
14.	Neelum	24.99
15.	Suvarnarekha	17.76
16.	Zardalu	25.14
17.	Bombai	28.48
18.	Bombay green	32.69
19	Himsagar	31.02
20.	Krishnabhog	27.27
	Mean	27.4775
	S.Em.±	4.591
	C.D.	12.986

4.4 Fruit drop:

It is evident from the data presented in table-7 that the average percentage of fruit drop varied from 61.29 to 100 %. The maximum fruit drop was recorded under Alphonso, Fernandin and Mulgoa (100 %) due to malformation followed by Langra (76.54 %) and Mallika (73.64 %). Minimum fruit drop was recorded under

Fig.No.7: Malformation percentage per tree

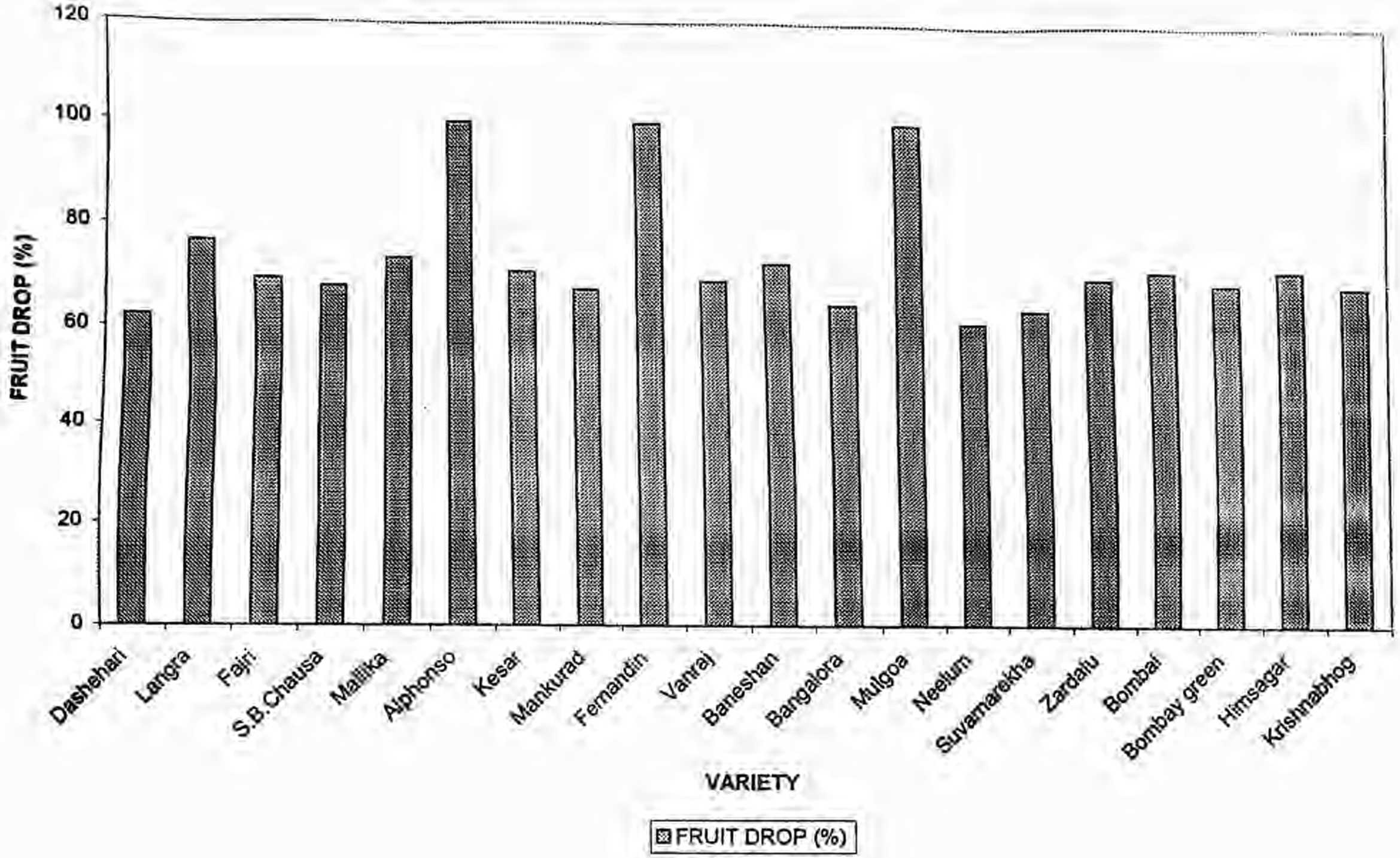


Neelum (61.29 %) followed by Dashehari (62.19 %) and Suvarnarekha (63.80 %). The percentage fruit drop in other varieties varied from 64.80 to 72.917 % .

Table 7. Percentage of fruit drop

S. No.	Varieties	Fruit drop %
1.	Dashehari	62.19
2.	Langra	76.54
3.	Fajri	69.57
4.	S.B.Chausa	68.20
5.	Mallika	73.64
6.	Alphonso	100.00
7.	Kesar	71.14
8.	Mankurad	67.74
9.	Fernandin	100.00
10	Vanraj	69.57
11	Baneshan	72.91
12.	Bangalora	64.80
13.	Mulgoa	100.00
14.	Neelum	61.29
15.	Suvarnarekha	63.80
16.	Zardalu	70.13
17.	Bombai	71.65
18.	Bombay green	69.14
19	Himsagar	71.84
20.	Krishnabhog	68.64
	Mean	73.63
	S.Em±	3.068
	C.D.	8.678

Fig.No.8: Average fruit drop percentage per tree



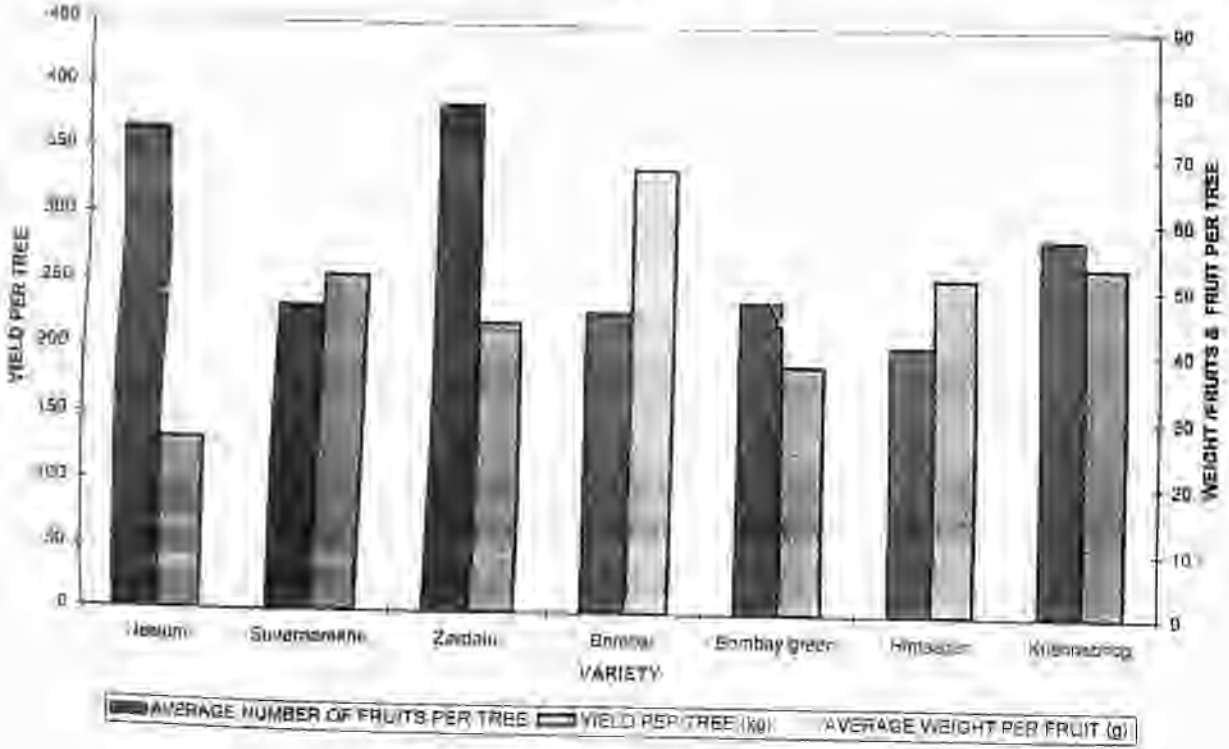
4.5 Yield parameters

The observations on the total number of fruits per tree and total yield per tree were recorded after picking and the average weight per fruit was calculated. The data presented in Table-8.

Table 8. Yield parameters

S. No.	Varieties	Average number of fruits per tree	Average yield per tree (kg)	Average weight per fruit (g)
1.	Dashehari	464.50	76.58	164.73
2.	Langra	410.25	100.47	244.98
3.	Fajri	267.75	90.17	336.93
4.	S.B.Chausa	278.50	74.22	266.51
5.	Mallika	308.50	99.12	321.58
6.	Alphonso	--	--	--
7.	Kesar	170.25	28.38	166.80
8.	Mankurad	125.25	26.69	213.40
9.	Fernandin	--	--	--
10	Vanraj	107.12	39.04	365.30
11	Baneshan	297.50	126.30	424.63
12.	Bangalora	552.00	179.53	324.94
13.	Mulgoa	-	-	-
14.	Neelum	364.87	48.28	131.89
15.	Suvarnarekha	231.12	58.93	255.42
16.	Zardalu	386.50	84.61	219.72
17.	Bombai	228.88	77.31	337.93
18.	Bombay green	237.67	45.08	189.70
19	Himsagar	205.00	57.71	257.39
20.	Krishnabhog	287.75	76.84	267.18
	Mean	289.61	75.83	264.06
	S.Em±	18.868	4.740	2.464
	C.D. at 5%	53.926	13.548	7.041

Fig.No.8: Yield parameters (Average number of fruits per tree, Average yield per tree (kg) and Average weight per fruit (g)



4.5.1 Average number of fruits per tree

Perusal of the data presented in Table-8 revealed that the average number of fruits per tree varied from 107.12 to 852.00. The maximum number of fruits was recorded under Bangalora (852.00) and it was significantly higher than other varieties, next were Dasheheri (464.50) and Langra (410.25) whereas, the minimum number of fruits was noted under Vanraj (107.12) followed by Mankurad (125.25) and Kesar (170.25). The average number of fruits per tree in other varieties ranged between 205.00 to 388.50.

4.5.2 Average yield per tree

The significant variations in the average yield per tree were noted amongst the varieties. The average yield ranged from 36.09 to 179.53 kg. The maximum yield per tree was recorded under Bangalora (179.53 kg) followed by Baneshan (126.30 kg) and Langra (100.47 kg). The minimum yield was recorded under Mankurad (26.69 kg) followed by Kesar (29.38 kg) and Vanraj (38.04 kg). The yield of other varieties varied from 46.05 to 95.12 kg per tree.

4.5.3 Average weight per fruit

The average weight per fruit ranged between 131.80 to 424.63 g. The maximum weight per fruit was recorded under Baneshan (424.63g) which was significantly superior over all the other varieties. The second biggest fruits were found in Vanraj (355.38 g) followed by Bombai (337.03 g) and Fajri (336.93 g). The minimum weight per fruit was recorded under Neelum (131.80 g) followed by Dasheheri (164.73 g). The average weight per fruit of other varieties ranged between 250.00 g to 324.44 g.

4.6 Physical properties of fruits

In order to study the physical properties of fruits the observations on fruit length, fruit width, specific gravity, weight of peel, weight of pulp and weight of stone were recorded after opening of fruit. The pulp/peel ratio, pericarp ratio and pulp/stone ratio was calculated. Data presented in table-9.

Table 9. *Physical properties of fruits*

S. No.	Varieties	Average length per fruit (cm)	Average width per fruit (cm)	Specific gravity	Peel %	Pulp %	Stone %	Pulp/ peel %	Peel/ stone ratio	Pulp / stone ratio
1.	Dashehari	11.13	6.15	1.04	12.79	73.30	13.90	5.73	0.91	5.27
2.	Langra	9.70	7.35	1.02	11.26	77.08	11.66	6.84	0.96	6.61
3.	Fajri	12.95	9.13	1.03	12.49	73.69	13.81	5.89	0.89	5.33
4.	S.B.Chausa	10.70	7.60	1.05	14.33	70.08	15.59	4.88	0.91	4.49
5.	Mallika	13.03	7.65	1.02	13.95	72.83	13.22	5.21	1.05	5.50
6.	Alphonso	-	-	--	-	-	-	-	-	-
7.	Kesar	9.28	6.00	1.06	16.71	62.41	20.88	3.73	0.79	2.99
8.	Mankurad	7.83	6.30	1.06	15.27	68.07	16.66	4.46	0.91	4.08
9.	Fernandin	-	-	-	-	-	-	-	-	-
10	Vanraj	10.20	8.00	1.02	13.22	72.29	14.48	5.47	0.90	4.99
11	Baneshan	13.08	11.10	1.02	13.38	75.15	11.48	5.61	1.16	6.54
12.	Bangalora	13.60	8.48	1.04	14.35	75.11	10.53	5.23	1.36	7.17
13.	Mulgoa	-	-	-	-	-	-	-	-	-
14.	Neelum	7.83	6.45	1.07	17.84	65.29	16.86	3.66	1.05	3.88
15.	Suvarnarekha	11.03	8.35	1.05	16.57	68.69	14.74	4.14	1.12	4.66
16.	Zardalu	9.53	6.48	1.07	13.14	68.70	18.16	5.22	0.71	3.78
17.	Bombai	12.93	8.23	1.03	10.17	80.12	9.60	7.89	1.06	8.34
18.	Bombay green	9.48	6.65	1.04	16.25	67.14	16.78	4.13	0.96	4.00
19	Himsagar	8.82	7.58	1.05	16.01	71.36	12.64	4.45	1.26	5.68
20.	Krishnabhog	9.25	8.30	1.04	11.65	76.40	11.95	6.56	0.97	6.45
	Mean	10.61	7.63	1.04	14.08	71.63	14.29	5.24	0.99	5.28
	S.Em±	0.220	0.1	0.004	0.168	0.323	0.204	0.083	0.026	0.154
	C.D. at 5%	0.630	0.284	0.011	0.480	0.923	0.582	0.238	0,074	0.442

4.6.1 Average length per fruit

From the perusal of the data presented in Table-9, it is evident that the average fruit length varied from 7.83 to 13.60 cm. The maximum average length of fruit was recorded under Bangalora (13.60 cm) followed by Baneshan (13.08 cm) and Mallika (13.03 cm) whereas the minimum length was noted under Mankurad and Neelum (7.83 cm) followed by Himsagar (8.82 cm). Average length of fruit of other varieties varied between 9.25 to 12.95 cm.

4.6.2 Average width per fruit

Similarly the average width per fruit varied significantly amongst the varieties. Maximum width was noted under Baneshan (11.10 cm) followed by Fajri (9.13 cm) and Bangalora (8.48 cm) whereas, the minimum fruit width was observed under Kesar (6.00 cm) followed by Dashehari (6.15 cm) and Mankurad (6.30 cm). The average fruit width in other varieties was between 6.48 to 8.35 cm.

4.6.3 Specific gravity of fruits

The specific gravity of the fruits varied significantly and it ranged between 1.02 to 1.07. The highest specific gravity was noted under Neelum (1.07) and Zardalu (1.07) followed by Kesar (1.06) while, the lowest was recorded in Baneshan, Vanraj and Langra (1.02). The specific gravity of other varieties varied from 1.03 to 1.05.

4.6.4 Average percentage of peel

The average peel percentage varied from 10.17 to17.84 %. The maximum peel percentage was obtained under Neelum (17.84 %) and was significantly superior over all other varieties. Minimum percentage was recorded under Bombai (10.17 %) followed by Langra (11.26 %) and Krishnabhog (11.65 %). The peel percentage in other varieties varied from 12.49 to 16.71 %.

4.6.5 Average percentage of pulp

Significant variations in the average pulp percentage were also found amongst the varieties (62.41 to 80.12). The maximum pulp percentage was recorded under Bombai (80.12 %) followed by Langra (77.08 %) and Krishnabhog (76.40 %) whereas, the minimum percentage of pulp was noted under Kesar (62.41 %) closely

Fig.No.10: Average length and width of fruits (cm)

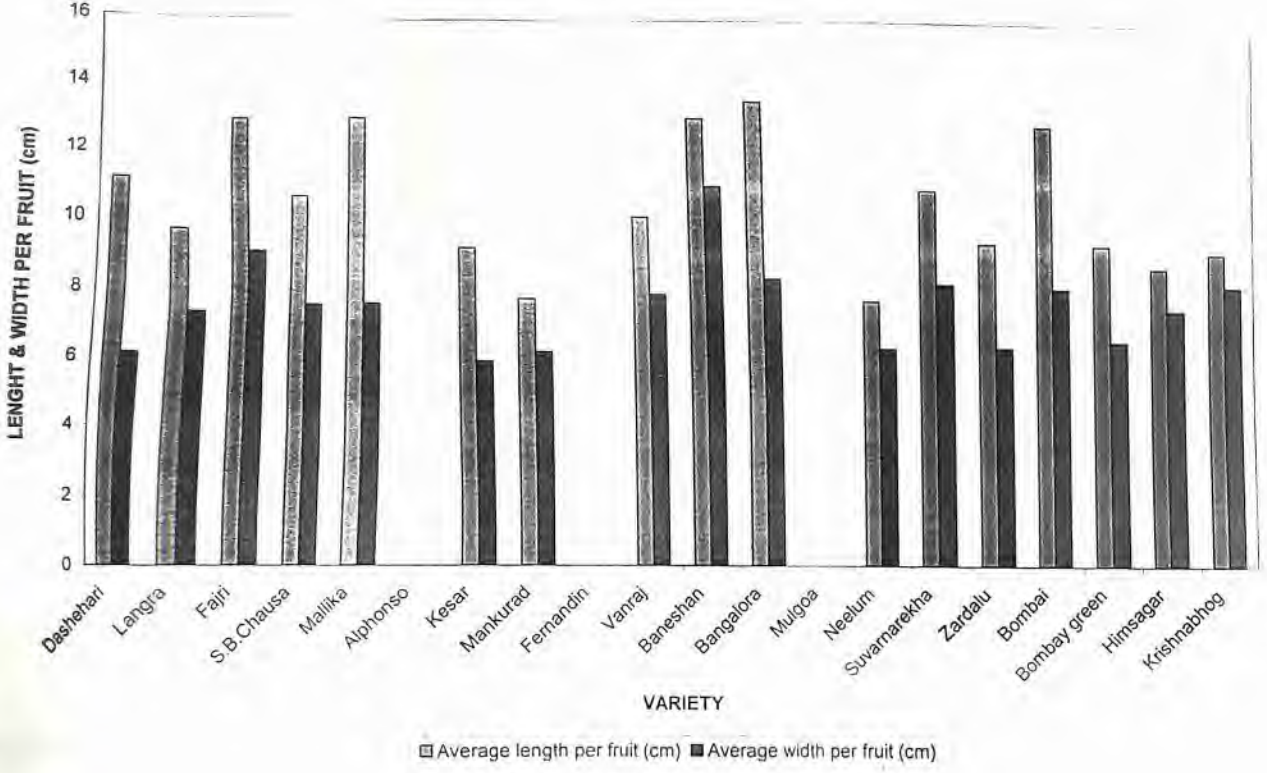
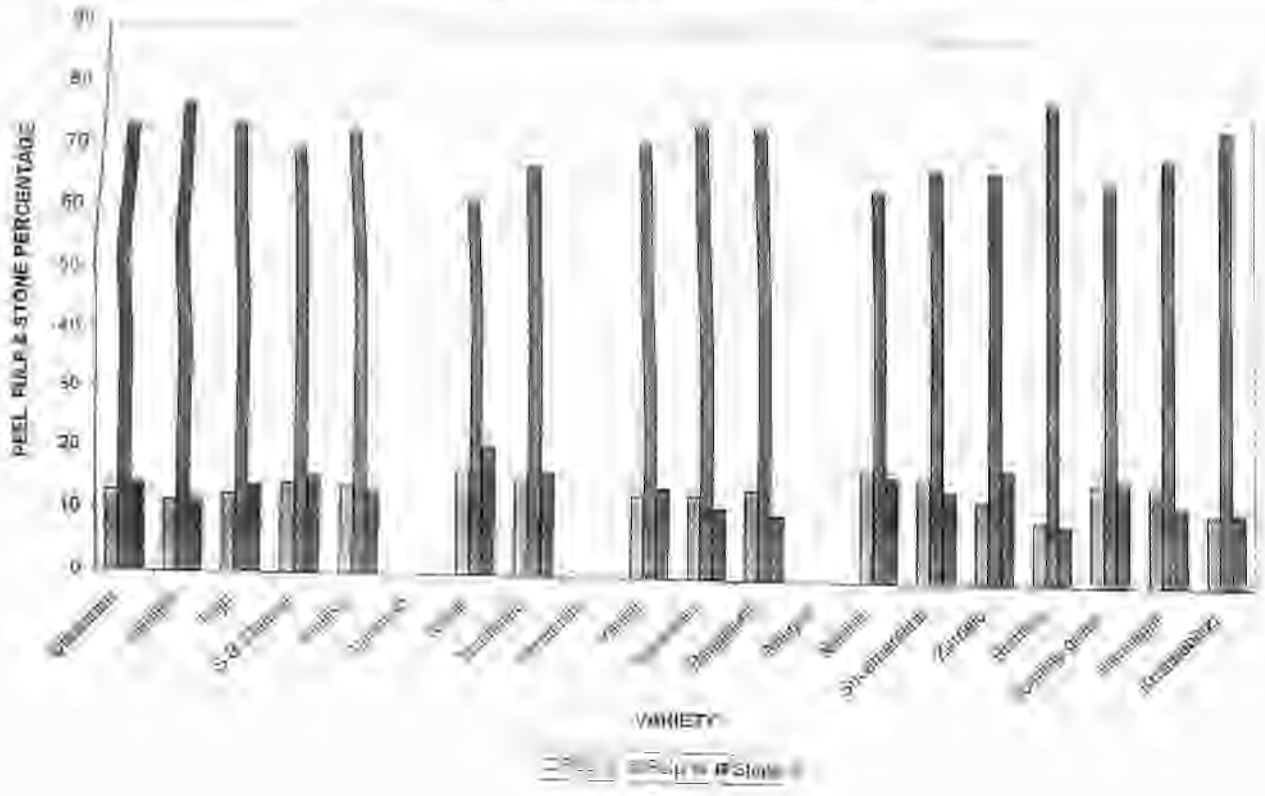
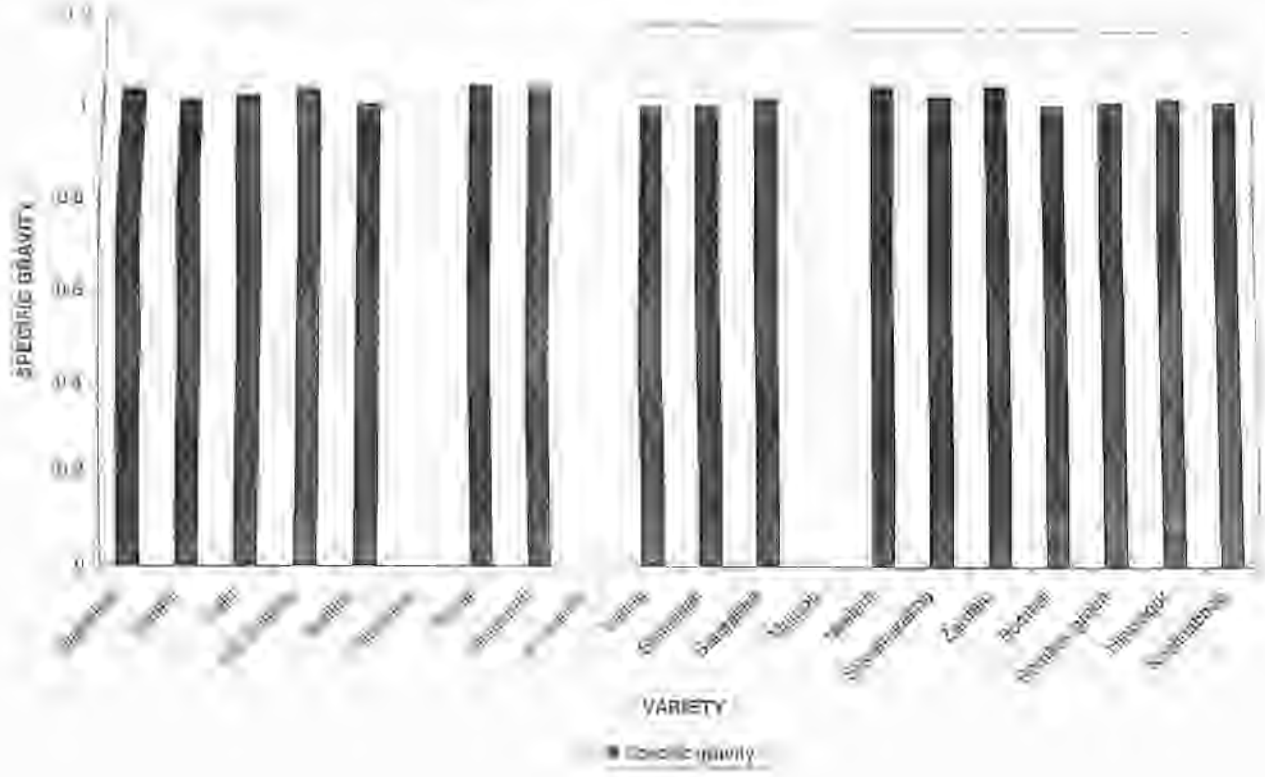


Fig. No 4.2: Average peel, pulp and stone percentage of fruits




SPECIFIC GRAVITY
VARIETY

followed by Neelum (65.29 %) and Bombay green (67.14%). The pulp percentage of other varieties was in between 68.07 to 75.15 %.

4.6.6 Average percentage of stone

The average percentage of stone was in between 9.60 to 20.88 %. The highest stone percentage was recorded under Kesar (20.88 %) and it was significantly higher than other varieties . Next were Zardalu (18.16 %) and Neelum (16.86 %), Bombay green (16.78 %) and Mankurad (16.66 %). The lowest stone percentage was found under Bombai (9.60 %) followed by Bangalora (10.53 %) and Langra (11.66 %). The stone percentage of other varieties differed from 11.95 % to 15.59 %.

4.6.7 Average pulp/peel ratio

The significant variations in the average pulp/peel ratio were also observed amongst the varieties (3.66 to 7.89). The maximum pulp/peel ratio was noted under Bombai (7.89) followed by Langra (6.84) and Krishnabhog (6.56) while, the minimum was recorded under Neelum (3.66) followed by Kesar (3.73) and Bombay green (4.13) . The pulp/peel ratio in other varieties was in between 4.14 to 5.89.

4.6.8 Average peel/stone ratio

The average peel/stone ratio varied from 0.71 to 1.36. The maximum peel/stone ratio was noted under Bangalora (1.36) followed by Himsagar (1.26) and Baneshan (1.16). Minimum peel/stone ratio was noted under Zardalu (0.71) followed by Kesar (0.79) and Fajri (0.89). The differences in other varieties were from 0.90 to 1.12.

4.6.9 Average pulp/stone ratio

The average pulp/stone ratio varied significantly and ranged between 2.99 to 8.34. Highest pulp/stone ratio was recorded in Bombai (8.34) followed by Bangalora (7.17) and Langra (6.61). Minimum pulp/stone ratio was under Kesar (2.99) followed by Zardalu (3.78) and Neelum (3.88) and the pulp/stone ratio in other varieties varied from 4.00 to 6.54.

Table 10: [illegible] skin colour, pulp colour, flavour, taste, texture of pulp and fibre content on the stone

S. No.	Variety	Fruit shape	Skin colour	Pulp colour	Flavour	Taste	Texture of pulp	Fibre content
[illegible]	[illegible]	Oblong to oblong oblique	Deep yellow	Yellow	Excellent	Very sweet	Firm and fibreless	Fine hair all over the surface
2	Langra	Ovate	Light green	Lemon yellow	Strong pleasant	Very sweet with a sub acidic tinge	Firm to soft	Fairly dense short and soft fibre all over the surface
3	Fazli	Large obliquely oval and some what flat	Light Lemon	Light cadmium	Mildly pleasant	Sweet	Soft and juicy	Sparse, short and soft fibre all over the surface
4	[illegible] Chausa	Ovate to oval-oblique	Yellow	Yellow	Strong and pleasant	Very sweet	Soft	Sparse, fine and short fibre all over the surface

		elliptic		yellow				
6.	Alphonso	-	-	-	-	-	-	-
7.	Kesar	Oblong	Pale yellow	Light yellow	Pleasant	Very sweet	Firm	Fine fibres over the surface
8.	Mankurad	Ovate	Yellow	Yellow	Pleasant to delightful	Very sweet	Firm	Dense, short soft fibres all over surface
9.	Fernandin	-	-	-	-	-	-	-
10	Vanraj	Ovate oblong	Radish deep yellow	Yellow	Pleasant	Sweet	Firm	Medium, dense and soft fibres all over surface
11	Baneshan	Obliquely oval	Shining golden yellow	Yellow	Pleasant	Sweet	Firm to meaty	Short sparse and soft fibres all over the surface
12.	Bangalora	Oblong	Golden corn colour	Yellow	Sub-acid (satisfactory)	Moderately sweet	Firm fibreless	Sparse, short and soft fibre all over

14.	Neelum	Ovate oblique	Yellow	Yellow	Good	Sweet	Firm	Covered with short and soft fibre all over
15.	Suvarnarekha	Ovate oblong	Light cadmium	Yellow	Pleasant	Sweet	Soft	Covered with short and soft fibres all over
16.	Zardalu	Oblong to obliquely	Golden yellow	Yellow	Very pleasant to delightful	Very sweet	Firm to soft	Dense, short and soft fibre all over covered
17.	Bombai	Ovate oblique	Yellow	Yellow	Pleasant	Sweet	Firm to soft	Fairly dense, soft and short fibre all over
18.	Bombay green	Ovate oblique	Greenish yellow	Orange	Pleasant and strong	Very sweet	Firm to soft	Dense, soft and short fibres all

14.	[illegible]	Ovate-oblique	Yellow	[illegible]	Good	Sweet	Firm	Covered with short and soft fibre all over
15.	Suvarnarekha	Ovate-oblong	Light coloured	[illegible]	Pleasant	Sweet	Soft	Covered with short and soft fibres all over
16.	[illegible]	Oblong to [illegible]	Golden yellow	[illegible]	Very pleasant or delightful	Very sweet	Firm to soft	Fibres short and soft fibre all over covered
17.	[illegible]	Ovate-oblique	Yellow	Yellow	Pleasant	Sweet	Firm to soft	Fairly dense soft and short fibre all over
18.	Bombay green	Ovate-oblique	Greenish yellow	Orange	Pleasant and strong	Very sweet	Firm to soft	Dense soft and short fibres all

19	*Himsagar*	*Ovate to ovate oblique*	*Yellow*	*Yellow*	*Delightful*	Very sweet	Firm	over Covered with short, dense and soft fibres all over
20.	Krishnabhog	Roundish oblique	Yellow	Light cadmium	Pleasant	Sweet	Firm	Covered with dense, short and soft fires all over the surface

4.7 Fruit quality

To determine the fruit quality, the fruits were analysed for the estimation of reducing sugar, non-reducing sugar, titrable acidity and total soluble solids (T.S.S.) after ripening and the total sugars were calculated. The results are given in Table-11.

4.8.1 Percentage of reducing sugar

From perusal of the data given in Table-11, it can be stated that the percentage of reducing sugar ranged between 4.34 to 6.37 % and differed significantly. Maximum reducing sugar was estimated under Langra (6.37 %) followed by Mallika 6.10 and Fajri (5.88 %) while the minimum was estimated under Zardalu (4.34 %) followed by Bombai (4.35 %) and Suvarnarekha (4.60 %). The percentage of reducing sugar in other varieties varied from 4.80 to 5.62 %.

4.8.2 Average percentage of non-reducing sugar

The percentage of non-reducing sugar in the fruits varied from 6.00 to 14.90 %. The maximum percentage of non-reducing sugar was estimated under Dashehari (14.90 %) which was significantly superior to other varieties. The second highest was Langra (13.32 %) followed by Zardalu (12.97 %) and Bombay green (12.10 %). Minimum non-reducing sugar was estimated under Bangalora (6.00 %) followed by Fajri 6.55% which were significantly inferior than other varieties. The percentage of non-reducing sugar in other varieties ranged between 8.07 to 11.00 %.

Table 11. Fruit quality

S. No.	Varieties	Average percentage of reducing sugar	Average percentage of non-reducing sugar	Average percentage of total sugar	Average percentage of acidity	Average total soluble solids (T.S.S.)
1.	Dashehari	5.60	14.90	20.50	0.36	24.50
2.	Langra	6.37	13.32	19.70	0.38	23.75
3.	Fajri	5.88	6.55	12.40	0.45	17.12
4.	S.B.Chausa	5.62	11.00	16.63	0.38	21.75
5.	Mallika	6.10	10.70	16.81	0.36	22.38
6.	Alphonso	-	-	-	-	-
7.	Kesar	5.49	8.32	13.82	0.52	19.50
8.	Mankurad	5.00	9.72	14.72	0.47	19.88
9.	Fernandin	-	-	-	-	-
10	Vanraj	5.05	8.62	13.67	0.41	18.75
11	Baneshan	4.80	8.07	12.88	0.49	16.63
12.	Bangalora	5.02	6.00	11.02	0.24	15.50
13.	Mulgoa	-	-	-	-	-
14.	Neelum	5.10	9.82	14.92	0.40	21.25
15.	Suvarnarekha	4.60	9.05	13.65	0.52	16.25
16.	Zardalu	4.34	12.97	17.32	0.38	21.75
17.	Bombai	4.35	9.80	14.15	0.50	17.75
18.	Bombay green	4.98	12.10	17.08	0.36	22.75
19	Himsagar	5.07	8.15	13.23	0.51	20.00
20.	Krishnabhog	5.57	9.28	14.85	0.51	21.00
	Mean	5.23	9.90	15.13	0.42	20.03
	S.Em±	0.186	0.357	0.310	0.017	0.547
	C.D. at 5%	0.531	1.018	0.887	0.048	1.564

4.3.3 Average Percentage of total sugars

The significant differences in the total sugars were also noted amongst the varieties. The percentage varied from 11.02 to 20.50. Maximum percentage of total sugars was estimated under Dashehari (20.50 %) followed by Langra (19.70 %). The minimum total sugar percentage was recorded under Bangalora (11.02 %) followed by Fajri (12.40%) and Baneshan (12.68 %). The percentage of total sugars in other varieties ranged between 13.23 to 17.32 %.

4.3.4 Percentage of acidity

The average percentage of acidity also varied significantly and it ranged between 0.24 to 0.52 %. Maximum percentage of acidity was estimated under Suvarnarekha and Kesar (0.52 %) followed by Himsagar and Krishnabhog (0.51 %). The minimum percentage of acidity was estimated under Bangalora (0.24 %) followed by Dashehari, Mallika and Bombay green (0.35 %). The percentage of acidity in other varieties ranged from 0.38 to 0.50.

4.3.5 Average total soluble solids (T.S.S.)

The total soluble solids of the fruits from different varieties were estimated with the help of hand-refractometer. Considerable variations were found in the percentage of T.S.S. of the fruits which varied from 16.50 to 24.50 %. The maximum percentage was estimated under Dashehari (24.50 %) followed by Langra (23.75 %) and Bombay green (22.75 %) while the minimum percentage was noted under Bangalora (16.50) followed by Suvarnarekha (16.25 %) and Baneshan (16.63 %). The percentage of T.S.S. in other varieties ranged between 17.12 to 21.75 %.

4.0 Correlation studies

Simple correlation coefficients were worked out to assess the association of various characters in all possible combinations.

4.1 Correlation between the vegetative growth and yield parameters

It is evident from the data given in Table-12 that the plant height was significant positively correlated with the canopy height (0.960), circumference of root stock (0.949), circumference of scion (0.935), spread N-S (0.905), spread E-W (0.861) and volume of the tree (0.939). But non-significant positive associations were found with the average yield (0.439), average weight per fruit (0.401) and average number of fruit per tree (0.256).

Canopy height was found to be positively correlated with the circumference of root stock (0.944), circumference of scion (0.922), spread N-S (0.886), spread E-W (0.870), volume (0.936), average number of fruits (0.217), average yield per tree (0.369) and average weight per fruit (0.420).

Positive associations were also observed between the circumference of root stock and scion (0.985), spread N-S (0.922), spread E-W (0.910), volume of the tree (0.963), average number of fruit per tree (0.211), average yield per tree (0.364) and average weight per fruit (0.380). Similarly circumference of scion was positively correlated with the spread N-S (0.927), spread E-W (0.911), volume of tree (0.958). Circumference of scion was also positively associated with the average number of fruits (0.286), average yield per tree (0.400) and average weight per fruit (0.343) but the correlations were non-significant.

Highly positive correlations were also observed between the spread N-S and spread E-W (0.958), volume of the tree (0.973), average yield per tree (0.475), average weight per tree (0.439) and average number of fruit per tree (0.321).

	Plant height (m)	Circumference (cm)		Spread (m)		Volume (m^3)	Average number of fruit per tree	Average yield per tree (kg)	Average weight per fruit (g)
		Root stock	Scion	N-S	E-W				
Plant height (m)	0.960*	0.949*	0.938*	0.905*	0.881*	0.939*	0.256	0.439	0.481
Canopy height (m)		0.944*	0.922*	0.896*	0.870*	0.938*	0.217	0.359	0.420
Circumference of Root stock (cm)			0.985*	0.922*	0.910*	0.963*	0.211	0.384	0.360
Circumference of scion (cm)				0.927*	0.910*	0.950*	0.266	0.400	0.343
Spread (N-S) (m)					0.988*	0.973*	0.321	0.475	0.436
Spread (E-W) (m)						0.950*	0.307	0.530*	0.519*
Volume (m^3)							0.234	0.387	0.364
Average number of fruit per tree								0.766*	-0.102
Average yield per tree (kg)									0.620*

* Significant at 5% level of probability.

Positive correlations were observed between spread E-W with the volume of tree (0.950), average yield per tree (0.530), average weight per fruit (0.519) and average number of fruit (0.307).

Volume of tree was positively correlated with the average number of fruits per tree (0.234), average yield per tree (0.387) and average weight per fruit (0.364).

The average number of fruit was positively correlated with the average yield per tree (0.756) but negative correlation was found with the average weight per fruit (-0.102).

The average yield was positively correlated with the average weight per fruit (0.528).

4.9.1 Correlation between the physical properties of fruits

It is obvious from the Table-13 that the specific gravity of fruits was negatively correlated with the fruit width (-0.609), fruit length (-0.633), peel percentage (-0.358) and pulp percentage (-0.723) whereas positively associated with the stone percentage (0.685). The association with the specific gravity and peel percentage was non-significant.

Table 13. Correlation between the physical properties of fruits

Characters	Fruit length (cm)	Fruit width (cm)	Fruit peel (%)	Fruit pulp (%)	Fruit stone (%)
Specific gravity	-0.633*	-0.609*	-0.358	-0.723*	0.685*
Fruit length (cm)		0.668*	-0.455*	0.593*	-0.597*
Fruit width (cm)			-0.358	0.587*	-0.655*
Fruit peel (%)				-0.866*	0.630*
Fruit pulp (%)					-0.933*

* Significant at 5% level of probability.

Fruit length was positively associated with fruit width (0.868) and pulp percentage (0.587) and negatively associated with the peel percentage (-0.435) and stone percentage (-0.65[illegible]

The fruit width was positively associated with the pulp percentage (0.487) and negatively associated with the peel percentage (-0.358) and stone percentage (-0.663).

Similarly the peel percentage was positively associated with the stone percentage (0.030) whereas, it was negatively associated with the pulp percentage (-0.866). Negative correlation was also observed between the pulp percentage and stone percentage (-0.930).

4.3.2 Correlation between the chemical properties of fruits

Simple correlation coefficients between the chemical properties of the fruits are presented in Table-14

Table 14. Correlation between the chemical properties of fruits

Characters	Non reducing sugar (%)	Total sugar (%)	Acidity (%)	T.S.S.
Reducing sugar %	0.152	0.378	0.215	0.404
Non reducing sugar (%)		0.974*	-0.258	0.862*
Total sugar (%)			0.269	0.914*
Acidity (%)				-0.269

* Significant at 5% level of probability

It is evident from the data given Table-14 that the reducing sugar was positively associated with non-reducing sugar (0.152), total sugar (0.378) and T.S.S. (0.404) while it was negatively correlated with the acidity percentage (-0.215) but associations were non-significant. The non reducing sugar was positively associated with the total sugar (0.974) and T.S.S. (0.862) and negatively associated with the acidity percentage (-0.258) but the association was non-significant.

The total sugars were positively associated with the T.S.S. (0.914) and negatively associated with the acidity (-0.289) but the association was non-significant. Similarly non-significant negative association was also observed between percentage of acidity and T.S.S. (-0.269)

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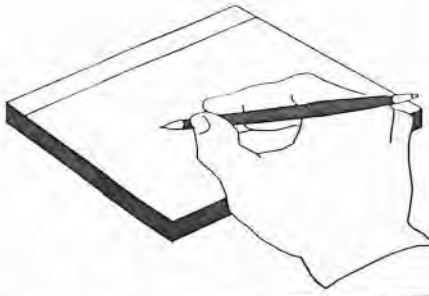
CHAPTER- V

DISCUSSION



CHAPTER –V

DISCUSSION

The results of present investigation entitled **"Evaluation of twenty commercial varieties of mango (*Mangifera indica* L.)"** have been discussed critically in the light of recent review of literature. The whole findings have been discussed in the appropriate headings, viz., vegetative growth characters, flowering, malformation, fruit drop, yield parameters, physical properties of fruit, fruit quality and correlation studies.

5.1 Vegetative growth characters

The growth of the twenty varieties was evaluated by recording the observations on the height of the tree, canopy height, spread (N-S and E-W), volume and circumference of root stock and scion. These characters differed significantly in the varieties.

The average height of the tree of all varieties was 5.70 m. The varieties having more height than this value are supposed to be taller as S.B. Chausa, Langra, Fajri, Alphonso, Mallika, Baneshan, Zardalu, Bombai and Dashehari. The remaining varieties exhibited lower height than the average. The maximum and minimum height was obtained in S.B. Chausa (8.07 m) and Neelum (4.39 m), respectively. Canopy height was maximum in S.B. Chausa (7.36 m) and minimum in Neelum (3.45 m). The circumference of root stock and scion was maximum in S.B. Chausa (143.00 cm and 124.25 cm). Spread of tree (N-S and E-W) was also maximum in S.B. Chausa (10.42 and 9.78 m) followed by Langra, Mallika and Fajri. Evaluating on the basis of average spread of varieties S.B. Chausa, Langra, Mallika, Bombai, Fajri, Zardalu and Baneshan may be grouped as spreading type. Neelum exhibited minimum spread (5.06 and 5.18 m). S.B. Chausa variety maintained the top position (589.85 m^3) with respect to volume of the tree. It differed significantly with all varieties. The variations in the growth parameters might be due to genetic

variation in the incidence of malformation amongst the varieties may probably be related to the hormonal balance and genetic characters of the variety which is related with the climatic conditions. Such results were also claimed by Dahshan (1988), Khader et al. (1988), Singh and Singh (1996), Kumar and Chakrabarti (1997).

5.4 Fruit drop

Fruit drop is an important character governing the total productivity of mango crop. The maximum percentage of fruit drop was recorded in Alphonso, Fernandin and Mulgoa followed by Langra and Mallika. Highest fruit retention was recorded in Neelum closely followed by Dashehari, Suvarnarekha, Bangalora and Mankurad and in the rest of the varieties average fruit drop was noticed. Thus the highest yield of Bangalora may be due to minimum fruit drop. The higher fruit drop in Langra was due to the formation of abscission layer and climatic condition. The variety with lower fruit drop is associated with the arrangement of stalk with the fruit and late formation of abscission layer. The variation in the fruit drop of mango varieties were also noted by Shrivastava *et al.* (1987), Sanyal and Maity (1992) and Jana and Sharangi (1998).

5.5 Yield parameters

All the varities varieties were evaluated in terms of average number of fruits, average weight per fruit and finally the average yield per tree. The higher yielding varieties under this trial were Bangalora, Baneshan, Langra, Mallika, Fajri, Zardalu, Bombai, Krishnabhog and Dashehari. Mankurad appeared as lowest yielder followed by Kesar and Vanraj. On the basis of an average production of seventeen varieties was (75.83Kg), Bangalora, Baneshan, Langra, Mallika, Fajri, Zardalu, Bombai, Krishnabhog and Dashehari appeared as high yielding varieties and all other varieties gave lower yield than the average and they may be grouped as poor yielders. Wide range of variations in the yield may be possible due to the variation in the food reserves and difference in vegetative growth characters. Maximum number of fruits per tree was obtained in Bangalora followed by Dashehari and Langra

whereas, minimum number was noted in Vanraj followed by Mankurad, Kesar and Bombai Thus, it clearly indicates that average number of fruits per tree alongwith the average weight per fruit directly govern the yield per tree. These findings are in accordance with Desai *et al.* (1985), Singh and Maurya (1988) Sharma et al. (1997) and Sharma et al. (2001).

5.6 Physical properties of fruits

The physical properties of fruits of these varieties have been evaluated in terms of length, width, specific gravity, peel, pulp and stone percentage and ratio of pulp/peel, pulp/stone and peel/stone. Maximum length of fruit was noted in Bangalora followed by Baneshan, Mallika and Fajri, while, the minimum length was observed in Neelum followed by Mankurad and Himsagar. On the other hand, the width of fruit was maximum in Baneshan followed by Fajri and Bangalora and minimum in the fruits obtained from Kesar followed by Mankurad and Neelum. Thus as a whole bigger size fruits were obtained in Baneshan, Vanraj, Bombai, Fajri, and Mallika. Smaller fruits were found in Neelum, Kesar and Mankurad The fruits of remaining varieties were medium size.

The specific gravity of the fruits was more in Neelum and Zardalu closely followed by Mankurad and Kesar. Fruits of Vanraj, Mallika, Langra and Baneshan gave lower specific gravity.

Higher pulp percentage was noted in the Bombai, Langra, Baneshan and Banglora, while the lowest pulp percentage was obtained in Kesar, followed by Neelum, Bombay green and Mankurad. The percentage weight of stone was higher in Kesar, Zardalu, Neelum, Bombay green and S.B. Chausa. Lower percentage of stone was observed in Bombai, Bangalora, Baneshan, Langra and Krishnabhog. The percentage weight of peel was higher in Neelum, Kesar, Zardalu and Bombay green and lower in Bombai, Langra and Krishnabhog.

High percentage of peel might be responsible for better keeping quality of the fruits. These three characters i.e. pulp, peel and stone reflex the edible portion of the fruits. Thus from the above observations recorded, it can be concluded that the fruits of Langra and Bombai consists maximum edible portion. The observations are in accordance with the results obtained by Shyamal and Mishra (1987); Bhuyan *et al.* (1988) and Rajpoot and Pandey (1997).

The higher pulp/peel ratio was obtained under Bombai, Langra and Krishnabhog while, lower in Neelum, Kesar, Bombay green and Suvaranrekha . The peel /stone ratio was higher in Bangalora,Himsagar and Baneshan whereas, it was lower in Zardalu, Kesar and Fajri. Thus it can be said the size of fruit is more or less dependent with the proportion of the pulp in the fruits. The higher pulp/stone ratio was found in Bangalora and lower in Kesar. These findings are in accordance by Shaymal and Mishra (1987) , Bhuyan et al. (1988), Rajput and Pandey (1997) and Sharma et al. (2001).

5.7 Fruit quality

The fruit quality of different varieties was analysed in terms of reducing sugar, non-reducing sugar and acidity. The total sugar were calculated by summing the reducing and non-reducing sugar. The fruits having high total sugars content were obtained from Dashehari and Langra whereas lower sugar content was noted in Bangalora, Fajri, and Baneshan. The maximum T.S.S. was found under Dashehari followed by Langra, Bombay green and Mallika while the minimum was noted in Bangalora and Suvarnarekha.

The titrable acidity in the fruits was maximum in Suvarnarekha nd Kesar followed by Himsagar and Krishnabhog and lowest in Bangalora followed by Dashehari, Bombay green and Mallika.

Looking to the overall qualitative characters of the varieties Dashehari, Langra, Bombay green, Mallika, S.B. Chausa and Zardalu were found superior and the varieties Bangalora, Baneshan, Fajri, Suvarnarekha and Vanraj of poor quality. Other varieties like Bombai, Neelum and Mankurad stand in the mid way so far as

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5.8 Correlation studies

The correlation coefficients were worked out for all the possible combinations of characters (Table 12, 13 and 14). Table-12 revealed that the tree height was positively correlated with canopy height, circumference of root stock and scion, spread N-S and E-W, volume of the tree, average yield per tree and average weight per fruit. It can be assumed that with the increase in height, the tree is more exposed to the sun which facilitated more synthesis of food materials and provided better vegetative growth. Canopy height was also positively correlated with the other growth parameters and average yield per tree and average weight per fruit. A tree with more canopy height also increased the spread in both directions due to which the fruiting area was increased and ultimately the yield was also enhanced. Circumference of root stock and scion was also positively associated with the spread (N-S and E-W), volume of the tree and average yield per tree. Spread (N-S and E-W) was also positively correlated with the volume of the tree, average yield per tree and average weight per fruit. Spread (E-W) was positively correlated with the average number of fruits per tree. Volume of the tree was also positively associated with the average yield per tree and average weight per fruit. It clearly indicates that the spreading varieties also produce the high volume of the tree. Positive relationship in vegetative growth characters was also reported by Prasad (1987).

The total number of fruits per tree was found positively correlated with the average yield per tree but it was not positively associated with the average weight per fruit. Yield per tree was not associated with the average weight per fruit, this might be because of the fact that where the average weight per fruit is higher the total number of fruits per tree remained less.

The specific gravity of fruits was negatively associated with the fruit length, fruit width, peel percentage and pulp percentage while positively correlated with the stone percentage. This shows that the fruits with higher specific gravity were having poor physical properties with higher percentage of stone and lower percentage of pulp. Significant positive association was observed with the fruit length, fruit width and stone percentage. It reveals that if the length of the fruit is more, the width is also increased due to which the total size of the fruits becomes larger and the larger fruit contain more pulp than smaller fruits.

Negative association was observed between the fruit length and pulp percentage and stone percentage. Negative relationship was also observed between the fruit pulp and stone, perhaps it might be due to completion stress.

It is evident from the data given in Table-14 that the reducing sugar was associated positively at non significant level with other chemical properties of the fruits. Significant positive correlation was observed between the non-reducing sugar, total sugar and T.S.S. It indicated that if non-reducing sugar content is higher the total sugar and T.S.S. content of the fruit will also be higher. Percentage acidity has got no relationship with other chemical qualities.

Similar association between above traits have also been reported by Singh et al. (1985), Prasad et al. (1987) and Kokadwar et al. (1992).

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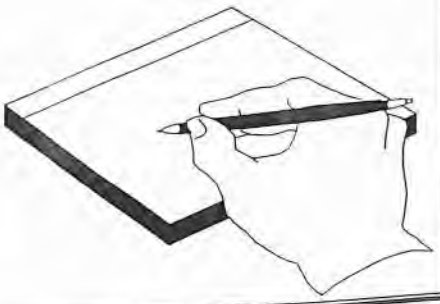
CHAPTER- VI

SUMMARY, CONCLUSION AND SUGGESTIONS



CHAPTER –VI

SUMMARY, CONCLUSION AND SUGGESTIONS FOR FURTHER WORK

Summary

With the objective of screening suitable varieties of mango for Kymore plateau, an experiment entitled **"Evaluation of twenty commercial varieties of mango (*Mangifera indica* L.)"** was carried out in the orchard at Fruit Research Station, Kuthulia, College of Agriculture, Rewa (M.P.) under All India Co-ordinated Research Project on Sub-tropical Fruits and the chemical analysis of the fruits was done in the laboratory of the Department of Food Science, College of Agriculture, Rewa during 2002-03.

The experiment consisted of twenty commercial varieties viz. Dashehari, Langra, Fajri, S.B. Chausa, Mallika, Alphonso, Kesar, Mankurad, , Fernandin, Vanraj, Baneshan, Bangalora, Mulgoa, Neelum, Suvarnarekha, Zardalu, Bombai , Bombay green, Himsagar, Krishnabhog.

The grafted plants of these varieties were planted at the recommended distance of 10 m x 10 m in the month of August-September, 1982. The experiment was conducted in the Randomized Block Design consisting of four replications. Two plants were planted per replication. The remarkable results obtained form this investigation are summarized below:

- Variation in the varieties was significant in respect of all the characters observed.
- Variety S.B.Chausa gave maximum height, canopy height, circumference of root stock and scion, spread (N-S and E-W), volume and vigorous as compared to other cultivars.

- Date of flower bud initiation, date of start of flowering, date of full bloom and date of fruit setting was earliest in Vanraj and late in Baneshan.
- The varieties Alphonso, Fernandin, Vanraj and Mulgoa were highly affected by floral malformation and Baneshan was least affected. No variety was found free from malformation.
- Maximum fruit drop was counted in Langra and minimum in Neelum and Zero percent of fruit retention was observed under Alphonso,Fernandin and Mulgoa.
- Maximum number of fruits and yield per tree was recorded under Bangalora.. The higher weight of fruits was recorded under Baneshan and Vanraj whereas, lower weight found in Neelum and Dashehari.
- No fruiting was observed in Alphonso, Fernandin and Mulgoa varieties during the year 2002-2003.
- Maximum length and width of fruit was noted in Bangalora and Baneshan, respectively. Maximum specific gravity was recorded in Neelum and Zardalu.
- Maximum pulp percentage was found in Bombai and minimum in Kesar. Maximum stone percentage was noted in Kesar and minimum in Bombai.
- The highest pulp/peel ratio was found in Bombai and highest peel/stone ratio was in Bangalora while Bombai gave maximum pulp/stone ratio.
- Reducing sugar was highest in Langra and non reducing sugar was in Dashehari. Maximum percentage of total sugar was estimated in Dashehari followed by Langra.
- Maximum acidity was analysed in Suvarnarekha followed by Kesar and minimum in Bangalora.
- All vegetative growth characters were positively associated with one another and also with the average yield per tree.

- Total number of fruits along with average weight per fruit per tree was positively associated with the total yield per tree.
- Specific gravity was negatively associated with fruit length, fruit width, peel and pulp percentage. Fruit length and fruit width were positively associated with pulp percentage.
- Reducing sugar was associated positively at non-significant level with other chemical properties of fruit while significant association was observed between non-reducing sugar with total sugar and T.S.S.

Conclusion

The varieties S.B. Chausa, Langra and Mallika were found vigorous. On the basis of the flowering behaviour, Vanraj,Zardalu and Dashehari appeared to be earlier and Baneshan, Neelum, Bangalora, and Krishnabhog appeared late. Bangalora, Baneshan, Langra, Mallika, Fajri and Dashehari were high yielding varieties. Physical and chemical analysis showed better values of the chemical constituents in reputed varieties like Langra, Mallika, S.B. Chausa and Dashehari.

Suggestions for further work:

1. The experiment should be repeated to confirm the findings of present investigation during on and off year for growth and flowering behaviour of varieties.
2. Floral biology of these varieties should also be studied in detail.
3. Ascorbic acid content of the fruits should also be estimated to find out the suitable variety/varieties for quality view point.

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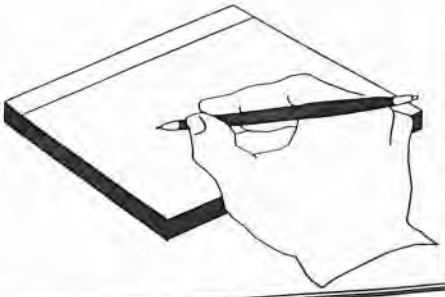

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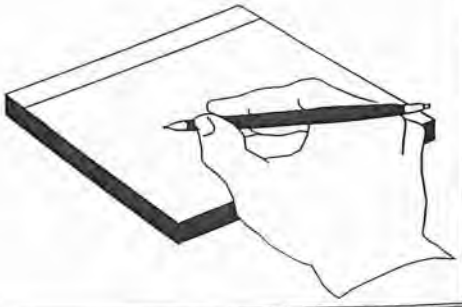
APPENDICES



APPENDICES

Appendix- I

Analysis of variance table for tree height (m)

Source of variation	d.f.	S.S.	M.S.S.	F Cal.	F tab 5%	F tab 1%
Replication	3	1.038	0.346	2.206		
Varieties	19	59.300	3.12	20.00*	1.772	2.248
Error	57	8.941	0.156			
Total	79	69.279				

*Significant at 5%

Appendix- II

Analysis of variance table for canopy height (m)

Source of variation	d.f.	S.S.	M.S.S.	F Cal.	F tab 5%	F tab 1%
Replication	3	0.674	0.224			
Varieties	19	56.412	2.96	11.60*	1.772	2.248
Error	57	14.543	0.255			
Total	79	71.629				

*Significant at 5%

Appendix- III

Analysis of variance table for circumference of root stock (cm.)

Source of variation	d.f.	S.S.	M.S.S.	F Cal.	F tab 5%	F tab 1%
Replication	3	161.83	53.943	0.7695		
Varieties	19	22103.938	1163.365	16.595*	1.772	2.248
Error	57	3995.982	70.10			
Total	79	26261.75				

*Significant at 5%

Appendix- IV

Analysis of variance table for circumference of Scion (cm.)

Source of variation	d.f.	S.S.	M.S.S.	F Cal.	F tab 5%	F tab 1%
Replication	3	192.707	64.235	1.324		
Varieties	19	19138.934	1007.312	20.766*	1.772	2.248
Error	57	2764.856	48.506			
Total	79	22096.497				

*Significant at 5%

Appendix- V

Analysis of variance table for tree spread (N-S). (m)

Source of variation	d.f.	S.S.	M.S.S.	F Cal.	F tab 5%	F tab 1%
Replication	3	3.617	1.205	1.825		
Varieties	19	160.432	8.443	12.79*	1.772	2.248
Error	57	37.649	0.660			
Total	79	201.698	201.698			

*Significant at 5%

Appendix- VI

Analysis of variance table for tree spread (E-W) (m)

Source of variation	d.f.	S.S.	M.S.S.	F Cal.	F tab 5%	F tab 1%
Replication	3	2.697	0.899	1.888		
Varieties	19	147.276	7.75	16.281*	1.772	2.248
Error	57	27.158	0.476			
Total	79	177.131				

*Significant at 5%

Appendix- VII

Analysis of variance table for tree volume (m^3)

Source of variation	d.f.	S.S.	M.S.S.	F Cal.	F tab	
					5%	1%
Replication	3	15645.636	5215.212	2.631		
Varieties	19	1266190.972	66641.630	33.62*	1.772	2.248
Error	57	112953.167	1981.634			
Total	79	1394789.775				

*Significant at 5%

Appendix- VIII

Analysis of variance table for fruit drop percentage

Source of variation	d.f.	S.S.	M.S.S.	F Cal.	F tab	
					5%	1%
Replication	3	44.330	14.77	0.392		
Varieties	19	10880.026	572.632	15.206*	1.772	2.248
Error	57	2146.549	37.658			
Total	79	13070.905				

*Significant at 5%

Appendix- IX

Analysis of variance table for number of fruits per tree

Source of variation	d.f.	S.S.	M.S.S.	F Cal.	F tab. 5%
Replication	3	2937.775	979.258	0.687	
Varieties	16	886390.736	55399.421	38.903*	1.868
Error	48	68352.412	1424.008		
Total	67	957680.923			

*Significant at 5%

Appendix- X

Analysis of variance table for yield per tree (kg)

Source of variation	d.f.	S.S.	M.S.S.	F Cal.	F tab. 5%
Replication	3	278.719	92.906	1.033	
Treatment	16	93127.497	5820.468	64.745*	1.868
Error	48	4315.06	89.897		
Total	67	97721.276			

*Significant at 5%

Appendix- XI

Analysis of variance table for average weight per fruit (g)

Source of variation	d.f.	S.S.	M.S.S.	F Cal.	F tab. 5%
Replication	3	144.6621	48.220	1.985	
Treatment	16	404533.7442	25283.35901	1040.898*	1.868
Error	48	1165.9175	24.28994792		
Total	67	405844.3238			

*Significant at 5%

Appendix- XII

Analysis of variance table for length of per fruit (cm.)

Source of variation	d.f.	S.S.	M.S.S.	F Cal.	F tab. 5%
Replication	3	0.224	0.074	0.379	
Treatment	16	231.684	14.480	74.25*	1.868
Error	48	9.379	0.195		
Total	67	241.287			

*Significant at 5%

Appendix- XIII

Analysis of variance table for weight per fruit (cm.)

Source of variation	d.f	S.S.	M.S.S.	F Cal	F tab 5%
Replication	3	0.226	0.0753	1.8825	
Treatment	16	106.085	6.630	165.75*	1.868
Error	48	1.959	0.040		
Total	67	108.270			

*Significant at 5%

Appendix- XIV

Analysis of variance table for specific gravity of fruit

Source of variation	d.f	S.S.	M.S.S.	F Cal.	F tab. 5%
Replication	3	0.000294352	0.000098117	1.4928	
Treatment	16	0.018812	0.00117575	17.88*	1.868
Error	48	0.003154848	0.000065726		
Total	67	0.222612			

*Significant at 5%

Appendix- XV

Analysis of variance table for peel percentage of per fruit

Source of variation	d.f.	S.S.	M.S.S.	F Cal.	F tab. 5%
Replication	3	0.619	0.206	1.807	
Treatment	16	290.578	18.161	159.307*	1.868
Error	48	5.489	0.114		
Total	67	296.686			

*Significant at 5%

Appendix- XVI

Analysis of variance table for percentage of fruit pulp

Source of variation	d.f.	S.S.	M.S.S.	F Cal	F tab. 5%
Replication	3	2.80	0.933	2.23	
Treatment	16	1342.73	83.920	200.76*	1.868
Error	48	20.10	0.418		
Total	67	1365.63			

*Significant at 5%

Appendix- XVII

Analysis of variance table for fruit stone percentage

Source of variation	d.f.	S.S.	M.S.S.	F Cal.	F tab. 5%
Replication	3	1.081	0.360	2.155	
Treatment	16	564.241	35.265	211.168*	1.868
Error	48	8.044	0.167		
Total	67	573.366			

*Significant at 5%

Appendix- XVIII

Analysis of variance table for pulp/peel ratio

Source of variation	d.f.	S.S.	M.S.S.	F Cal.	F tab. 5%
Replication	3	0.252	0.084	3.00	
Treatment	16	82.998	5.187	185.25*	1.868
Error	48	1.364	0.028		
Total	67	84.614			

*Significant at 5%

Appendix- XIX

Analysis of variance table for peel/stone ratio

Source of variation	d.f.	S.S.	M.S.S.	F Cal.	F tab. 5%
Replication	3	0.004	0.00133	0.4645	
Treatment	16	1.676	0.10475	36.498*	1.868
Error	48	0.138	0.00287		
Total	67	1.818			

*Significant at 5%

Appendix- XX

Analysis of variance table for pulp/stone ratio

Source of variation	d.f.	S.S.	M.S.S.	F Cal.	F tab. 5%
Replication	3	0.494	0.164	1.708	
Treatment	16	126.338	7.896	82.25*	1.868
Error	48	4.624	0.096		
Total	67	131.456			

*Significant at 5%

Appendix- XXI

Analysis of variance table for reducing sugar percentage

Source of variation	d.f.	S.S.	M.S.S.	F Cal.	F tab. 5%
Replication	3	0.0629	0.02096	0.1513	
Treatment	16	21.4198	1.3387	9.665*	1.868
Error	48	6.6488	0.1385		
Total	67	28.1315			

*Significant at 5%

Appendix- XXII

Analysis of variance table for non-reducing sugar percentage

Source of variation	d.f.	S.S.	M.S.S.	F Cal.	F tab. 5%
Replication	3	0.81	0.27	0.529	
Treatment	16	363.74	22.73	44.56*	1.868
Error	48	24.6	0.51		
Total	67	389.28			

*Significant at 5%

Appendix- XXIII

Analysis of variance table for peel/stone ratio

Source of variation	d.f.	S.S.	M.S.S.	F Cal.	F tab. 5%
Replication	3	0.70838	0.236	0.611	
Treatment	16	413.90123	25.869	67.018**	1.868
Error	48	18.5265	0.386		
Total	67	433.13611			

*Significant at 5%

Appendix- XXIV

Analysis of variance table for percentage of titrable acidity

Source of variation	d.f.	S.S.	M.S.S.	F Cal.	F tab. 5%
Replication	3	0.0022	0.0007	0.5833	
Treatment	16	0.03818	0.0238	19.833*	1.868
Error	48	0.0584	0.0012		
Total	67	0.4424			

*Significant at 5%

Appendix- XXV

Analysis of variance table for T.S.S.

Source of variation	d.f.	S.S.	M.S.S.	F Cal.	F tab. 5%
Replication	3	12.677	4.225	3.523	
Treatment	16	468.192	29.262	24.405*	1.868
Error	48	57.573	1.199		
Total	67	538.442			

*Significant at 5%

Appendix- XXVI

Analysis of variance table total sugar

Source of variation	d.f.	S.S.	M.S.S.	F Cal.	F tab. 5%
Replication	3	0.70838	0.237	0.613	
Treatment	16	413.90123	25.869	67.018*	1.868
Error	48	18.5265	0.386		
Total	67	433.13573			

*Significant at 5%

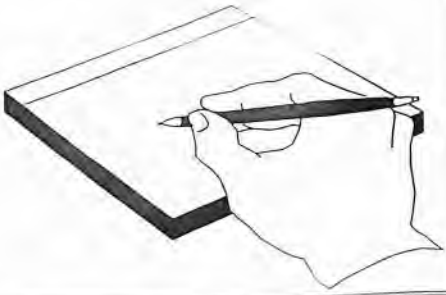
Appendix- XXVII

Analysis of variance table for malformation percentage

Source of variation	d.f.	S.S.	M.S.S.	F Cal.	F tab. 5%
Replication	3	87.522795	29.174		
Treatment	19	20452.34808	1076.439	12.763*	1.868
Error	57	4807.139825	84.335		
Total	79	25347.0107			

*Significant at 5%

VITA



VITA

The author of the thesis, .Ram Abhilash Saket S/o Shri Dashrath Prasad was born on 10th July 1973 at village & Post: Majhiyar District Rewa (M.P.). He passed his Higher Secondary School Certificate Examination (10 +2) from Govt. Higher Secondary School No. 1, Rewa (M.P.).

In the year 1995, he joined Jawaharlal Nehru Krishi Vishwa Vidyalaya, College of Agriculture, Rewa (M.P.) and successfully completed B.Sc.(Ag.) Degree in the year 1999-2000 with O.G.P.A. 6.28 out of 10 Point scale. Subsequent to his graduation, he joined the Department of Horticulture at College of Agriculture, Rewa. He completed all the course requirements for Master's degree in the year 2002-03 with 7.08 OGPA in First division marks. For partial fulfillment of Master's degree, he was allotted an interesting and need based research problem on **"Evaluation of twenty commercial varieties of mango (*Mangifera indica* L.)"** which was successfully completed by him and presented in the form of this thesis.

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$$r = \frac{\sum xy - \frac{\sum x . \sum y}{N}}{\sqrt{[\sum x^2 - (\sum x)^2/n\} - \{\sum y^2 - (\sum y)^2/n\}}}$$

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

where,

r = coefficient of correlation

n =Number of treatments (varieties)

x, y = characters under study

Presentation of data

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

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The specific gravity of fruits was negatively associated with the fruit length, fruit width, peel percentage and pulp percentage while positively correlated with the stone percentage. This shows that the fruits with higher specific gravity were having poor physical properties with higher percentage of stone and lower percentage of pulp. Significant positive association was observed with the fruit length, fruit width and stone percentage. It reveals that if the length of the fruit is more, the width is also increased due to which the total size of the fruits becomes larger and the larger fruit contain more pulp than smaller fruits.

Negative association was observed between the fruit length and peel percentage and stone percentage. Negative relationship was also observed between the fruit pulp and stone, perhaps it might be due to completion stress.

It is evident from the data given in Table-14 that the reducing sugar was associated positively at non significant level with other chemical properties of the fruits. Significant positive correlation was observed between the non-reducing sugar, total sugar and T.S.S. It indicated that if non-reducing sugar content is higher the total sugar and T.S.S. content of the fruit will also be higher. Percentage acidity has got no relationship with other chemical qualities.

Similar association between above traits have also been reported by Singh et al. (1985), Prasad et al. (1987) and Kokadwar et al. (1992).