

**Studies on flowering behaviour of important varieties of mango (*Mangifera indica* L.) in Odisha**

**A**

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(FRUIT SCIENCE AND HORTICULTURE TECHNOLOGY)**

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## **CERTIFICATE- I**

This is to certify that the thesis entitled “**Studies on flowering behaviour of important varieties of mango (*Mangifera indica* L.) in Odisha**” submitted in partial fulfilment of the requirements for the award of the degree of **MASTER OF SCIENCE IN AGRICULTURE (FRUIT SCIENCE)** to the Orissa University of Agriculture and Technology is a faithful record of bonafide and original research work carried out by **Sri Krushna Chandra Mohanty, Adm. No. 05 FSC/16** under my guidance and supervision. No part of this thesis has been submitted for any other degree or diploma.

It is further certified that the assistance and help received by him from various sources during the course of investigation has been duly acknowledged.

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## CERTIFICATE- II

This is to certify that the thesis entitled “**Studies on flowering behaviour of important varieties of mango (*Mangifera indica* L.) in Odisha**” submitted by **KRUSHNA CHANDRA MOHANTY, Adm. No. 05 FSC/16** to The Orissa University of Agriculture and Technology, Bhubaneswar in partial fulfilment of the requirements for the degree of **MASTER OF SCIENCE IN AGRICULTURE** in the discipline of **Fruit Science** has been approved by the Student’s Advisory Committee and the External Examiner.

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# ABSTRACT

The present investigation entitled “**Studies on flowering behaviour of important varieties of Mango (*Mangifera indica* L.) in Odisha**” was carried out at Central Horticultural Experiment Station, ICAR-Indian Institute of Horticultural Research at Bhubaneswar during 2017-18. The objective of the experiment is to study the flowering behaviour of some popular mango cultivar under the East and South Eastern Coastal Plains Agroclimatic conditions of Odisha. There were 12 treatment combinations with 3 varieties in 4 directions of the plant. The treatments are laid out in factorial CRD with 3 replications and each replication consisted of 2 plants. The results revealed that the first appearance of flower was observed in variety Arka Neelachal Kesari on 23<sup>rd</sup> November followed by Amrapali (5<sup>th</sup> January). Further the appearance of flowering was first noticed in East direction in all the 3 cultivars under study where as the west direction experienced late flowering. The days taken to 50% flowering was minimum in Arka Neelachal Kesari *i.e* 13.67 days as compared to Dusheheri (18 days). Maximum days (17.33 days) were taken for in north direction for 50% flowering and least (13.11 days) in east. So far as the flowering intensity is concerned, significantly higher (59.44%) was observed in East direction whereas the lowest (42.22%) was in west direction. The variety Amrapali has the highest flowering intensity (60.88%) as compared to Dusheheri (41.67%). The duration of flowering was observed to be maximum in west side (41.33%) and minimum in north side(40%). The cultivar Amrapali exhibited maximum flowering duration (43 days) followed by Arka Neelachal Kesari (33days). Highest sex ratio was observed in north direction (0.19) than East direction (0.14). In variety Dusheheri the sex ratio is 0.2 as compared to Amrapali (0.14). Highest percentage of fruit set at marble stage was found in cultivar Dusheheri (7.52%) followed by Amrapali (7.20%). Further it was highest in east direction (7.58%) and lowest in north direction (6.04%) but the final fruit set percentage at mature stage was found in cultivar Dusheheri (3.72%) and lowest in Arka Neelachal Kesari (1.87%). The fruit set was highest in east direction (2.92%) and the lowest in north direction (2.14%). The variety Amrapali recorded maximum fruit weight (193.31 g), fruit length (9.69 cm) , fruit diameter(6.26cm), higher TSS (9.16<sup>0</sup> Brix), lowest acidity(0.39%) as compared to other two varieties. The fruits of the East position branches had the maximum fruit weight (183.66 g), maximum fruit length (9.01 cm), maximum fruit diameter (6.13cm) and maximum TSS(9.16<sup>0</sup> Brix ) as compared to other directions. Days taken to 50% flowering was significantly and positively correlated with percentage of perfect flower (0.727) and sex ratio(0.714) where as it is highly negative and significantly correlated with flowering intensity (-0.747). Flowering intensity is highly positive and significantly correlated with total number of male flowers per panicle (0.876) where as it is highly negative and significantly correlated with days taken to 50% flowering. Fruit retention percentage at mature stage is highly positive and significantly correlated with fruit retention percentage at mature stage calculated from the total number of hermaphrodite flowers (0.945). Hence it can be concluded that the cultivar Amrapali has the maximum flowering duration and intensity as well as fruit weight and TSS making it an ideal variety for adoption by the Odisha farmers. The mango plants are to be pruned in such a way that there will be maximum orientation of canopy architecture towards East side to get better yield and quality of fruit.

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# ABBREVIATIONS

A.O.A.C.	:	Association of Official Analytical Chemists
° C	:	Degree Celsius
cm	:	Centimeter
<i>et al.</i>	:	and others
<i>viz.</i>	:	Namely
mg	:	milligram
No.	:	Number
Mm	:	Milli meter
CD	:	critical difference
%	:	Per Cent
ha	:	Hectare
<i>i.e.</i>	:	that is
kg	:	kilogram
TSS	:	Total Soluble Solids
m	:	meter
/	:	Per
<i>cv.</i>	:	Cultivar
g	:	gram
<i>etc.</i>	:	Etcetera
Fig.	:	Figure
@	:	at the rate of
S.E (m)	:	Standard error of mean
S	:	Significant
NS	:	Non significant
L.	:	Linnaeus
<i>i.e</i>	:	that is
mt	:	metric tonn
A.M	:	Ante meridiem
P.M	:	Post meridiem
Hrs	:	Hours
vs	:	Versus
ANOVA	:	Analysis of variance



CHAPTER-I  
**INTRODUCTION**

# INTRODUCTION

---

The king of fruit, “Mango” (*Mangifera indica* L.) is the only adorable member of the anacardiaceae family for its unmatched flavour. Mangoes have delighted people’s senses with their sweet fragrance and flavour for ages. Indians have been cultivating this juicy fruit for more than 4000 years (Mukherjee, 1953a; Kostermans & Bompard, 1993), though scientific fossil evidence indicates that the mango made its first appearance even 25 to 30 million years ago in Northeast India, Myanmar and Bangladesh, from where it travelled down to southern India.

Legend has it that the Buddha was presented with a mango grove so he could rest under the shady trees. The famous Persian poet Amir Khusrau called the mango “Naghza Tarin Mewa Hindustan”, the fairest fruit of Hindustan. However, its development and culture in the subcontinent was primarily contributed by the Mughal Emperors, particularly Akbar who planted Lakh Bagh, amateur gardeners, nurserymen and farmers by selection and subsequent cloning.

At present, mango is grown in an area of 4946 thousand ha with an world production of 46.51 million metric tons. Originated in South-East Asia, it is cultivated in around 111 countries around the world. According to Mukherjee (1953), the natural spread of the genus is limited to the Indo- Malaysian region, stretching from India to the Philippines and New Guinea in the east. There are 41 valid species of *Mangifera*, which are distributed throughout the world. Mango is an important fruit of tropical and subtropical regions between 23<sup>0</sup> North and 24.5<sup>0</sup> South latitudes of the world with the centre of production in India. Mango is the main fruit of Asia and this fruit has developed its own importance all over the world. Being a useful and delicious fruit, it is the part of culture and religion since the time immemorial. Besides taste and good qualities, it is called “The King of Fruits” and known as most important national fruit of India.

India is the largest producer of mango with an production of 19686.9 thousand metric tonnes from an area of 2262.8 thousand hacter followed by China and Thailand (NHB, 2016-17). The major mango growing states are Uttar Pradesh, Andhra Pradesh, Bihar, Karnataka, Tamil Nadu, Kerala, Maharashtra, West Bengal, Gujarat and Odisha. In Odisha, it is grown in an area of 199.30 thousand hacter producing 816.20 thousand metric tonnes with an productivity of 4.10 metric ton/ha. (NHB 2016-17).

Mango is one of the most delicious, nutritious and popular fruit. This fruit recognized as a good source of  $\beta$ -carotene and vitamin-A, vitamin B-complex, vitamin-C, nutritive minerals, digestible sugars and trace elements. Its taste, flavour and aroma are very fascinating to everyone.

Mangoes are grown in widely in tropical and subtropical areas around the world having strong tendency towards alternate or biennial bearing habit. Biennial bearing, unfruitfulness etc. are some of long standing problems for successful mango production and breeding. In order to overcome some of the problems, knowledge on floral biology is of utmost priority. Some fundamental descriptions on the floral biology were made by different workers at different phases of time at different places. Flowering of mango is an important physiological event that sets the start of fruit production. Initiation is the first event that takes place for mangoes to flower. Flowering is decisive factor in the productivity of mango. The process associated with mango involves shoot initiation followed by floral differentiation of apical bud, and panicle emergence (Murti and Upreti, 2000). Variability of mango flowering depends upon cultivar, tree age, environmental condition and growth conditions in the dry or humid tropics (Singh, 1960). Flowering in mango is very complex phenomenon making challenging for physiologists, breeders and growers. Several concepts were proposed by several researchers, but none of them holds good at least for one variety since the flowering in mango is being influenced by several factors. Flowering is one aspect of mango reproductive biology that has attracted interest from researchers worldwide.

Mango trees are polygamous bearing both perfect and hermaphroditic flowers, having both pistil and staminate structures and purely male or staminate flowers. Both types of flowers are born on same inflorescence *i.e.* male and hermaphrodite which is andromonoecious (Mukherjee and Litz, 2009). Generally in Odisha condition mango comes early in flowering with respect to North India. The flowering period starts from November and extended up to February. The flowering period of mango is usually of short duration of 2 to 3 weeks; low temperature may extend it, whereas higher temperature may shorten it. The mango tree does not flower simultaneously in all directions of canopy and, at least, two distinct flushes are noticed. The panicles located on the eastern and south-eastern aspects of the tree come first in flowering. The numbers of flower in one panicle varies between 800-6000, depending upon the cultivars and age of the tree. Proportion of perfect to the staminate flowers (sex ratio) is a variable component within panicles, trees and among cultivars. Normally it ranged from 0.20 to

0.95 per cent. The initial fruit set in mango is directly related to the proportion of perfect flowers and it appears to be a genetical characteristic of a cultivars but the final retention depends on a number of factors including climate, soil moisture, diseases and pest.

Flowering, fruit setting and its development in mango is composite observable fact and it is the first of several events that set the stage for mango production every year. It might be governed by number of factors *viz.*, favourable growth conditions, previous crop load, varietal feature, endogenous hormonal status, C: N ratio, timing and intensity of flowering, *etc* greatly determine when and how much fruits are produced during a given season. Induction of flowering and setting fruit with retention up to maturity is a serious melody. Research on these aspects were carried out by many workers to diagnose for the transition of vegetative growth to reproductive phase. But, the information on single parameter is not enough to interpret the overall assessment even in biennial and regular cultivars like Alphonso and Kesar. Nutrient content play an important role for production of quality fruit as fruit quality is directly related to availability of nutrient in plant body.

No detail study on flowering behaviour was undertaken yet in Odisha. Therefore, it becomes important to gather knowledge of flowering, fruiting, sex ratio, fruit characters and fruit retention on mango for improvement and getting higher yield and systemic work can be initiated and problems of flowering and fruiting can be identified in Odisha. Looking to above fact and experiment entitled “Studies on flowering behaviour of important varieties of Mango (*Mangifera indica* L.) in Odisha” was under taken during the year 2017-2018 at the Central Horticultural Experiment Station (CHES), Aiginia, Bhubaneshwar with the following objectives :-

1. To study the flowering behaviour of important mango varieties.
2. To establish correlations among various flowering traits in different mango varieties.



CHAPTER-2  
**REVIEW OF LITERATURE**

# REVIEW OF LITERATURE

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Review of literature is very essential for any researcher. The main objectives of review of literature is to determine what work (both theoretically and practically) has been done in past, which assist in delineation of problematic area, provides a basis for conceptual frame work, and the methods and procedures used suggest operational definitions of major concepts which helps in interpretation of current findings. Hence, it can be concluded that the review of literature provide guidelines to an investigator, making his work more easy and appropriate. Greater accuracy and higher degree of precision can be achieved through the use of review of literature what has been done and complemented earlier by previous investigator is revealed through the study of review of literature.

Mango is one of the most important fruit crops of India. It becomes important to gather knowledge of flowering, fruiting, sex ratio, fruit characters and fruit retention on mango to overcome production problems associated with the successful production. Considering the importance of mango in Indian horticulture, attempts have been made to improve the productivity of this crop in recent past. The literature pertaining to the different aspects of present study has been reviewed under following heads:

- 2.1 Flowering behaviour of mango genotypes
- 2.2 Fruiting behaviour and fruit characteristics of mango genotypes
- 2.3. Correlation studies

## **2.1. Flowering behaviour of mango genotypes**

Singh (1967) found a lower percentage of hermaphrodite flower in the Eastern side of the tree, which gets more sunlight and the highest on the North side. All these facts lead us to believe that the photoperiodism has a definite effect in the reproductive process of mango.

Bana *et al.* (1976) noted that the complete opening of flowers took about a month and half. Maximum number of flowers opened at 4 A.M. and minimum between 12 noon to 2 P.M.

Yadav and Singh (1985) observed that South Indian varieties shown earlier emergence of panicle as compared to those of North Indian varieties.

Scholefield (1986) observed characters like; inflorescence size, flower number, flower sex and fruit set in cultivars Bangalora, Batavi, Common, Glenn, Irwin and Kensington. Large differences were shown between cultivars in flowers per inflorescence (1431 to 3962), and final fruit set per inflorescence (0.33 to 1.39). The number of hermaphrodite flowers per cent which set fruit varied from 231.2 for Common to 1416.0 for Kensington.

Thimmappaiah and Suman (1987) at Punjab recorded that the number of flowers ranged from 302-994, panicle length from 11.2-42.1 cm (both highest in Surkhaverma) and hermaphrodite flowers from 2.8-31.4% (highest in Langra). Highest initial set and yield was noted for Bangalora and best fruit retention was in Prabhasankar. Varieties with longer panicles produced larger numbers of flowers especially male flowers. Varieties with a moderate number of hermaphrodite flowers and good retention of fruit gave the best yields. Fruit set at the 15th day ultimately determined yield and was significantly correlated with retention and yield ( $r = 0.66$ ).

Baghel *et al.* (1988) reported that 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 and the longest panicle were recorded in Sunderja. However, the highest number of panicles/sq m and the lowest ratio of hermaphrodite to male flowers were observed in Langra. The numbers of fruits/panicle were highest in Malda but the total number of fruits/tree was highest in Langra.

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

Singh and Bhagat (1989) measured date and duration of panicle emergence and anthesis; time and date of anthesis; number of flowers per panicle and sex ratio; time

of dehiscence of anthers; receptivity of stigma; size and viability of pollen grains; and fruit set in four mango cultivars. With respect to many of the fruits, the two early cultivars Gulabkhas and Mithua gave slightly superior values to the two later cultivars Sukul and Sipia.

Narayanaswamy and Thimmaraju (1990) studied the flowering behaviour for two north Indian cultivars (Dashehari and Langra) and one hybrid (Mallika) at Bangalore and reported that Langra had the highest percentage of hermaphrodite flowers (61.4%), followed by Dashehari (32.5%) and Mallika (25.6%). Ratio of male: hermaphrodite flowers were 1.0: 1.6, 1.1: 1.0 and 2.9: 1.0, respectively for Dusheheri, Langra and Mallika. The change in climatic condition did not affect the pattern of hermaphrodite flower production.

Behera *et al.* (1994) recognized the panicle emergence started from first week of December in Suvarnarekha and third week of the same month in Totapuri and continued up to first and second week of March. More number of flowers per panicle was produced in Totapuri than Suvarnarekha. The sex ratio was also found to be higher in Totapuri variety ( $0.055 \pm 0.008$ ) as compared to Suvarnarekha ( $0.047 \pm 0.005$ ).

Desai *et al.* (1994) observed that the inflorescence was a conical panicle, the rachis turning from light green to bright pink when fully expanded. There was an average of 947.9 flowers/panicle, of which 75.73% were perfect. Anthesis occurred throughout the day, but especially between 07.00 and 11.00 hrs.

Rajput (1995) studied flowering behaviour in Raipur and reported that date of bud burst, panicle emergence, 50% flowering and full bloom were earliest in the cultivars Dashehari. Date of panicle emergence and 50% flowering were earlier in Dashehari, Mallika, and Neeleshwari but late in Langra, Amrapali and Sunderja.

Singh *et al.* (1997) at Ranchi recorded flowering and fruiting in the early maturing mango varieties Bombai and Zardalu and the medium maturing varieties Dashehari and Langra, grown in an orchard. The average sex ratio (male: hermaphrodite) of the 4 varieties was calculated as 2.1:1, 2.3:1, 2.48:1 and 1.64:1, respectively for the above varieties. Percentage fruit set and average number of days from flowering to maturity were higher in the medium maturing varieties.

Avilan *et al.* (1998) studied that the panicles of 21 cultivars from the mango collected by Centro Nacional de Investigaciones Agropecuarias (CENIAP), Maracay, Venezuela and classified those varieties 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  $\leq 4\%$ , the potential fruit yield was high. Flowering period averaged ~ 6 weeks, commencement coinciding with the end of the rainy season. For most cultivars, flowering commenced in the first half of December and continued until the latter part of January with maximum flowering intensity in the 3rd and 4th weeks of January.

Dhaliwal *et al.* (1999) recorded higher percentage of hermaphrodite flowers on the northern side and lowest on the eastern side of mango. The percentage of hermaphrodite flowers increased with the advancement of season irrespective of the cultivars and direction of panicle of the trees.

Dod *et al.* (1999a) identified the cultivars Kesar and Dashehari as the most suitable for the hot and dry climatic conditions of Akola. The greatest number of panicles/m<sup>2</sup> and the lowest ratio of hermaphrodite to male flowers were observed in cv. Kesar.

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

Afifi *et al.* (2000) recorded that the ratio of male/perfect flowers was lower in Langra than in Fajri Kalan, especially in the "on" year for the former (0.66 vs. 0.90) and "off" year for the later (1.35 vs. 1.67). The level of pollen germination was high in both cultivars (87.52% in Langra and 92.86% in Fajri Kalan)

Bose *et al.* (2001) recorded the mango inflorescence is a branched terminal panicle (10 to 60 cm long). The number of panicles per tree ranged from 200 to 3000 with average of 200 to 6000 flowers per panicle. A panicle has both male and

hermaphrodite flowers.

Chandra *et al.* (2001) stated that the date of flowering and duration of flowering days varied distinctly in different mango cultivars and hybrids. The length and breadth of the panicle and number of flowering laterals per square metre showed distinct variation in mango cultivars. The flowering laterals per square metre were a major contributor for final plant yield. The total number of panicles showed great variation among the mango cultivars ranging from 1236.0 in Kesar to a maximum of 10 377.0 in Mallika followed by Ratna (8555.0). In a panicle, the total numbers of flowers constitute perfect flowers and male flowers and the numbers of perfect flowers with abundance of pollen contribute towards the setting of fruits. The number of perfect and male flowers is also varietal characteristics. They also observed that the number of flowers was minimum (102) in Kesar and maximum (2256) in Mallika . The number of male flowers was also maximum in Mallika (8122) and minimum in Kesar (1134). The length and breadth of panicle was also observed higher in Mallika.

Ma WeiHong and Xie Jiang Hui (2001) at China recorded that Tainong 1 and Rexuan 4 had the highest frequency of hermaphrodite flowers (around 50%). The number of flowers per inflorescence among the 10 varieties ranged from 1200 to 10 480, while fruit set percentage was only 0.07-1.12%. The best varieties for commercial cultivation were judged to be Mallika (from India), Jinhuangmang and Rexuan 4, all of which are late flowering, with a high frequency of hermaphrodite flowers and high production. Jinhuangmang produced the largest fruits (917 g).

Kumar *et al.* (2001) found that the total number of hermaphrodite and male flowers per panicle were highest (407.67 and 2070.33, respectively) in Kensington. Cowasji Patel had the lowest number of hermaphrodite flowers. Male flowers appeared for a longer period on Philippine and Cowasji Patel, compared to Dashehari. The percentage of hermaphrodite flowers exhibited more variation compared to male flowers.

Mane *et al.* (2001a) evaluated the fruit retention in six mango cultivars (Ratna, Pairi, Parbhani Hapus, Totapuri and Faizli). Among these cultivars, Ratna was the earliest to flower (15th January), while Totapuri had the longest flowering period (37th days) and the highest number of fruit set per panicle was (86.43). Fruit retention was

highest in Parbhani Hapus (59.45, 14.62 and 2.56% at the pea, marble and full grown stages, respectively), while Faizli recorded the longest duration of fruit maturity (131 days).

Sarkar *et al.* (2001) studied that the vegetative, floral and fruit characteristics in ten mango hybrids viz. Amrapali, Mallika, Ratna, Mahmood Bahar, Prabhar Shankar, Neelgoa, Neeleshan, Neeludin, A.U. Rumani and Swarnajahangir with control cultivars Benishan and Totapuri. Panicle length and breadth were found highest in Amrapali. The cultivars Ratna, Mahmood Bahar and Swarnajahangir recorded the highest number of male flowers per panicle, and male:hermaphrodite ratio, respectively Muhammad

Muhammad Asif *et al.* (2002) observed that early panicle initiation in variety Dasehari on eastern side of the plant followed by Langra and Anwar Rataul. Langra had highest number of flowers (598.75) with maximum hermaphrodite flowers (473.08; 79%) on west and southern side of the plant, respectively. The least male flowers (125.75) were also found in Langra. Anwar Rataul depicted minimum number (59.83; 7.25%) of hermaphrodite flowers. Proportion of hermaphrodite flowers in all the three cultivars was quite variable regarding plant side. Such studies in commercial cultivars of mango will certainly be helpful in understanding its floral biology to improve the fruit plant yield.

Kumar and Jaiswal (2003a) reported that the longest duration of panicle emergence (56 days) was observed in Langra. Panicle emergence was earliest in Neelum (8 January); where as in the other cultivars it started from 19<sup>th</sup> January to 31<sup>st</sup> January and continued until 24<sup>th</sup> March. Panicle length varied from 17.92 cm in Vanraj to 29.28 cm in Bangalora. The blooming period was shortest in Langra (26.27 days) and longest in Bangalora (42.17 days). Anthesis started on 10 February and continued until 24 March. The total number of flowers per panicle varied from 718.75 (Kesar) to 1690.47 (Langra). The percentage of perfect flowers was highest in Neelum (21.25%) and lowest in Baneshan (0.94%). The male:female ratio ranged from 3.72 (Neelum) to 111.09 (Baneshan). Due to its long blooming period, Bangalora has potential to be an efficient pollinator.

Kumar and Jaiswal (2003b) reported that the longest duration of panicle emergence (56 days) was observed in Langra. Panicle emergence was earliest in Neelum (8 January); panicle emergence in the other cultivars started from 19 January to 31

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

Chattopadhyay (2005) found that in Northern India, mango flowers in February-March, whereas in the eastern parts of the country flowering takes place during January-February and in November-December and flower bud differentiation reported to start as earlier as October. The length of flowering season varied from 30 days in some of the early varieties and 10 to 12 days in late flowering varieties.

Shinde *et al.* (2005) recorded that the low percentage of hermaphrodite flowers (4.98-8.19%) during the 2<sup>nd</sup> phase of flowering was due to the low temperature (14.46-16.60 degrees C) from 10 December 2000 to 7 January 2001. During this period, the humidity was also low (64.99-69.61%). During the 1<sup>st</sup> (15 October to 9 December 2000) and 3<sup>rd</sup> (15 January to 11 February 2001) phases of flowering, the percentage of hermaphrodite flowers reached 13-17% when the minimum temperature was 18-25 degrees C and the humidity was 68-85%. The minimum temperature and humidity were significantly correlated with the percentage of hermaphrodite flowers. The percentage of hermaphrodite flowers was lowest (5.59%) during the 2<sup>nd</sup> meteorological week. The reduction in the percentage of hermaphrodite flowers from the 5<sup>th</sup> to the 4<sup>th</sup> meteorological week was attributed to low temperature (14°C) and humidity (60-70%).

Pandey and Kumar (2006) recorded that the number of flowers per panicle ranged from 1010.66 in Ratna to 1559.66 in Neeleshan. Sex ratio varied from 2.46 in Amrapali to 4.72 in Sabri. The maximum duration of panicle emergence was observed in Langra (55.11 days), IIHR-51 (45.39 days), Amrapali (44.86 days) and IIHR-10 (44.41 days). The duration of the flowering season ranged from 34.00 days in Langra to 12.00 days in Prabhashankar.

Sharma and Singh (2006) reported that sex ratio was highest (35.9) in flowers that appeared in panicles of un-pruned trees and lowest (26.6) in flowers of severely pruned trees. Flowers that appeared in panicles at tree top had comparatively lower sex ratio (27.7) than those, which appeared at lower canopy heights. Further, highest fruited panicles appeared in moderately pruned trees (80.3) and lowest in un-pruned trees (24.6). Fruited panicles appeared in their maximum at canopy top (87.4), but their number was drastically reduced at lower canopy heights. All the measured parameters were significantly influenced by the interaction, pruning intensity x canopy height. In all, moderate pruning was the best for all practical purposes.

## **2.2 Fruiting behaviour and fruit characteristics of mango genotype**

Teaotia and Upadhyay (1969) evaluated some important coloured varieties of mango at Basti and stated that fruit weight of Suvarnarekha (234 g) was highest followed by Hushnara (176.35 g) and Rumani (176 g) whereas Baramasi Ahra had the lowest fruit weight (97.06 g). The fruit length and diameter were maximum in Janardan Pasand ( $9.78 \times 7.5$  cm).

Jindal and Sharma (1981) found that weight, length and diameter of the fruits and that of stones were related to each other. The fruits of “Sipia Sah Pasand” were the heaviest while maximum T.S.S. content was observed in “Padhwari” closely followed by Dashehari seedlings. The highest T.S.S. / Acid ratio was found in Dashehari.

Kulkarni and Rameshwar (1981) reported that TSS ranged from 13.1% (Totapari) to 27% (Dashehari) among some important mango cultivars at Sangareddy, Andhra Pradesh. Reducing sugars were around 3% in most of the cases, while non-reducing sugar content was ranged from 6.2% (Totapari) to 18% (Mahmuda Vikarabad). Fazli and Dashehari contained the least acidity (0.1%), whereas Badami Model had the most (0.62%). Among table cultivars, Langra scored the maximum

ascorbic acid content (66.6 mg/100 g juice). Maximum carotenoids were found in Alphonso and minimum in K.O. 7. All the mid season juicy cultivars like Peddarasam, Chinnarasam, Suvarnarekha, Bombay, Navaneetam and Kaju showed a variation in total carotenoid content between 1885 to 3248 µg/100g β-carotene.

Among sixteen cultivars of mango screened by Kalra *et al.* (1981) and Kalra (1982) at Lucknow, Dashehari had the highest TSS content followed by Mallika, while the maximum reducing sugars were found in Kolanka Goa and maximum vitamin C content in Langra.

Atul Chandra and Swaminathan (1987) identified seedling mango from Dashehari. The breadth of the fruit was 5.67 cm, which was lesser than in its parent Dashehari with 6.44 cm.

Atul Chandra and Swaminathan (1987) observed higher fruit weight in Dashehari (175.18 g per fruit), while the seedling mango having lesser fruit weight of 170.10 g per fruit as compared to its parent Dashehari.

Shrivastava *et al.* (1987) reported a total soluble solids content of 20.90 per cent in Mallika, 20.20 per cent in Dashehari, 19.30 per cent in Langra, 19.00 per cent in S.B. Chausa, 18.60 per cent in Alphonso, 18.40 per cent in Mankurad, 17.80 per cent in Kesar, 16.80 per cent in Suvarnarekha, 16.20 per cent in Neelum, 16.20 per cent Mulgoa, 15.90 per cent in Baneshan, 15.70 per cent in Fernandin, 15.10 per cent in Vanraj, 14.90 per cent in Fazli and 13.90 per cent in Bangalora.

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

Fruits of seven mango cultivars were analyzed for bio-chemical characters over two seasons (1983 and 1984) in Himachal Pradesh by Jagmohan *et al.*, 1989. The total soluble solids was high in Alphonso (21.7 % in both seasons) and reducing sugar was high in Dashehari (2.7 and 2.9%).

Out of 19 varieties studied, Piarifully had the maximum sugar content of 14.68 per cent and closely followed by Dashehari, which had the sugar of 14.65 per cent.

(Chakraborty *et al.*, 1991). However, the lowest sugar content was found in cultivar Sorikhos

Ali *et al* (1992) revealed that the maximum fruit weight was recorded in Cultivar Fazli (460.0g) followed by Samar Bahisht Chausa (389.0g), least peel percentage (10.6 to 10.8%) in Baganpalli, Wadia Muna Syed and Swarnarekha, smallest stone in Paiyot (7.6%) and Maximum pulp in Baganpalli (79.4%). Highest TSS (27.5%) and Vitamin-C contents (180.2 mg/100g) were found in cultivar Gulabkhas and Sanglakhi, respectively. The cultivar 'Tamuria' was found excellent to all other varieties with minimum acidity (0.2%). Maximum Total sugar (18.00%), Non-reducing (11.70%) and Reducing sugar (5.57%) were found in Yakta cultivar of mango.

Gowda and Ramanjaneya (1994) observed significant differences in fruit weight, length and breadth in different varieties under Bangalore conditions. The fruit weight was maximum in Totapari followed by Baganapalli, while it was between 250 to 300 gm/fruit in Mulgoa, Padiri and Swarnarekha. Moderate fruit weight was observed in Alphonso, Langra and Panakalu. Fruit length was more than 8.5 cm in all the varieties except Alphonso and Panakalu (less than 8 cm). Fruit breadth was less than 5 cm in both Dashehari and Panakalu, while it was more than 8 cm in case of Mulgoa, Baganapalli and Totapari.

Singh and Yadav (1994) reported high fruit weight coupled with large size in Baneshan, Bangalora, Fazli, Sunderja and Mallika out of twenty cultivars. While working on five mango varieties in Punjab, Sharma and Josan (1995) noted that Mallika fruits recorded the maximum fruit weight and size followed by Langra, Amrapali, Dashehari and Alphonso.

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

Sharma and Josan (1995a) reported TSS in the range of 15.2 to 20.7 per cent in Alphonso and Dashehari under Punjab conditions. They also stated the highest percentage of reducing sugars in Dashehari and the lowest in Alphonso.

Sharma and Josan (1995b) observed maximum length of fruit in the variety Mallika (16.8 cm), followed by Amrapali (13.5 cm) and Dashehari (12.5 cm).

Kakar *et al.* (1999) evaluated that the fruit morphological characteristics of mango cultivars Fazli, Gulab Khasa, Suwarnareca, Langra and Bombay Alphonso showed there were significant differences in morphological characteristics among cultivars. Cv. Suwarnareca had the longest fruits (13.58 cm), heaviest fruits (524.83 g), largest edible portion (70.25%), and fruit volume (472 cm) followed by cv. Fazli.

Sharma *et al.* (1999) reported that Dashehari had the highest total soluble solids (20.04%), reducing sugar content (3.87%), TSS to acid ratio (75.42) and sugar: acid ratio (14.33) among four cultivars evaluated under arid-irrigated conditions of Punjab.

According to Kumar *et al.*, (2001a) fruit breadth was 8.72 cm in Vanraj, 8.12 cm in Baneshan, 7.10 cm in Mallika, 6.32 cm in Kesar and 5.12 cm in Dashehari.

Kumar *et al.* (2001b) recorded the average percentage of total soluble solids was 23 in Alphonso, 21.75 in S.B. Chausa, 21.25 in Zardulu, 20.75 in Neelum, 19.25 in Vanraj, 18.75 in Kesar, 16.50 in Baneshan, 16.25 in Fazli, Mankurad and Mallika, cultivars in Madhya Pradesh. Average total soluble solids content in degree brix in different hybrids was 28.00 in Amrapali, 25.00 in Prabha Shankar, 21.88 in Neelgoa, 21.75 in Mallika, 20.00 in Mahmoodbahar, 17.25 in Ratna was recorded by Sarkar *et al.* (2001).

Mane *et al.* (2001b) recorded that Fazli have the highest values for fruit weight (395.33 g) and fruit volume (390.00 cc). Faizli and Pairi recorded the highest pulp percentage (65.03%), while Ratna recorded the highest percentages of skin (29.06%) and stone (25.53%). Whereas Neelam recorded the highest number of fruits per tree (250.00), while Totapuri recorded the highest weight of fruits per tree (6.08 kg).

Sarkar *et al.* (2001) observed the fruit breadth of 8.10, 7.95, 7.60, 6.90, 7.35 and 5.50 cm in Baneshan, A.U.Rumani, Neeleshan, Ratna Totapuri and Amrapali respectively.

Shinde *et al.* (2001) conducted a study during 1996- 99 in two locations in Maharashtra, India (Vengurle and Rameshwar) to determine the heat units required for the fruit maturity of mango cultivars (Alphonso, Kesar and Ratna). The days required for the maturation of Alphonso, Kesar and Ratna fruits at Vengurle were 103.33, 110.33 and 118.00 days, respectively, vs. 80.0, 86.0 and 97.5 days at Rameshwar. Alphonso, Kesar and Ratna fruits matured 23.33, 24.33, 20.50 days earlier at Rameshwar than at Vengurla. The total heat units required for maturation of fruits were more or less equal at both locations and these varied in Alphonso, Kesar and Ratna from 752 to 803, 843 to 898, and 932 to 977 day-degrees, respectively.

Tripathi (2001) observed variations in TSS and acidity among different mango cultivars. He reported high TSS in Bijoragarh, Amrapali, Surkhuru-2, Lucknow Safeda, Dashehari, Mallika, Sepia, DadhaPeda and Surkhuru-1, whereas the minimum acidity was recorded in Chausa Dwarf, Langra, Dashehari, Chausa, Alphonso and high ascorbic acid content in Kazalio, Pulihora and Langra.

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

Sanjay Singh (2002) reported the total soluble solids in percentage *viz.*, 23 in Amrapali, 19.98 in Langra, 19.80 in Zardalu, 19.50 in Rataul, 19.00 in Alphonso, 18.50 in Himsagara, 18.18 in Anupan and 16.11 in Bangalora. Dhillon *et al.* (2004) recorded the total soluble solids content in per cent in different varieties of mango was 18.7 in S.B. Chausa, 18.5 in Dashehari, 17.50 in Alphonso, 16.30 in B.G. Malda, 16.3 in Krishna Bhog, 15.7 in Langra, and 14.0 in Fazli under Punjab conditions.

Sharma (2002) found that the total soluble solids content was highest in the variety Dashehari (21.00 Brix), followed by Chausa (20.00 Brix), Mallika (19.50 Brix) and Langra (17.80 Brix). While the least total soluble solids was recorded in Bombay Green (17.00 Brix) variety. Naresh Kumar (1997) observed that the maximum total soluble solids recorded in Mankurad (20.930 Brix) followed by Alphonso (19.700 Brix) and Langra (18.780 Brix), while the minimum total soluble solids was recorded in Bangalora (15.760 Brix) variety.

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

Kudachikar *et al.* (2003) observed total soluble solids (TSS) to acidity ratio showed an increased trend during fruit development in Alphonso and Raspuri. At maturity, the TSS to acidity ratio reached values between 2.7 and 3.0. Hence, the TSS to acidity ratio could also be considered as the reliable chemical index for harvest maturity. The results indicated that the fruits of both the cultivars took 115 days to reach full maturity and could attain harvest maturity in 110 days after fruit set.

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

Doreyappa Gowda and Huddar (2004) recorded fruit breadth of 8.61 cm in Totapuri, 8.21 cm in Banganpalli, 8.10 cm in Mallika, 7.30 cm in Alphonso, 6.14 cm in Neelum, 5.86 cm in Amrapali and cultivars of mango.

Dalal *et al.*, (2005) reported that the Neelum had highest fruit yield per tree (1605.66 fruits and 27.44 kg) and fruit set was most pronounced in Keshar (4.56%) and Neelum (4.13%).

Pandey and Kumar (2006) reported that the maximum fruit set (29.26%) and fruit retention (3.01%) was recorded in Amrapali.

### **2.3 Correlation studies**

Prasad (1987) carried out correlation studies with growth behaviour, fruit characteristics and components of 40 varieties of mango and noted positive significant correlations between number of fruits and fruit size with TSS, ascorbic acid, fruit weight and fruit volume. Plant spread towards North-South and East-West had positive indirect effect through different aspects of growth behaviour of plants. Direct and indirect positive effects of plant characters with number of fruits there different aspects and yield were also found in the relationship observations.

Thimmappaiah and Suman (1987) at Punjab recorded that the number of flowers ranged from 302-994, panicle length from 11.2-42.1 cm (both highest in Surkhaverma) and hermaphrodite flowers from 2.8-31.4% (highest in Langra). Highest initial set and yield was noted for Bangalora and best fruit retention in Prabhasanker. Varieties with longer panicles produced larger numbers of flowers especially male flowers. Varieties with a moderate number of hermaphrodite flowers and good retention of fruit gave the best yields. Fruit set at the 15th day ultimately determined yield and was significantly correlated with retention and yield ( $r = 0.66$ ).

Yadav *et al.* (2003) estimated correlation at the genotypic level was higher than in the phenotypic level, indicating the strong correlation of characters genetically and the lowering effect of environmental interaction at the phenotypic level. Fruit length, fruit diameter, stone weight, peel weight, pulp weight and pulp percentage showed highly positive and significant genotypic and phenotypic correlation with fruit weight. Fruit weight showed the highest positive and significant genotypic and phenotypic correlation with pulp weight. Selection indices based on fruit size (length and diameter) with high pulp content were the most important factors for identifying high fruit weight

types. Stone weight showed a strong and positive correlation with the peel weight. Fruit length was found to be negatively and significantly correlated with total soluble solids content and total sugar, but was positively correlated with fruit acidity, pulp weight and peel weight.

Sharma and Singh (2006) revealed that sex ratio was highest (35.9) in flowers that appeared in panicles of un-pruned trees and lowest (26.6) in flowers of severely pruned trees. Flowers that appeared in panicles at tree top had comparatively lower sex ratio (27.7) than those, which appeared at lower canopy heights. Further, highest fruited panicles appeared in moderately pruned trees (80.3) and lowest in un-pruned trees (24.6). Fruited panicles appeared in their maximum at canopy top (87.4), but their number was drastically reduced at lower canopy heights. All the measured parameters were significantly influenced by the interaction, pruning intensity x canopy height. In all, moderate pruning was the best for all practical purposes.



CHAPTER-3  
**MATERIALS AND METHODS**

# MATERIALS AND METHODS

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A detailed account of the materials used and methods followed during the course of this investigation are embodied in the ensuing chapter

## 3.1 Experimental site

The study “**Studies on flowering behaviour of important varieties of Mango (*Mangifera indica*L.) in Odisha**” was carried out in the existing gardens managed by Central Horticultural Experiment Station, ICAR-Indian Institute of Horticultural Research, Bhubaneswar during 2017-18. The farm is located at a distance of about 1 km away from the famous “Khandagiri caves” towards south and in the close proximity of the capital city Bhubaneswar and lies at 20°15' N latitude, 85°15' E longitude and 42 m above mean sea level

## 3.2 Soil characteristics

A composite soil sample at a depth of 15 cm was collected with help of soil auger. The soil sample was air dried in shade and ground to pass through 2 mm sieve and subjected to mechanical and chemical analysis to assess the physical and chemical status of the soil (Table no.3.2). According to triangular method of soil classification recognized by International Society of Soil Science, the texture of soil was loam (sand 82.44%, clay 13.67% and silt 3.8%) and having pH 4.7 which depicts the acidic nature of the soil of the experimental field.

## 3.3 Climate and weather conditions

Geographically, the experimental site falls under the eighteenth agro-climatic region of the country i.e. East and South Eastern coastal plain as per the classification done by Centre for Environmental Studies, Forest and Environment Department, Government of Odisha. Bhubaneswar has a hot and humid climate with hot dry summer and comparatively mild winter. It is situated at north latitude of 20° 15' and longitude of 85°52' east. It is positioned at about 60 kms away from Bay of Bengal at an altitude of 25.5 m above mean sea level. The average annual rainfall of Bhubaneswar is 1552 mm (Based on average of preceding 10 years), of which approximately 85% is received during July to September. The rainfall code of the place is D<sub>1</sub>E<sub>3</sub> (B<sub>1</sub>A<sub>2</sub>B<sub>1</sub>) C<sub>1</sub>D<sub>1</sub>E<sub>2</sub>. The average temperature varies from 14<sup>0</sup> C in winter to 40<sup>0</sup> C in summer and relative humidity varies between 49 and 90% from June to December.

**Table 3.1: Meteorological observation for the period of study (2017-18)**

Monthly Average (2017-18)										
Sl. No	Month	Temperature (°C)		Rain fall (mm)	Relative Humidity (%)		Wind Velocity (km/hr)	BSH	Evaporation (mm)	No. of Rainy Days/0.25
		Max	Min	Daily	7hr	14hr	Km/hr	Hrs.		
1	November	29.6	18.7	55.2	89	56	3.0	7.1	3.3	4
2	December	28.2	14.4	36.3	92	48	1.9	7.0	3.4	1
3	January	28.0	12.0	0	92	35	1.8	7.3	3.7	0
4	February	33.7	15.9	0	91	29	2.5	8.4	4.2	0
5	March	36.9	22.6	0	91	34	4.1	8.7	38.8	0
6	April	37.5	24.7	11	86	46	7.0	9.0	49.9	7

**3.4 Edaphic conditions**

A composite soil sample up to a depth of 15 cm was collected with help of soil auger in order to determine the soil pH, organic carbon, electrical conductivity, nitrogen, phosphorus, potassium, boron and zinc prior to sowing.

**Table 3.2. Chemical properties of experimental field:**

Sl. No.	Properties	Value (2017-18)	Method employed
<b>Chemical Composition of the soil</b>			
1.	Soil reaction (pH)	4.7	1:2.5 (soil: water) suspension using glass electrode pH meter (Jackson, 1973)
2.	Organic carbon (g/kg)	2.03	Walkley and Black's titration method (Walkley, 1964)
3.	Available nitrogen (kg ha <sup>-1</sup> )	125	Alkaline potassium permanganate method (Subbiah and Asija, 1956)
4.	Available phosphorus (kg ha <sup>-1</sup> )	13.46	Bray's 1 method (Bray and Kurtz, 1945)
5.	Available potassium (kg ha <sup>-1</sup> )	198.2	Extracting with Neutral normal ammonium acetate solution and estimated by Flame photometer (Jackson, 1973)

### 3.5 Antecedent of the experimental field:

The study was carried out in CHES, under ICAR-Indian Council of Horticultural Research.

#### 3.5.1 Experimental Details

Name of crop	: Mango ( <i>Mangifera Indica</i> L.)
Family	: Anacardiaceae
Varieties	: Arka Neelachal Kesari, Amrapali, Dashehari
Year of study	: 2017-2018
Age of tree	: Amrapali & Arka Neelachal Kesari (11 years) Dashehari (19 years)
Spacing	: 5m x 5m (Amrapali & Arka Neelachal Kesari) 10m x 10m (Dashehari)
Design of the experiment	: Factorial Completely Randomized Design
Total No. of Treatments	: 12 ( 3 variety & 4 direction combination)
Total No. of Replications	: 3
Plants taken in each replication	: 2

#### 3.5.2 Procedure for tagging the shoots

First the shoots of the mango tree were tagged and such 20 shoots were tagged in each direction viz., east, west, north and south. . So, a total of 80 shoots were tagged per plant.

Assign the numbers for each tag .Accordingly, per tree will have the tags numbered from 1 to 80. In this way, for six trees in each variety were tagged and there will be 480 tags which should be numbered from 1 to 480 ( for first tree 1-80, 2<sup>nd</sup> tree 81-160, 3<sup>rd</sup> tree 161-240, 4<sup>th</sup> tree 241-320, 5<sup>th</sup> tree 321-400 and 6<sup>th</sup> tree 400-480. The observations are recorded as per the tags numbered on experimental tree.

First step is to look for the flowered/ No flowering: in this case go on recording the status on all 480 tags. For e.g. Label No.1 the flowering panicles comes out from the tag shoot and record it as Shoot no./ Label no.1 = flowered, Shoot no./ Label no.2 = flowered, Shoot no./ Label no.3 = Not flowered, Shoot no./ Label no.4 = flowered, Shoot no./ Label no.5 = Not flowered.

Like wise take the observation from all 480 label shoots. Count the total number of shoots flowered. Accordingly, count will be available on how many shoots having flowering panicle, how many shoots having vegetative flush and how many shoots remain as it is (no physiological change).

**Table 3.3: Details of selected varieties**

SI No.	Name of varieties	Brief Description
1.	Arka Neelachal Kesari	Developed by CHES, Bhubaneswar as a clonal selection of Gulabkhas. It is an extra early variety suitable to hit the market in March- April. Ripe fruits are colourfully elegant with intense red blush at shoulder region. It is a vigorous and moderate yielder. It has medium intensity of flowering with moderate percentage of perfect flower. Fruits take shortest time to get matured. It is almost free from fruit fly and anthracnose. Tree ripe fruits sometime develop internal tissue breakdown (jelly seed) type symptom.
2.	Amrapali	The hybrid (Dusheheri × Neelum) has been developed at IARI, New Delhi. It is the most important variety which matures in May-June (late variety). It is precocious, regular, semi- vigorous and prolific bearer hybrid. It has high flowering intensity with moderate percentage of perfect flower. Fruit are medium in size and excellent in taste with high TSS. Pulp is deep orange and red in colour. Tree ripe fruits develop jelly seed like symptoms.
3.	Dusheheri	It is a mid season variety matures in May. It is vigorous, shy bearer and moderate yielder. It has bunch bearing habit. It has moderate flowering intensity with high percentage of perfect flower. Under tropical humid and hot climate , it bears smaller fruit then that of North-India

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

### **3.5.3 Flowering**

Date of first appearance of flower

Flowering intensity

Days taken for 50% flowering

Duration of flowering

Number of male flower

Number of hermaphrodite flower

Total no. of flower

Percent perfect flower

Sex ratio

Inflorescence shape

Panicle length & width

Density of flowers in the inflorescence

Inflorescence colour

### **3.5.4 Fruiting parameters**

No. of fruits at marble stage/ panicle

No. of fruits at mature stage/ panicle

Fruit retention at maturity from fruit-set (%)

#### **3.5.4.1 Physical quality**

Fruit weight (gm)

Fruit length (cm)

Fruit diameter (cm)

### 3.5.4.2. Chemical quality

TSS (°brix)

Acidity (%)

### 3.5.3 Flowering

**3.5.3.1 Date of first appearance of flower:** The date on which the flower initiation was started was recorded.

**3.5.3.2 Flowering intensity:** first total number of flowering panicles are calculated then using the following formula flowering intensity is calculated.

$$\text{Flowering intensity (\%)} = \frac{\text{Number of panicles flowered}}{\text{Total number of shoots tagged}} \times 100$$

**3.5.3.3 Days taken for 50% flowering:** It is the total days taken calculated from the date of appearing of first flower to the date of 50% flowering. .

**3.5.3.4 Duration of flowering:** it is the total days taken calculated from the date of appearing of first flower to the date of 100% flowering.

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

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

**3.5.3.7 Total number of flowers:** It is the all total number of flowers per panicle calculated as sum of both male & hermaphrodite flowers.

**3.5.3.8 Sex ratio:** Among the tagged panicle, select 4-5 panicles per tree. On daily basis the panicle has to be observed. For this purpose, one need to visit on daily basis. When the flower opens on a given day, count them and remove. Next day repeat the same procedure again and it should be repeated on daily basis till all the flowers gets open. The total number of male and hermaphrodite flower were noted per panicle and percent of sex ratio was calculated.

**3.5.3.9 Inflorescence shape:** shape of the inflorescence was observed as it is narrowly pyramidal, pyramidal or broadly pyramidal and noted accordingly.

**3.5.3.10 Inflorescence length & width:** The length and width of the panicle was noted using measuring scale.

**3.5.3.11 Density of flowers in the inflorescence:** The presence of flowers in a panicle was observed as it is dense, sparse or medium and recorded accordingly.

**3.5.3.12 Inflorescence colour:** The colour of the main and secondary axes of a panicle was observed and recorded accordingly.

### **3.5.4 Fruiting**

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

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

**Fruit retention percent at maturity from fruit set at marble stage:** It is calculated basing upon the data available i.e number of fruits present at marble stage to mature stage per panicle.

$$\text{Fruit retention percent} = \frac{\text{Number of fruits at mature stage}}{\text{Number of fruits at marble stage}} \times 100$$

#### **3.5.4.1. Physical quality**

**3.5.4.1.1 Fruit weight (g):** Five randomly selected mature fruits in each direction of one variety were weighted and weight was recorded in grams.

**3.5.4.1.2 Fruit length (cm):** The length of five fruits randomly selected fruits were measured by vernier calliper and the average length of fruit was noted.

**3.5.4.1.3 Fruit diameter (cm):** The diameter of the five randomly selected fruits were measured by vernier calliper and the average breadth of the fruit was noted.

#### **3.5.4.2 Chemical quality**

**3.5.4.2.1 TSS (Brix):** The homogenized fruit sample was crushed and juice was extracted through muslin cloth and few drops of juice were placed on the surface of change. The hinged part was placed black. The hand refractometer was then placed

against the sun and the reading were recorded by revolving the eye pieces at room temperature (A.O.A.C., 1970).

**3.5.4.2.2 Acidity:** Acidity was estimated by simple acid alkaline titration method as described in A.O.A.C (1970). First 10 ml. of fruit solution was transferred into a 100 ml volumetric flask and the volume was made up to mark with distilled water. It was shaken well to 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.

$$\text{Total acidity} = \frac{\text{Value of normality of alkali} \times \text{Volume made up} \times 64}{\text{Weight of sample taken}} \times 100$$

Where 64 = Equivalent weight of an acid

Volume made up = Volume of titrated up

### 3.6 Statistical analysis of the data

The data recorded on various characteristics of flowering and fruiting behaviour of mango were subjected to Fisher's method of analysis of variance and interpretation of data was taken up as per Sukhatme and Amble (1995) in factorial completely randomized design. The level of significance used in 'F' test was P = 0.05. Least significant difference or C.D. values were calculated wherever the 'F' test was significant.

The test of significance was worked out as follows:

$$S.E.(m) \pm = \sqrt{EMS/r}$$

Where,

S.E.(m) = Standard error of mean

EMS = Error Mean Square

r = Number of replication

C.D at 5% =  $\sqrt{2} \times S.E(m) \times t_{0.05}$  value at error degrees of freedom



CHAPTER-4  
**EXPERIMENTAL RESULTS**

# EXPERIMENTAL RESULTS

The present investigation entitled “**Studies on flowering behaviour of important varieties of Mango (*Mangifera indica* L.) in Odisha**” was undertaken during the year 2017-2018 at the Central Horticultural Research Station (CHES), ICAR-Indian Institute of Horticultural Research, Aiginia, Bhubaneswar. The periodical observations are summarized in the form of tables (Table 4.1 to table 4.19) illustrated through figures (Fig 4.1 to 4.4) wherever felt necessary. The data were statistically computed and the ANOVA tables for all the characters studies have been appended for reference in Appendices.

## 4.1 Flowering characters

### 4.1.1. Date of first appearance of flower

The dates of first appearance flowers were recorded in each treatment and the range of such dates is presented in Table 4.1. It is observed that the first appearance of flower was observed in variety Arka Neelachal Kesari (23<sup>rd</sup> November) followed by Amrapali (5<sup>th</sup> January) whereas the late emergence of flower was observed in variety Dusheheri (5<sup>th</sup> February).

If we go through analyse direction wise ( E,W,N,S) the table clearly indicates that in all of the three varieties first appearance of flower was observed in east direction whereas late appearance of flower was observed in west direction in most of the cases.

**Table No. 4.1. Date of first appearance of flower**

Variety	East	West	North	South
Arka Neelachal Kesari	23-11-2017	23-11-2017	28-11-2017	02-12-2017
Amrapali	05-01-2018	08-01-2018	06-01-2018	09-01-2018
Dusheheri	02-02-2018	05-02-2018	03-02-2018	02-02-2018

### 4.1.2 Days taken to 50% flowering

Days taken to 50% flowering were recorded in all three varieties and in each directions represented in table 4.2. It is found that the days taken to 50% flowering is minimum in Arka Neelachal Kesari (13.67days) where as it is maximum in Dusheheri (18days). In cases of directions, the days taken to 50% flowering is maximum in north

direction (17.33days) and minimum in east direction (13.11days). Days taken to 50% flowering shows significant different among all the varieties and directions. In case of interaction between variety and direction it also shows significantly different results.

**Table No. 4.2 Days taken to 50% flowering**

Variety	East	West	North	South	Mean
Arka Neelachal Kesari	11.33	17.00	14.33	12.00	13.67
Amrapali	13.00	16.33	17.00	14.67	15.25
Dasheheri	15.00	17.67	20.67	18.67	18.00
<b>Mean</b>	13.11	17.00	17.33	15.11	

	Variety(V)	Direction (D)	V×D
<b>S.E. (m) ±</b>	0.326	0.377	0.653
<b>CD at 5%</b>	0.952	1.100	1.905

#### 4.1.3 Flowering intensity

Table no. 4.3. clearly indicates that Amrapali variety shows significantly higher percentage of flowering intensity(60.83%) followed by Arka Neelachal Kesari (52.08%) whereas variety Dusheheri experiences the lowest (41.67%) among all the three varieties. On the other hand significantly maximum percentage of flowering intensity is observed in east direction (59.44%) followed by south (55%) where as it is minimum (42.22%) in west direction. It is found that the flowering intensity is at par in west and north direction.

#### 4.1.4 Duration of flowering

The data regarding duration of flowering is presented in table no.4.4. The duration of flowering ranged from 29 days to 46 days among the varieties. The mean duration of flowering is observed to be significantly maximum for Amrapali variety (43days) followed by variety Dusheheri (38.25 days) where as it is minimum for variety Arka Neelachal Kesari (33days). In case of different directions, west side (41.33 days) experiences the significantly longest mean duration of flowering followed by north(40 days), south (36.67 days) and east (34.33 days) respectively.

**Table No. 4.3 Mean table of flowering intensity of three major cultivars**

Variety	East	West	North	South	Mean
Arka Neelachal Kesari	63.33	41.67	45.00	58.33	52.08
Amrapali	75.00	53.33	50.00	65.00	60.83
Dusheheri	40.00	31.67	35.00	41.67	37.08
<b>Mean</b>	59.44	42.22	43.33	55.00	
	<b>Variety(V)</b>	<b>Direction (D)</b>	<b>V×D</b>		
<b>S.E. (m) ±</b>	2.394	2.764	4.787		
<b>CD at 5%</b>	6.985	8.066	NS		

**Table No. 4.4 Average duration of flowering in three different cultivars**

Variety	East	West	North	South	Mean
Arka Neelachal Kesari	29.00	38.00	35.00	30.00	33.00
Amrapali	39.00	46.00	45.00	42.00	43.00
Dusheheri	35.00	40.00	40.00	38.00	38.25
<b>Mean</b>	34.33	41.33	40.00	36.67	
	<b>Variety(V)</b>	<b>Direction (D)</b>	<b>V×D</b>		
<b>S.E. (m)±</b>	0.821	0.948	1.641		
<b>CD at 5%</b>	2.395	2.766	NS		

**4.1.5 Total number of male flowers per panicle**

The data regarding number of staminate flowers per panicle presented in Table no.4.5. Total Number of staminate flowers ranged from 435.17 to 911.83. The significantly maximum number of staminate flowers was counted in Amrapali (836.17) followed by Arka Neelachal Kesari(736.17). The minimum number of staminate flowers was recorded in Dusheheri (483.75). The highest male flower was found in east direction (763.11) and lowest in north direction (617.11).

**Table No.4.5 Mean total number of male flowers per panicle in three major cultivars**

Variety	East	West	North	South	Mean
Arka Neelachal Kesari	861.83	729.17	578.50	775.17	736.17
Amrapali	859.50	737.17	836.17	911.83	836.17
Dusheheri	568.00	435.17	436.67	495.17	483.75
<b>Mean</b>	763.11	633.83	617.11	727.39	

	Variety(V)	Direction (D)	V×D
<b>S.E. (m) ±</b>	36.686	42.362	73.372
<b>CD at 5%</b>	107.063	NS	NS

#### 4.1.6 Number of hermaphrodite flower

The data regarding number of hermaphrodite flowers was presented in Table no. 4.6. Number of hermaphrodite flowers was ranged from 82.67 to 125.83. The significantly maximum number of hermaphrodite flowers was recorded in Amrapali (117.04) followed by Arka Neelachal Kesari (101.46) and minimum number of hermaphrodite flowers is observed in Dusheheri variety (93.42). In aspects of direction the highest number of hermaphrodite flower found in south direction (104.50) followed by east direction (104.33) which are at par each other whereas lowest number of hermaphrodite flower is observed in west direction (96.83).

**Table No.4.6. Mean total number of hermaphrodite flowers in three different cultivars**

Variety	East	West	North	South	Mean
Arka Neelachal Kesari	98.83	93.83	102.33	110.83	101.46
Amrapali	125.00	114.00	125.83	103.33	117.04
Dusheheri	89.17	82.67	102.50	99.33	93.42
<b>Mean</b>	104.33	96.83	110.22	104.50	

	Variety(V)	Direction (D)	V×D
<b>S.E. (m) ±</b>	5.255	6.068	10.510
<b>CD at 5%</b>	15.335	NS	NS

#### 4.1.7 Sex ratio (hermaphrodite/male)

The data regarding sex ratio is presented in Table no.4.7. The ratio of hermaphrodite and staminate flowers ranged from 0.11 to 0.24 among all the three varieties, whereas the ratio ranges for the east direction from 0.11 to 0.16, west direction from 0.13 to 0.20, south direction from 0.15 to 0.24 and north direction 0.11 to 0.21. The mean sex ratio was observed to be significantly highest for the north direction (0.19) and lowest for the east direction (0.14).

The mean sex ratio is found to be significantly higher for Dusheheri variety (0.20) followed by Arka Neelachal Kesari (0.14) and Amrapali (0.14) which are at par each other.

**Table No.4.7. Average sex ratio in three major cultivars**

Variety	East	West	North	South	Mean
Arka Neelachal Kesari	0.11	0.13	0.19	0.15	0.14
Amrapali	0.15	0.16	0.15	0.11	0.14
Dusheheri	0.16	0.20	0.24	0.21	0.20
<b>Mean</b>	0.14	0.16	0.19	0.16	

	Variety(V)	Direction (D)	V×D
<b>S.E. (m) ±</b>	0.010	0.011	0.020
<b>CD at 5%</b>	0.029	0.033	NS

#### 4.1.8 Panicle length

The data regarding the panicle length is presented in table number 4.8. The panicle length ranges from 20.10cm to 37.50cm in accordance with all the directions and varieties. The mean significantly highest length is observed in case of Amrapali variety (35.56 cm) followed by Dusheheri (23.87 cm) where as it is shortest in Arka Neelachal Kesari variety (21.95 cm) among all the three varieties.

In view of directions, highest panicle length is observed in south direction (28.93cm) followed by east (28.30cm) and north (25.70cm) direction whereas shortest length is observed in west direction (25.57cm).

**Table No.4.8. Mean panicle / Inflorescence length in three major cultivars**

Variety	East	West	North	South	Mean
Arka Neelachal Kesari	22.96	21.37	20.10	23.37	21.95
Amrapali	36.86	33.37	34.50	37.50	35.56
Dusheheri	25.09	21.95	22.51	25.93	23.87
<b>Mean</b>	28.30	25.57	25.70	28.93	

	Variety(V)	Direction (D)	V×D
<b>S.E. (m) ±</b>	0.989	1.142	1.979
<b>CD at 5%</b>	2.887	NS	NS

#### 4.1.9 Panicle width

The data regarding the panicle width is presented in table number 4.9. The panicle width ranges from 12.77cm to 24.83cm in accordance with all the directions and varieties. The mean significantly highest width is observed in case of Amrapali variety(22.60cm) followed by Arka Neelachal Kesari (13.68cm) where as it is shortest in Dusheheri variety(13.63cm) among all the three varieties.

In view of directions, highest panicle width is observed in east direction (18.01cm) followed by south (17.24cm) and north (15.92cm) direction whereas shortest length is observed in west direction (15.39cm).

#### 4.1.10 Inflorescence shape

Panicle shape in each varieties are observed and the findings are compared. It is found that the shape of panicle is broadly pyramidal in case of Amrapali variety where as it is pyramidal in case of Dusheheri variety and conical in case of Arka Neelachal Kesari.

#### 4.1.11. Density of flowers in the inflorescence

In case of Amrapali variety the density of flower is dense where as in case of Arka Neelachal Kesari it is medium. But in case of Dusheheri it is found to be medium to sparse density of flowers in the inflorescence.

**Table No.4.9 Mean panicle / Inflorescence width in three major cultivars**

Variety	East	West	North	South	Mean
Arka Neelachal Kesari	15.32	13.49	11.81	14.10	13.68
Amrapali	23.27	19.54	22.76	24.83	22.60
Dusheheri	15.43	13.13	13.20	12.77	13.63
<b>Mean</b>	18.01	15.39	15.92	17.24	

	Variety(V)	Direction(D)	V×D
<b>S.E. (m) ±</b>	0.825	0.952	1.650
<b>CD at 5%</b>	2.407	NS	NS

**4.1.12 Inflorescence colour**

The extra early variety Arka Neelachal Kesari shows light – dark red in colour when the inflorescence colour is a matter of concern. However Amrapali inflorescence imparts a combination of green to light red combination where as inflorescence colour of Dusheheri variety shows yellowish green in colour.

**4.2 fruiting character****4.2.1. Fruit retention percentage at different stages****4.2.1.1 Per cent fruit set at marble stage**

Per cent fruit set at marble stage is calculated on the basis of perfect flower in the panicle and the data represented in the table no.4.10. Per cent fruit set at marble stage ranges from 5.56 % to 8.59 %. From the table it is observed that the mean highest significant percentage of fruitset at marble stage is found in Dusheheri (7.52%) followed by Amrapali (7.20%) where as it is minimum in Arka Neelachal Kesari variety (6.20%).

As far as the direction is concerned the study revealed that highest percentage of fruit set at marble stage is observed in east direction (7.58%) followed by west (7.14%) and south( 7.13%) direction respectively which are at par each other. In contrast the minimum fruit set at marble stage is observed in north direction (6.04%).

**Table No. 4.10. Average per cent fruit set at marble stage in three major cultivars**

Variety	East	West	North	South	Mean
Arka Neelachal Kesari	7.07	6.41	5.56	5.75	6.20
Amrapali	7.23	7.01	5.99	8.59	7.20
Dusheheri	8.44	8.01	6.57	7.06	7.52
<b>Mean</b>	7.58	7.14	6.04	7.13	

	Variety(V)	Direction(D)	V×D
<b>S.E. (m) ±</b>	0.348	0.402	0.696
<b>CD at 5%</b>	1.016	NS	NS

**4.2.1.2 Average per cent fruit retention at mature stage from marble stage**

Per cent fruit set at mature stage is calculated on the basis of number of fruits at marble stage in the panicle and the data represented in the table no.4.11. Per cent fruit set at mature stage ranges from 23.15 % to 54.17 %. From the table it is observed that the mean highest significant percentage of fruitset at mature stage is found in Dusheheri (49.01 %) followed by Arka Neelachal Kesari (27.54%) where as it is minimum in Amrapali variety (26.38%).

As far as the direction is concerned the study revealed that highest percentage of fruit set at mature stage is observed in east direction (37.28%) followed by north (35.36%) and south (32.78%) direction respectively. In contrast the minimum fruit set at marble stage is observed in west direction (31.81%).

**4.2.1.3 Percent fruit retention at mature stage from perfect flowers**

Per cent fruit set at mature stage is calculated on the basis of number of hermaphrodite (perfect flowers) in the panicle and the data represented in the table no.4.12. Per cent fruit set at mature stage ranges from 1.44 % to 4.61 %. From the table it is observed that the mean highest significant percentage of fruitset at mature stage is found in Dusheheri (3.72 %) followed by Amrapali (1.87%) where as it is minimum in Arka Neelachal Kesari variety (1.71%)

As far as the direction is concerned the study revealed that highest percentage of fruit set at mature stage is observed in east direction (2.92%) followed by west (2.38%) and south (2.30%) direction respectively. In contrast the minimum fruit set at marble stage is observed in north direction (2.14%).

**Table No. 4.11. Average percent fruit retention at mature stage from marble satge in three major cultivars**

Variety	East	West	North	South	Mean
Arka Neelachal Kesari	27.78	27.30	28.89	26.19	27.54
Amrapali	29.91	20.50	31.94	23.15	26.38
Dusheheri	54.17	47.62	45.24	49.01	49.01
<b>Mean</b>	37.28	31.81	35.36	32.78	

	Variety(V)	Direction (D)	V×D
<b>S.E. (m) ±</b>	2.902	3.351	5.804
<b>CD at 5%</b>	8.469	NS	NS

**Table No. 4.12. Average per cent fruit retention from total number of perfect flowers**

Variety	East	West	North	South	Mean
Arka Neelachal Kesari	1.96	1.74	1.60	1.53	1.71
Amrapali	2.18	1.44	1.87	1.97	1.87
Dusheheri	4.61	3.96	2.94	3.38	3.72
<b>Mean</b>	2.92	2.38	2.14	2.30	

	Variety(V)	Direction (D)	V×D
<b>S.E. (m) ±</b>	0.262	0.302	0.523
<b>CD at 5%</b>	0.764	NS	NS

## 4.2.2 Physical quality

### 4.2.2.1 Fruit weight

The data regarding average fruit weight are presented in Table no 4.13. The fruit weight ranged from 140.87 g to 202.00 g. Amrapali recorded significantly maximum fruit weight (193.31 g) followed by Arka Neelachal Kesari (183.88 g). The minimum fruit weight (151.85 g) was found in Dusheheri.

In case of directions, it doesn't shows any significant different among all

observation findings states that maximum fruit weight is observed in east direction (183.66 g) followed by South (179.44 g) and north (172.59 g) direction whereas the lowest fruit weight is observed in west (169.68g) direction.

The increased fruit weight might be due to rapid multiplication and enlargement of cells and greater accumulation of Sugar and water in expanded cells which is greatly influenced by genetic makeup of particular cultivar. These results are in agreement with the findings of Uthaiah *et al.* (1990), Dalal *et al.* (2005) and Dutta and Dhua (2004).

**Table No. 4.13. Mean table of fruit weight in three major cultivars**

Variety	East	West	North	South	Mean
Arka Neelachal	185.00	184.67	180.00	185.83	183.88
Keasri					
Amrapali	194.57	183.50	192.67	202.50	193.31
Dusheheri	171.42	140.87	145.09	150.00	151.85
<b>Mean</b>	183.66	169.68	172.59	179.44	

	Variety(V)	Direction (D)	V×D
<b>S.E. (m) ±</b>	3.863	4.461	7.726
<b>CD at 5%</b>	11.273	NS	NS

#### 4.2.2.2 Fruit length

The average length of fruits was influenced significantly by different varieties. This result is presented in Table 4.14. The fruit length ranged from 7.81 cm to 10.16 cm.

Amrapali recorded maximum fruit length (9.69 cm) which was highest among all the three varieties. The Dusheheri (8.32cm) was closely followed by Arka Neelachal Kesari (8.18 cm). The Arka Neelachal Kesari variety found significantly shortest fruit length (8.03 cm) among all.

In case of direction is concerned longest fruit is observed in east direction (9.01cm) followed by south (8.88cm) and west (8.53 cm) directions whereas the shortest fruit length is observed in north (8.51cm) directions.

### 4.2.2.3 Fruit diameter

The fruit diameter was influenced significantly by different varieties. This result is presented in Table 4.15. The fruit diameter ranged from 5.17cm to 6.53cm.

Amrapali recorded maximum fruit diameter (6.26 cm) which was highest among all the three varieties. The Arka Neelachal Kesari (5.81cm) was closely followed by Dusheheri (5.34 cm). The Dusheheri variety found significantly shortest fruit diameter (5.34 cm) among all.

So far as direction is concerned maximum fruit diameter is observed in east direction (6.13cm) followed by south (5.77cm) and north (5.74 cm) directions whereas the minimum fruit diameter is observed in west (5.57cm) directions.

**Table No. 4.14. Mean table of fruit length in three major cultivars**

Variety	East	West	North	South	Mean
Arka Neelachal Kesari	8.27	7.81	8.02	8.60	8.18
Amrapali	10.16	9.19	9.28	10.15	9.69
Dusheheri	8.60	8.58	8.21	7.90	8.32
<b>Mean</b>	9.01	8.53	8.51	8.88	

	Variety(V)	Direction (D)	V×D
<b>S.E. (m) ±</b>	0.128	0.148	0.256
<b>CD at 5%</b>	0.373	NS	NS

### 4.2.3 Chemical quality

#### 4.2.3.1 Total Soluble Solids

The data regarding TSS of fruits are presented in Table no. 4.16. The TSS of fruits ranged from 17.70 brix to 20.53 brix. Amrapali recorded significantly higher TSS of fruits (19.89 brix) followed by Dusheheri (19.59 brix). The lower TSS of fruit (17.88 brix) was found in Arka Neelachal Kesari variety.

In case of directions, it doesn't shows any significant different among all. Observation findings states that maximum fruit TSS is observed in east direction (19.16 brix) followed by South (19.13 brix) and north (19.13 brix) direction whereas the lowest

TSS is observed in west (19.07 brix) direction.

**Table No.4.15 Mean table of fruit diameter in three major cultivars**

Variety	East	West	North	South	Mean
Arka Neelachal Kesari	6.23	5.58	5.88	5.54	5.81
Amrapali	6.42	5.91	6.17	6.53	6.26
Dusheheri	5.73	5.23	5.17	5.23	5.34
<b>Mean</b>	6.13	5.57	5.74	5.77	

	Variety(V)	Direction (D)	V×D
<b>S.E. (m) ±</b>	0.123	0.142	0.245
<b>CD at 5%</b>	0.358	NS	NS

#### 4.2.3.2 Acidity

The data regarding acidity of fruits are presented in Table no. 4.17. The acidity of fruits ranged from 0.32% to 0.43%. Arka Neelachal Kesari recorded slightly higher acidity of fruits (0.41%) followed by Amrapali (0.39%). The lower acidity of fruit (0.37) was found in Dusheheri variety.

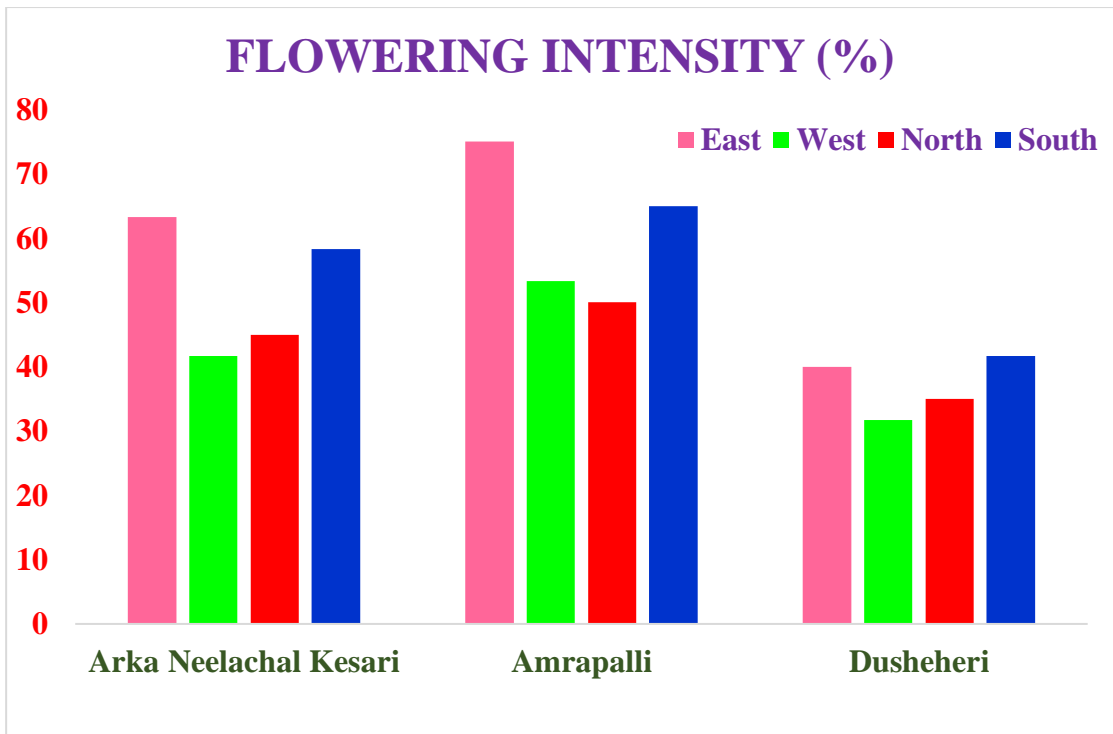
In case of directions, it doesn't shows any significant different among all. From the table it is observed that maximum acidity is observed in west direction (0.43%) followed by east (0.39%) and north (0.39%) direction whereas the lowest acidity is observed in south (0.35%) direction.

**Table No. 4.16 Mean table of total soluble solid of three major varieties**

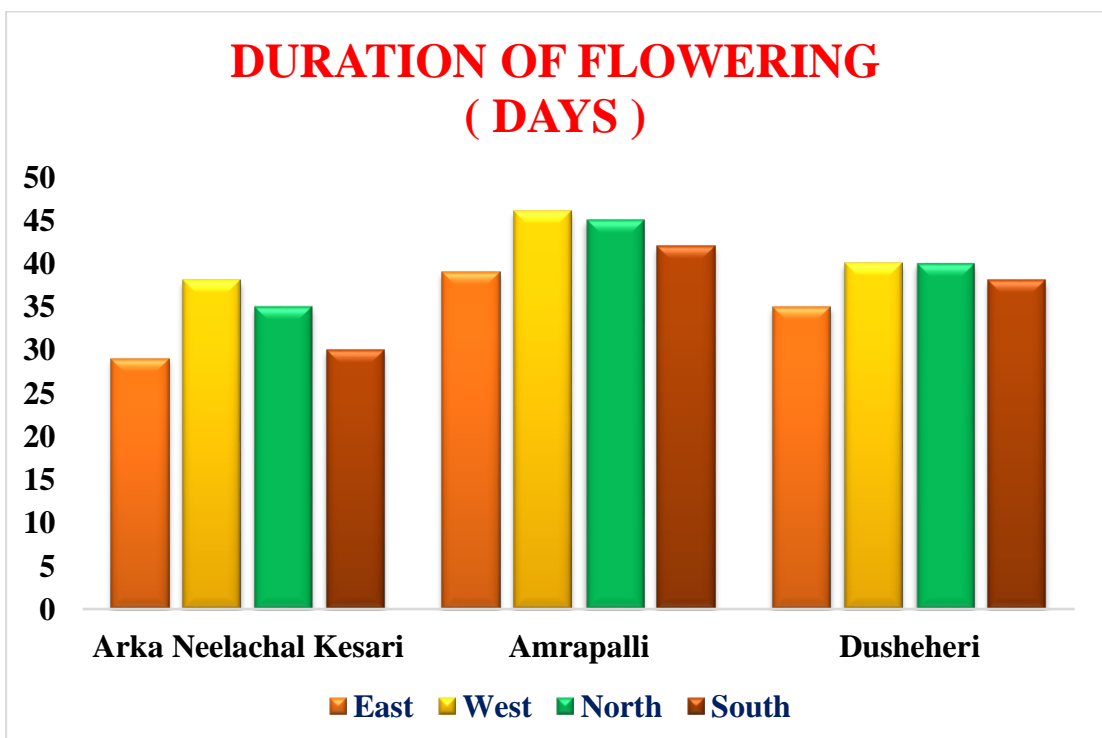
Variety	East	West	North	South	Mean
Arka Neelachal Kesari	17.73	18.10	17.70	18.00	17.88
Amrapali	20.43	19.80	19.17	20.17	19.89
Dusheheri	19.30	19.30	20.53	19.23	19.59
<b>Mean</b>	19.16	19.07	19.13	19.13	
	<b>Variety(V)</b>	<b>Direction (D)</b>	<b>V×D</b>		
<b>S.E. (m) ±</b>	0.254	0.293	0.507		
<b>CD at 5%</b>	0.740	NS	NS		

**Table No.4.17. Mean table of acidity of three different cultivars**

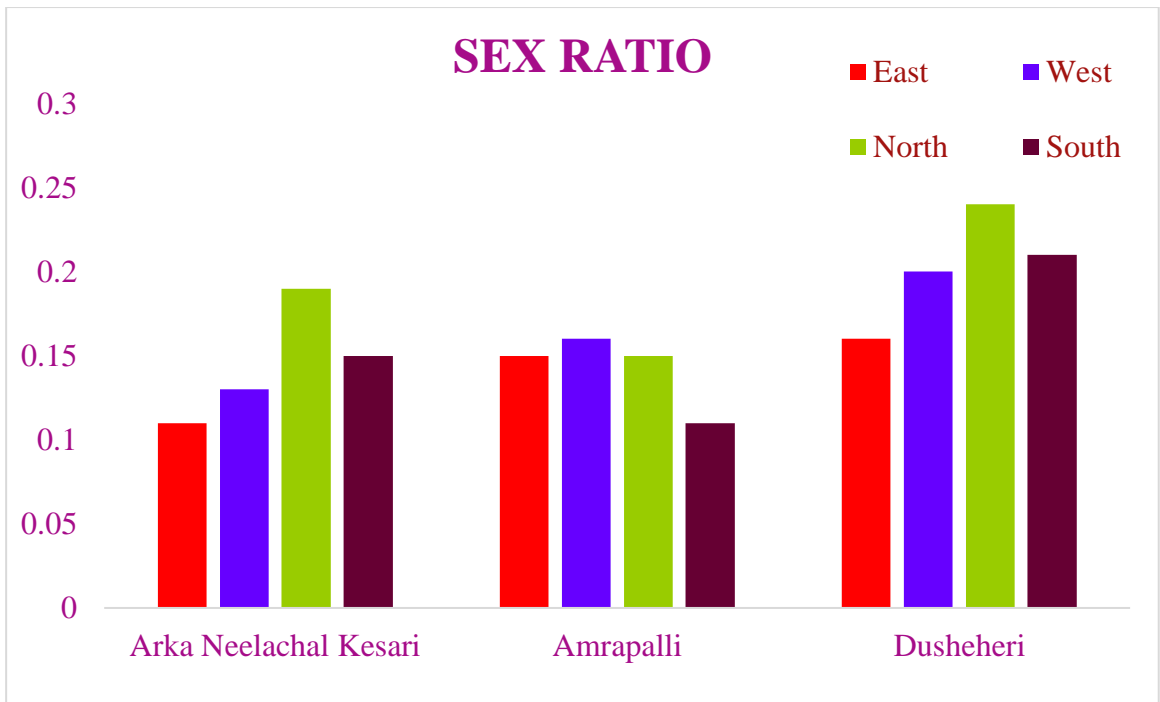
Variety	East	West	North	South	Mean
Arka Neelachal Kesari	0.43	0.43	0.43	0.36	0.41
Amrapali	0.37	0.43	0.37	0.37	0.39
Dusheheri	0.37	0.43	0.37	0.32	0.37
<b>Mean</b>	0.39	0.43	0.39	0.35	
	<b>Variety(V)</b>	<b>Direction (D)</b>	<b>V×D</b>		
<b>S.E. (m) ±</b>	0.028	0.033	0.057		
<b>CD at 5%</b>	NS	NS	NS		



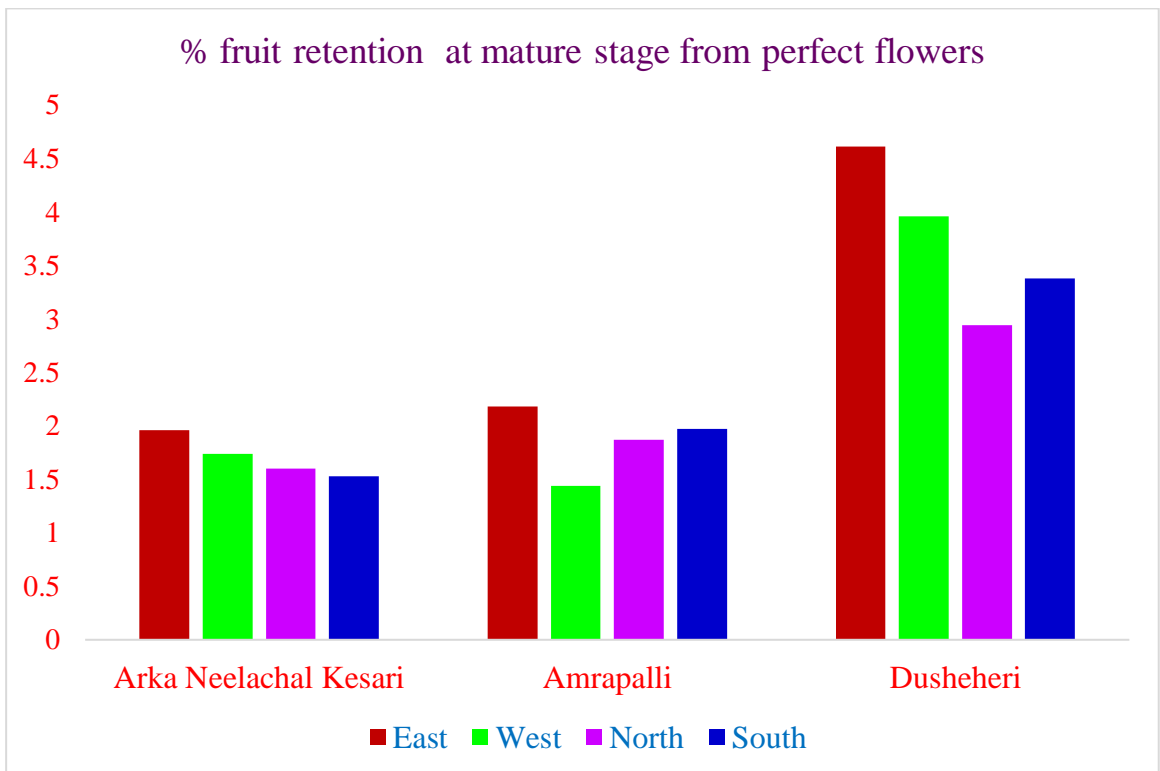
**Fig. 4.1. Percentage of flowering intensity of three cultivars in different direction**



**Fig. 4.2. Duration of flowering of three different cultivars in different directions**



**Fig. 4.3. Sex ratio of three different cultivars in different directions**



**Fig. 4.4. Percentage fruit retention at mature stage from total number of perfect flowers**

### 4.3 Correlation studies

To understand the association between two characters, here correlation coefficients are presented in Table 4.19.

Days taken for 50% flowering is highly positive and significantly correlated with percentage of perfect flower (0.727) and sex ratio (0.714) where as it is only positively and significantly correlated with duration of flowering (0.604). In other hand days taken for 50% flowering is highly negative and significantly correlated with flowering intensity (-0.747) where as it is only negatively significant correlated with total number of male flowers per panicle (-0.675).

Fruit set percentage at marble stage (0.032), fruit retention percentage at mature stage (0.513) and fruit retention percentage at mature stage (0.385) from number of perfect flowers are positively correlated with days taken to 50% flowering.

Duration of flowering is positively and significantly correlated with panicle length (0.610) where as it is only positively correlated with panicle breadth (0.529), percent perfect flower (0.176), sex ratio (0.173) and fruit set percentage at marble stage (0.178). This parameter shows negative correlation with flowering intensity (-0.127), total male flower per panicle (-0.008), fruit retention percentage at mature stage (-0.072) and fruit retention percentage at mature stage (-0.041) from number of perfect flowers.

Flowering intensity is highly positive and significantly correlated with total number of male flowers per panicle (0.876) where as it is highly negative and significantly correlated with days taken to 50% flowering. However it is positively and significantly correlated with panicle length (0.645) and panicle breadth (0.692) and in contrast it is negatively and significantly correlated with percent perfect flower (-0.699), sex ratio (-0.688) and fruit retention percentage at mature stage (-0.562). In adding to this, flowering intensity is positively correlated with fruit set percentage at marble stage (0.037) where as it is negatively correlated with fruit retention percentage at mature stage (-0.562) from number of perfect flowers.

Panicle length is highly positive and significantly correlated with panicle breadth (0.965) where as it is positively and significantly correlated with total male flower per panicle (0.628) along with it is only positively correlated with fruit set percentage at marble stage (0.324). In contrary flowering intensity is negatively correlated with percent perfect flower (-0.397), sex ratio (-0.393), fruit retention percentage at mature stage (-0.372), fruit retention percentage at mature stage calculated from the total number of hermaphrodite flowers (-0.244).

Panicle breadth is highly significant and positively correlated with total number of male flowers per panicle (0.740) where as it is only positively correlated with fruit set percentage at marble stage (0.319). However it is negatively correlated with percent perfect flower (-0.539), sex ratio (-0.541), fruit retention percentage at mature stage (-0.449), fruit retention percentage at mature stage calculated from the total number of hermaphrodite flowers (-0.300).

Total number of male flower per panicle is highly negative and significantly correlated with percent perfect flower (-0.893), sex ratio (-0.893), fruit retention percentage at mature stage (-0.784) where as it is negatively and significantly correlated with fruit retention percentage at mature stage calculated from the total number of hermaphrodite flowers (-0.666). However it is negatively correlated with fruit set percentage at marble stage (-0.026).

Percentage of perfect flower is highly positive and significantly correlated with sex ratio (0.999) where as it is positively and significantly correlated with fruit retention percentage at mature stage (0.650). However it is positively correlated with fruit retention percentage at mature stage calculated from the total number of hermaphrodite flowers(0.458) and negatively correlated with fruit set percentage at marble stage (-0.178).

Sex ratio is positively and significantly correlated with fruit retention percentage at mature stage(0.644) where as it is only positively correlated with fruit retention percentage at mature stage calculated from the total number of hermaphrodite flowers(0.456) and it is negatively correlated with fruit set percentage at marble stage(-0.179).

Fruit set percentage at marble stage is positively and significantly correlated with fruit retention percentage at mature stage calculated from the total number of hermaphrodite flowers (0.611) where as it is only positively correlated with fruit retention percentage at mature stage (0.347).

Fruit retention percentage at mature stage is highly positive and significantly correlated with fruit retention percentage at mature stage calculated from the total number of hermaphrodite flowers (0.945).

**Table no. 4.19. Correlation study among various important flowering traits.**

	<b>DFF</b>	<b>DF</b>	<b>FI</b>	<b>IL</b>	<b>IB</b>	<b>TMF</b>	<b>PPF</b>	<b>SR</b>	<b>FSM</b>	<b>FRM</b>	<b>FRPF</b>
<b>DFF</b>		<b>0.604*</b>	<b>-0.747**</b>	<b>-0.124<sup>NS</sup></b>	<b>-0.236<sup>NS</sup></b>	<b>-0.675*</b>	<b>0.727**</b>	<b>0.714**</b>	<b>0.032<sup>NS</sup></b>	<b>0.513<sup>NS</sup></b>	<b>0.385<sup>NS</sup></b>
<b>DF</b>			<b>-0.127<sup>NS</sup></b>	<b>0.610*</b>	<b>0.529<sup>NS</sup></b>	<b>-0.008<sup>NS</sup></b>	<b>0.176<sup>NS</sup></b>	<b>0.173<sup>NS</sup></b>	<b>0.178<sup>NS</sup></b>	<b>-0.072<sup>NS</sup></b>	<b>-0.041<sup>NS</sup></b>
<b>FI</b>				<b>0.645*</b>	<b>0.692*</b>	<b>0.876**</b>	<b>-0.699*</b>	<b>-0.688*</b>	<b>0.037<sup>NS</sup></b>	<b>-0.674*</b>	<b>-0.562<sup>NS</sup></b>
<b>IL</b>					<b>0.965**</b>	<b>0.628*</b>	<b>-0.397<sup>NS</sup></b>	<b>-0.393<sup>NS</sup></b>	<b>0.324<sup>NS</sup></b>	<b>-0.372<sup>NS</sup></b>	<b>-0.244<sup>NS</sup></b>
<b>IB</b>						<b>0.740**</b>	<b>-0.539<sup>NS</sup></b>	<b>-0.541<sup>NS</sup></b>	<b>0.319<sup>NS</sup></b>	<b>-0.449<sup>NS</sup></b>	<b>-0.300<sup>NS</sup></b>
<b>TMF</b>							<b>-0.893**</b>	<b>-0.893**</b>	<b>-0.026<sup>NS</sup></b>	<b>-0.784**</b>	<b>-0.666*</b>
<b>PPF</b>								<b>0.999**</b>	<b>-0.178<sup>NS</sup></b>	<b>0.650*</b>	<b>0.458<sup>NS</sup></b>
<b>SR</b>									<b>-0.179<sup>NS</sup></b>	<b>0.644*</b>	<b>0.456<sup>NS</sup></b>
<b>FSM</b>										<b>0.347<sup>NS</sup></b>	<b>0.611*</b>
<b>FRM</b>											<b>0.945**</b>
<b>FRPF</b>											

**DFF** -Days taken to 50% flowering

**DF**-Duration of flowering

**FI**-Flowering intensity

**IL**-Panicle length

**IB**-Panicle breadth

**TMF**-Total male flower/panicle

**PPF**-Per cent perfect flower

**SR**-Sex ration (hermaphordite/male)

**FSM**-Fruit set percentage at marble stage

**FR**-Fruit retention percentage calculated on marble stage

**FRPF**-Fruit retention percentage as calculated on total number of hermaphordite flowers



CHAPTER-5  
**DISCUSSION**

# DISCUSSION

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The results described in the preceding chapter for the project entitled “Studies on flowering behaviour of important varieties of Mango (*Mangifera indica* L.) in Odisha” are discussed critically in this chapter with the help of facts and evidences carried out by different researchers on mango and related crops during different periods at different places. The whole findings *in toto* have been discussed in the appropriate headings *viz*, flowering characters, fruiting characters and correlations

## 5.1 Flowering characters

A wide variation have been observed in the flowering behaviour of different mango varieties under different directions. The variety Arka Neelachal Kesari came to flowering very early (23<sup>rd</sup> November) irrespective of all the varieties and directions. In case of Amrapali, flowering starts on 5<sup>th</sup> January and in Dusheheri it is 2<sup>nd</sup> February. It has been observed that the first flowering was noticed in panicles positioned at East direction irrespective of varieties which is a peculiar finding in Northern Hemisphere.

Similarly the days taken to 50% flowering was minimum in case of Arka Neelachal Kesari (13.67 days) followed by Amrapali (15.25 days) and Dusheheri (18 days). The days to 50% flowering was minimum in case of flowers at East direction followed by South, West and North. Similarly the duration of flowering also exhibited similar trend for varieties and directions except in West direction where it took maximum time for total flower opening. Therefore, a possibility for carrying out selection for earliness to flower as well as the duration of flowering. This characteristic is important, as extended flowering may lead to undesirable fruit production (Sharma, 2009). As the variety Arka Neelachal Kesari came to flowering very early and the fruits are harvested during March-April, it is categorised under extra early variety. So there is a scope for more expansion of area under this variety to fetch early market. The initiation of flowering was observed in Eastern direction in most of the cases and it seems to be due to orientation of the plants to sunlight. This might be the cause of earliest panicle initiation in East and South direction in all the cultivars. This results collaborates the findings of Desai *et al.*, (1985) while working on floral biology of mango varieties.

The flowering intensity in different mango varieties showed significant variations. Amrapali has been highest percentage of flowering intensity (60.83%) followed by Arka Neelachal Kesari (52.08%) and Dusheheri (37.08%). The flowering intensity was highest in Eastern direction followed by South, North and West. Similarly the panicle length and breadth exhibit significant variations among the varieties with Amrapali being the maximum. However there is no significant differences for panicle length and breadth as far as different directions are concerned. However the panicle length and breadth are maximum in East directions. The number of male flowers and the number of hermaphrodite flowers per panicle showed significant variations among the varieties. The number of male and hermaphrodite flowers were maximum in Amrapali followed by Arka Neelachal Kesari and Dusheheri. On the other hand, the male and hermaphrodite flower numbers on different sides (East, West, North & South) are not significantly variable. But the number of hermaphrodite flowers in North direction was highest irrespective of varieties. The differences in the flower number in different directions and varieties were studied by various workers (Majumdar & Mukharjee, 1961 and Desai *et al.*, 1985). Desai *et al.*, (1985) observed higher percentage of perfect flowers on the North and the lowest in Eastern side of the plant of different cultivars of mango. It has been claimed by Wunnachit and Sedgely (1992) that the number of hermaphrodite flowers can be used as a selection criterion.

The percentage of perfect flowers was highest in Dusheheri followed by Arka Neelachal Kesari and Amrapali. However the percent of perfect flower was highest in North side among the varieties. This may be due to the fact that presence of comparatively less number of male flowers in the North directions. The sex ratio (hermaphrodite/ male) was highest in Dusheheri (0.20) followed by Arka Neelachal Kesari (0.14) and Amrapali (0.14), which have equal sex ratio. As far as the direction is concerned, significant variations observed for sex ratio being highest in North direction. The variability in the flower sex ratio seems to be governed by a cultivar of physiological and environmental condition (Asif *et al.*, 2002). Various researchers observed a variable proportion of hermaphrodite/perfect flowers to the male/ staminate flowers (sex ratio) within an andromonoecious panicles, trees and among the cultivars but it is usually less than 50% (Chadha & Pal, 1986: Gunjate *et al.*, 1983: and Joubert *et al.*, 1993).

Significant variations were also observed for fruit set percentage at marble stage among different varieties with maximum fruit set being observed in Dusheheri (7.52%) followed by Amrapali (7.20%) and Arka Neelachal Kesari (6.20%). There is no wide variation for fruit set at marble stage among different directions. But maximum fruit set at marble stage was observed in East direction. The fruit retention percentage at maturity stage as calculated on the basis of number of fruits at marble stage was significantly highest in cultivar Dusheheri (49.01%). The fruit retention at maturity stage is found to be at par for varieties Arka Neelachal Kesari (27.54%) and Amrapali (26.38%). The variations in fruitset among different varieties might be influenced by flowering behaviour and environmental conditions particularly temperature during flowering period (Geetha *et al.*, 2016). Researchers opined that influence of temperature as the most significant environmental factor for commercial mango production by affecting the frequency, intensity etc. (Davenport *et al.*, 1997).

## **5.2 Fruit characters**

The fruit morphological characters like fruit weight, fruit length and fruit diameter were studied for different varieties. A significant variation exist for all these characters among the varieties. The increased fruit weight in Amrapali (193.31 gm) is might be due to rapid multiplication and enlargement of cells and greater accumulation of sugar and water in expanded cells which is greatly influenced by genetic makeup of particular cultivars (Dutta & Dhua, 2004; Dalal *et al.*, 2005). The differences in fruit length of mango among the cultivars was also reported by many researchers like Kakkar *et al.*, (1999) and Bhowmick and Banik, (2005).

The total soluble solids varied significantly among the cultivars, Amrapali having the highest TSS (19.89 Brix) followed by Dusheheri (19.59Brix). The increase in total soluble solids may be accounted to the hydrolysis of polysaccharides, conversion of organic acids into soluble sugars and enhanced solubilization of insoluble starch and pectin in cell wall and middle lamella. Similar results have also made by Kudachikar *et al.* (2003), Dalal *et al.* (2005) and Chaudhari *et al.* (2006).

### **5.3 correlation studies**

The correlation was studied among 12 flowering traits from days taken to 50% flowering to fruit retention percentage.

It was clear from the table no 4.19 that flowering intensity is significantly and positively correlated with male flower per panicle and negatively correlated with percentage of perfect flowers. The fruit set percentage at marble stage was significantly correlated with final fruit set with the varieties. Significant and positive correlation was observed between fruit retention at mature stage calculated on the basis of fruits at marble stage and fruit retention calculated on the basis of total perfect flower .significant and positive correlation was also found between percentage of perfect flowers and days taken to 50% flowering. The fruit set at marble stage is positively correlated with percentage of perfect flowers and sex ratio.



CHAPTER-6  
**SUMMARY AND CONCLUSION**

## SUMMARY AND CONCLUSION

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The present investigation entitled “**Studies on flowering behaviour of important varieties of Mango (*Mangifera indica* L.) in Odisha**” was undertaken during the year 2017-2018 at the Central Horticultural Research Station (CHES), ICAR-Indian Institute of Horticultural Research, Aiginia, Bhubaneswar. The experiment consisted of three commercial varieties viz. Arka Neelachal Kesari, Amrapali and Dusheheri. Directions viz. east, west, north and south also taken into consideration for experimental findings.

The experiment was conducted in the factorial Completely Randomized Design consisting of three replications where as two plants are taken in to consideration for each replication. The remarkable observations obtained from this investigation are given below.

1. The first appearance of flower was observed in variety Arka Neelachal Kesari (23<sup>rd</sup> November) followed by Amrapali (5<sup>th</sup> January).
2. In all of the three varieties first appearance of flower was observed in east direction whereas late appearance of flower was observed in west direction in most of the cases.
3. The days taken for 50% flowering is minimum in Arka Neelachal Kesari (13.67days) where as it is maximum in Dusheheri (18days).
4. In cases of directions, the days taken for 50% flowering is maximum in north direction (17.33days) and minimum in east direction (13.11days).
5. Amrapali variety shows significantly higher percentage of flowering intensity (60.83%) followed by Arka Neelachal Kesari (52.08%) whereas variety Dusheheri experiences the lowest (41.67%) among all the three varieties.
6. Significantly maximum percentage of flowering intensity is observed in east direction (59.44%) followed by south (55%) where as it is minimum (42.22%) in west direction.
7. The duration of flowering is observed to be significantly maximum for Amrapali variety (43days) followed by variety Dusheheri (38.25days) where as it is minimum for variety Arka Neelachal Kesari (33days).
8. In case of different directions, west side (41.33days) experiences the significantly longest duration of flowering followed by north (40days).

9. The significantly maximum number of staminate flowers was counted in Amrapali (836.17) followed by Arka Neelachal Kesari (736.17).
10. The highest male flower was found in east direction (763.11) and lowest in north direction (617.11).
11. The significantly maximum number of hermaphrodite flowers was recorded in Amrapali (117.04) followed by Arka Neelachal Kesari (101.46).
12. In aspects of direction the highest number of hermaphrodite flower found in south direction (104.50) followed by east direction (104.33).
13. The sex ratio was observed to be significantly highest for the north direction (0.19) and lowest for the east direction (0.14).
14. The sex ratio is found to be significantly higher for Dusheheri variety (0.20) followed by Arka Neelachal Kesari (0.14) and Amrapali (0.14) which are at par each other.
15. The significantly highest length is observed in case of Amrapali variety (35.56 cm) followed by Dusheheri (23.87cm).
16. Highest panicle length is observed in south direction (28.93cm) followed by east (28.30cm) and north (25.70cm) direction.
17. The significantly highest width is observed in case of Amrapali variety (22.60cm) followed by Arka Neelachal Kesari (13.68cm).
18. Highest panicle width is observed in east direction (18.01cm) followed by south (17.24 cm) and north (15.92cm) direction.
19. The highest significant percentage of fruitset at marble stage is found in Dusheheri (7.52 %) followed by Amrapali (7.20%).
20. Highest percentage of fruit set at marble stage is observed in east direction (7.58%) followed by west (7.14%) and south (7.13%) direction respectively which are at par each other.
21. The highest significant percentage of fruitset at mature stage is found in Dusheheri (49.01 %) followed by Arka Neelachal Kesari (27.54%).
22. Highest percentage of fruit set at mature stage is observed in east direction (37.28%) followed by north (35.36%) and south (32.78%) direction respectively.

23. Mean highest significant percentage of fruitset at mature stage is found in Dusheheri (3.72 %) followed by Amrapali (1.87%) where as it is minimum in Arka Neelachal Kesari variety (1.71%).
24. Highest percentage of fruit set at mature stage is observed in east direction (2.92%) followed by west (2.38%) and south (2.30%) direction respectively.
25. Amrapali recorded significantly maximum fruit weight (193.31 gm) followed by Arka Neelachal Kesari (183.88 gm).
26. Maximum fruit weight is observed in east direction (183.66 gm) followed by South (179.44 gm) and north (172.59 gm) direction whereas the lowest fruit weight is observed in west (169.68) direction.
27. Amrapali recorded maximum fruit length (9.69cm) which was highest among all the three varieties. The Dusheheri (8.32cm) was closely followed by Arka Neelachal Kesari (8.18cm).
28. In east direction (9.01cm) followed by south (8.88cm) and west (8.53cm) directions whereas the shortest fruit length is observed in north (8.51cm) directions.
29. Amrapali recorded maximum fruit diameter (6.26cm) which was highest among all the three varieties. The Arka Neelachal Kesari (5.81cm) was closely followed by Dusheheri (5.34 cm).
30. maximum fruit diameter is observed in east direction (6.13cm) followed by south (5.77cm) and north (5.74cm) directions whereas the minimum fruit diameter is observed in west( 5.57cm) directions.
31. Amrapali recorded significantly higher TSS of fruits (19.89 brix) followed by Dusheheri (19.59 brix).
32. Maximum fruit TSS is observed in east direction (19.16 brix) followed by South (19.13 brix) and north (19.13 brix) direction whereas the lowest TSS is observed in west (19.07 brix) direction.
33. Arka Neelachal Kesari recorded slightly higher acidity of fruits (0.41%) followed by Amrapali (0.39%).
34. Maximum acidity is observed in west direction (0.43%) followed by east (0.39%) and north (0.39%) direction whereas the lowest acidity is observed in south (0.35%) direction.

### **Correlation studies**

1. Days taken to 50% flowering is highly positive and significantly correlated with percentage of perfect flower (0.727) and sex ratio (0.714).
2. Days taken for 50% flowering is highly negative and significantly correlated with flowering intensity (-0.747).
3. Duration of flowering is positively and significantly correlated with panicle length(0.610)
4. Flowering intensity is highly positive and significantly correlated with total number of male flowers per panicle (0.876) where as it is highly negative and significantly correlated with days taken to 50% flowering.
5. Flowering intensity is positively and significantly correlated with panicle length (0.645) and panicle breadth (0.692) and in contrast it is negatively and significantly correlated with percent perfect flower (-0.699), sex ratio (-0.688) and fruit retention percentage at mature stage (-0.562).
6. Panicle length is highly positive and significantly correlated with panicle breadth (0.965) where as it is positively and significantly correlated with total male flower per panicle (0.628).
7. Panicle breadth is highly significant and positively correlated with total number of male flowers per panicle (0.740)
8. Total number of male flower per panicle is highly negative and significantly correlated with percent perfect flower (-0.893), sex ratio (-0.893), fruit retention percentage at mature stage (-0.784).
9. Total number of male flower is negatively and significantly correlated with fruit retention percentage at mature stage calculated from the total number of hermaphrodite flowers (-0.666).
10. Percentage of perfect flower is highly positive and significantly correlated with sex ratio (0.999) where as it is positively and significantly correlated with fruit retention percentage at mature stage (0.650).
11. Sex ratio is positively and significantly correlated with fruit retention percentage at mature stage (0.644).
12. Fruit set percentage at marble stage is positively and significantly correlated with fruit retention percentage at mature stage calculated from the total number of hermaphrodite flowers (0.611).

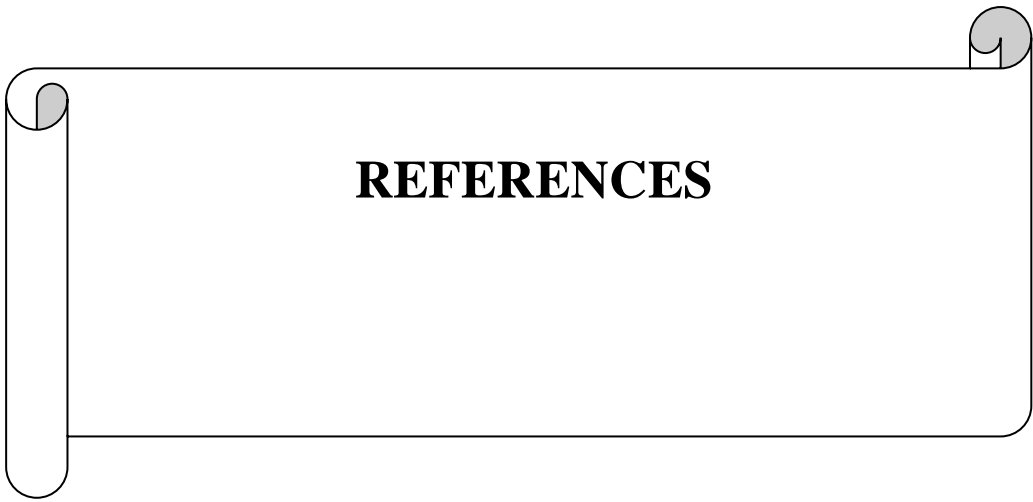
13. Fruit retention percentage at mature stage is highly positive and significantly correlated with fruit retention percentage at mature stage calculated from the total number of hermaphrodite flowers (0.945).

## **Conclusion**

The present investigation revealed pertinent information on the phenology of important mango cultivars under the East and Southern East Coastal Plain Agro-climatic condition of Odisha. Significant variations were observed among the varieties for all the flowering and fruiting characters studied except acidity content of the fruit. Furthermore significant variations were also observed among the four directions for, days taken to 50% flowering, flowering duration and flowering intensity irrespective of the varieties.

1. The variety Arka Neelachal Kesari flowered earlier and harvested early as compared to the other varieties.
2. Maximum flowering duration and intensity as well as panicle length were recorded in the cultivar Amrapali.
3. Percentage fruit set at marble stage, fruit retention percentage on the basis of total number of hermaphrodite flowers and fruit retention percentage on the basis of fruits retained at marble stage was highest in Dusheheri.
4. Maximum average fruit weight and TSS (<sup>0</sup>Brix) were recorded in Amrapali.
5. Percentage fruit set at marble stage is significantly and positively correlated with fruit retention percentage calculated on the basis of total number of perfect flowers per panicle.

Hence it can be recommended that the orientation of canopy architecture of mango should be more towards east and south directions in Northern hemisphere by adopting suitable training methods to obtain maximum flowering. The variety Arka Neelachal Kesari is a suitable cultivar for Odisha condition to get early flowering and fruiting.



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( Fig. 4.5 Tagging of desired shoots of mango plant )



( Fig. 4.6 Heavy floriferous condition of cultivar Amrapali )



( Fig. 4.7 Inflorescence of Arka Neelachal Kesari cultivar )



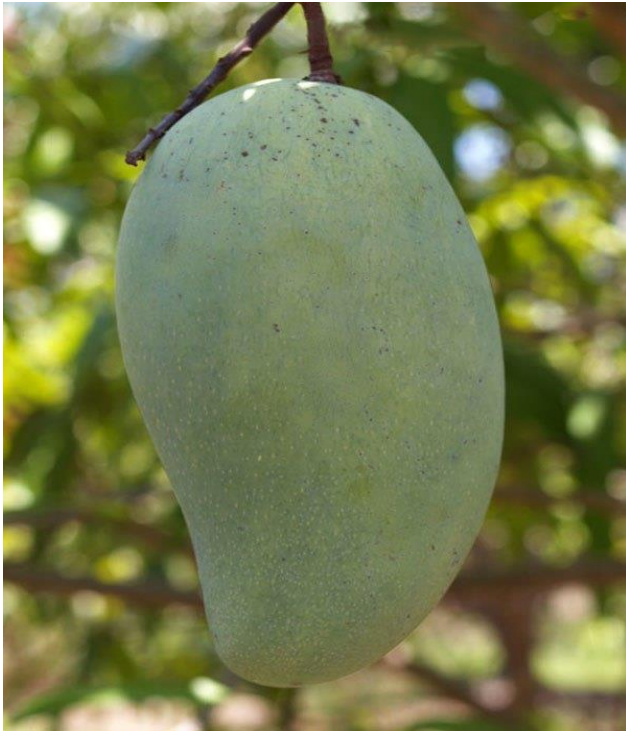
( Fig. 4.8 Inflorescence of Amrapali cultivar )



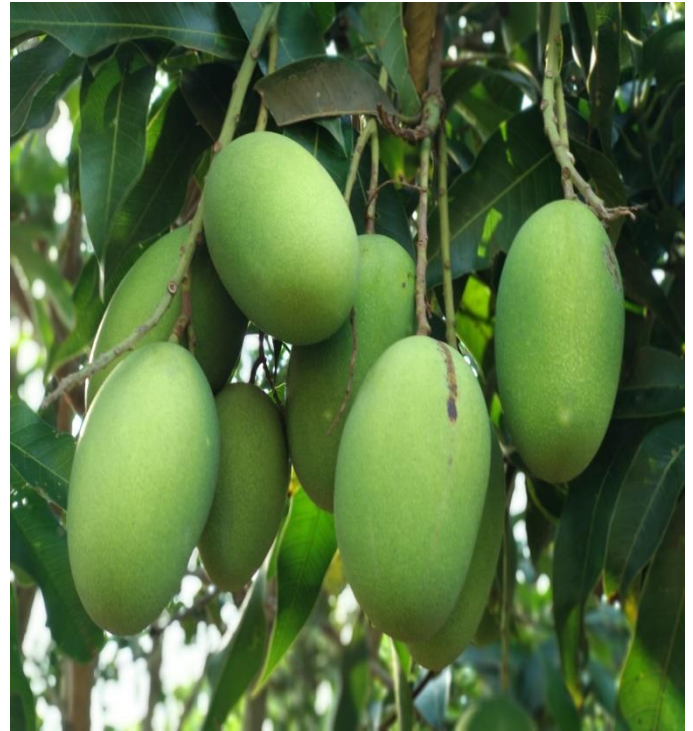
( Fig. 4.9 Inflorescence of Dusheheri cultivar )



( Fig. 4.10 Plants of Dusheheri block tagged for investigation )



( Fig. 4.11 Fruit of cultivar Amrapali )



( Fig. 4.12 Fruit of cultivar Dusheheri )



( Fig. 4.13 Fruit of cultivar Arka Neelachal Kesari )



( Fig. 4.14 Brix meter used for measuring TSS )