



LOVELY
PROFESSIONAL
UNIVERSITY

Transforming Education Transforming India

Studies on performance of self grafted mango cultivars under nursery and field condition in Punjab region

THESIS

Submitted to the

LOVELY PROFESSIONAL UNIVERSITY, PHAGWARA

In partial fulfilment of the requirements for the degree of

Master of Science

in

Fruit Science

By

Harman Bir Singh

11505126

Under the Guidance of

Dr. Senthil Kumar

DEPARTMENT OF AGRICULTURE

LOVELY PROFESSIONAL UNIVERSITY

PUNJAB 144411

June 2017

CERTIFICATE-I

This is to certify that the thesis entitled “ **Studies on performance of self grafted mango cultivars under nursery and field condition in Punjab region** ” submitted in partial fulfilment of the requirement for the award of the degree of **MASTER IN SCIENCE (AGRICULTURE) FRUIT SCIENCE** to Lovely Professional University, Phagwara, Punjab is a bonafide research work carried out by **Mr. Harman Bir Singh** (Registration No. 11505126) under my guidance and Supervision. No part of the thesis has been submitted for any degree or diploma.

The assistance and help received during the course of investigations have been fully acknowledged.

Supervisor)

(Signature of

Dr. Senthil kumar

UID: 19420

Designation: Assistant Professor

Department of Horticulture

School of Agriculture

Lovely Professional University

Phagwara, Punjab

(Signature of co-supervisor)

Dr Shailesh Kumar

UID: 19105

Designation: HOD and Assistant Professor

Department of Horticulture

School of Agriculture

Lovely Professional University

Phagwara, Punja

Certificate- II

This is to certify that thesis entitled “**Studies on performance of self grafted mango cultivars under nursery and field condition in Punjab region** ” submitted by Mr. Harman Bir Singh (Registration No. 11509894) to Lovely Professional University, Phagwara, Punjab, in partial fulfilment of the requirements for the award of degree of **MASTER OF SCIENCE (AGRICULTURE) Fruit Science** has been approved after the oral examination of the same in collaboration with the internal examiner.

Dr. Senthil Kumar
(Supervisor)

Internal Examiner

Dr Deepika Saxena
(Co-Supervisor)

Dr. Ramesh Kumar
(Dean, School of Agriculture)

Dr Shailesh kumar
Head of Department

DECLARATION

I hereby declare that the project work entitle “**Studies on performance of self grafted mango cultivars under nursery and field condition in Punjab region** ” is an authentic record of my work carried at **Lovely Professional University** as requirements of Project work for the award of degree of **Master of Science in Fruit Science**, Under the Guidance of **Dr. Senthil Kumar**, Assistant Professor, School of Agriculture, Lovely Professional University, Phagwara, Punjab, India. I also declare that the material contained in this thesis has not been published earlier in any manner.

Harman Bir Singh
(Registration No. 11505126)

Acknowledgement

Putting all the thing aside I would like to thank “God- The Almighty” for providing me the gracious gifts of all strength with patience and courage bestowed upon me to overcome various challenges to cross important milestone of my assigned profession.

It is an immense pleasure for me to express my profound sense of gratitude and indebtedness to my esteem, major advisor Dr. Senthil Kumar, Assistant Professor, School of Agriculture, Lovely Professional University, Punjab for his valuable, affectionate and inspiring guidance and his immense zeal of hard work, never withering patience and constant inspiration and encouragement to me during the course of the present investigation and for preparation of the manuscript.

It is a great honour to express my deep gratitude to my Co-advisor, Dr. Deepika seksana, Assistant Professor, School of Agriculture, Lovely Professional University, Punjab, for his valuable and constructive criticism during the entire period of research work.

I acknowledge my heartfelt thanks to (Head of Department o Dr. Shailesh Kumar Singh f Agronomy) and respected faculty members of the department for their needful help during the entire course of studies.

I owe a special word to my family members whom I kept awaiting during all these years and who faced so many difficulties during my long period of absence. This work would not have been possible without the support of my grandparents Sardar Shiv Singh Sandhu , my parents Sardar Balbir Singh and Sardarni Gurmeet Kaur, my brother Navdeep Singh whose sacrifices and struggles have been inspiring me to bring not only the smiles on their faces but tears of happiness in their eyes, I take this precious moment to express my heartfelt thanks to my family members whose association has always been a boost to me.

I also express my thanks to the whole team of field for their help during the research trail.

Time stop ticking, when I think of acknowledging the nice company and unwavering help of dearest friends Sudir Partap, Bhupinder Singh, Amanpreet, Davinder , Paras Kambj, who kept me in an exalted state even during the moments of despondency and were always with me with supporting hands.

On a different note, many people have been a part of my education and I offer my regards to all of those who supported me in any respect during the completion of the study.

Place: LPU, Phagwara

Dated: June, 2017

(Harman Bir Singh)

TABLE OF CONTENTS

Content	Page no.
Title page.....	i
Certificate-I.....	ii
Certificate-II.....	iii
Declaration.....	iv
Acknowledgment.....	v
Table of content.....	vi
List of figures.....	viii
List of table	x
List of abbreviations.....	xii
Abstract.....	xiii
CHAPTER-1	
Introduction.....	1
Objectives.....	4
CHAPTER-2	
Review of literature.....	5
CHAPTER-3	
Materials and Research Methodology.....	13
Experimental Site	13
Geographical site	13
Treatments details and Experimental Design	15
Description of grafting methods.....	17
Field Preparation and Planting Material	20
After care Operations	24
Treatment observation parameter	25
Statistical analysis	25

CHAPTER-4

Result and discussion	26
Days of sprouting	30
Hight of rootstock	31
Diameter of root stock	40
Diameter of scion	46
Number of leaves per plant.....	53

CHAPTER-5

Summary and Conclusion.....	54
References.....	56
Agrometerological Data	61

List of Tables

S No.	Title	Page No.
4.1	Days of sprouting	27
4.2	Height of root stock after 30 days	29
4.3	Height of root stock after 60 days	30
4.4	Height of root stock after 90 days	32
4.5	Height of root stock after 120 days	34
4.6	Diameter of root stock after 30 days	35
4.7	Diameter of root stock after 60 days	37

4.8	Diameter of root stock after 90 days	38
4.9	Diameter of root stock after 120 days	40
4.10	Diameter of scion after 30 days	42
4.11	Diameter of scion after 60 days	43
4.12	Diameter of scion after 90 days	45
4.13	Diameter of scion after 120 days	47
4.14	Number of leaves after 30 days	48
4.15	Number of leaves after 60 days	50
4.16	Number of leaves after 90 days	51
4.17	Number of leaves after 120 days	53

List of Figures

S No.	Title	Page No.
4.1	Days of sprouting	28
4.2	Height of root stock after 30 days	29
4.3	Height of root stock after 60 days	31
4.4	Height of root stock after 90 days	33
4.5	Height of root stock after 120 days	34
4.6	Diameter of root stock after 30 days	36
4.7	Diameter of root stock after 60 days	39
4.8	Diameter of root stock after 90 days	41
4.9	Diameter of root stock after 120 days	42
		44

4.10	Diameter of scion after 30 days	
		45
4.11	Diameter of scion after 60 days	
		47
4.12	Diameter of scion after 90 days	
		49
4.13	Diameter of scion after 120 days	
		50
4.14	Number of leaves after 30 days	
		52
4.15	Number of leaves after 60 days	
		53
4.16	Number of leaves after 90 days	
4.17	Number of leaves after 120 days	
4.18	Graft survival percent	

LIST OF SYMBOLS AND ABBREVIATIONS

Abbreviated Form	Full Form
%	Percent
T	Tonne
ha	Hectare
MT	Metric tonne
AT.MAX	Atmospheric maximum temperature
AT.MIN	Atmospheric minimum temperature
RH.M	Relative humidity morning
<i>et al</i>	et alia and others
RH.M	Relative humidity evening
cv	Cultivar
RCBD	Randomized Complete Block Design
t	Treatment
Rf	Rainfall
°	Degree
Cm	Centimetre
M	Metre
PAU	Punjab Agricultural University

DAS	Days after Sprouting
<i>i.e.</i>	that is
resp.	Respectively
±	Plus-minus sign
Fig.	Figure
Temp.	Temperature
ANOVA	Analysis of variance

Abstract

The present investigation entitled ‘Studies on performance of self grafted mango cultivars under nursery and field condition in Punjab region ’ was carried out during 2016 to 2017 in farmers field in village zaffarwal block dhariwal district Gurdaspur To assess the performance of self graft combinations of Dashehari, Langra, Amrappali, Malta, Surkha and Fazli for morphological traits and to evaluate which variety shows higher success in terms of days of sprouting ,number of leaves , height and diameter of scion and root stock by using side veneer grafting method done on local root stock . For that root stock of one year was taken first of all stones of mango were raised in nursery condition then these root stocks are taken and operation of grafting is performed in nursery in month of August .The experiment was laid out in Randomized Block Design with 6 treatment combinations In each block about five plants are planted with three replications

The parameter like number of days to sprout was recorded in nursery and other rest of parameter were analysed under field condition by planting in main field . Observations were taken at 30, 60, 90, 120 days the main objective to discover that which cultivar shows higher success after grafting in terms of diameter of scion ,diameter of root stock , height of root stock , height of scion etc

The minimum number of days for sprout was found in Treatment 3 (Surkha) (16.10 DAS) followed by Treatment 5 Fazali (17.16 DAS) The maximum height of Root Stock was reported in the T5 (22.23) (Fazali) which was followed by Treatment 4 (Langra) (21.60 cm) treatment 2 (Amarpali) . The maximum diameter of root stock 30 days was found in T4 (Langra) 9.61 followed by T6 (Malta) 9.16, T1 (DDushehari) 9.13 which was significant than other varieties The maximum Diameter of scion after 120 days found in T1 (Dusheri) 9.05 followed by T5 (Fazali) 8.47, T6 (Malta) 8.13 . The maximum number of leaves was recorded in T2 (Amarpali) 6.13 followed by T6 (Malta) 5.73 T3 (Surkha) 5.40 The research shows that treatment surkha shows higher survival rate of graft and it takes minimum days to develop a new scion then all other varieties this investigate that this variety is most compatible to graft in August by using side veneer grafting

Key words mango .treatment. side veneer grafting

Chapter-1

INTRODUCTION

Mango (*Mangifera Indica*) is king of fruits. It has delicious taste and flavour and also have many suitable characters. This crop belongs to Anacardiaceae family. The origin of mango is South-Asia, the indo-Burma region. It is related with certain religious and traditional rituals from the ancient times. (Chattopadhyay) 1976. In India it was grown over 400 years. India has 56% of share in total mango production in the world.

Genus of mango as *Mangifera* belongs to order Sapindales in the family Anacardiaceae. It is main family of tropical species with 73 genera. The other fruits related to *Mangifera* are cashew, pistachio, dragon plum, kaffir plum etc. (Whitmore, 1975). Besides this Anacardiaceous species also give many useful products like wax, Gum, Wood, Tanning material etc. The Genus *Mangifera* consist of 69 species. Wild species of mango found in Sri Lanka, China, India, Malaysia and Bangladesh.

The trees which grow from seed are known as seedlings. Stone of mango fruit is used as seed to cultivate mango trees raised from seeds have long juvenile phase and also given non-uniform yield. Seedling trees have life of about 100 years while grafted plants live near about 80 years. The tree of mango is medium to large 10-40m in height. It is evergreen, bark is usually grey brown to black, smooth or irregular and cracked. It contains about 15% of gum, 78% Resin and tannic acid. The terminal bud is small in size. Twigs are smooth and thin and dark green colour. Root of tree is unbranched, long as tap root system. 18 year old plant have effective root system with depth 1.2m. The leaves of mango plant are 15-45 cm in length, simple, alternatively arranged. The length variation in petioles is ranging from 1-12cm. There is great difference in shape of leaf as oval shaped, oblonged, linear oblong, ovate, roundish oblong (Singh, 1960)

The inflorescence of mango is small to broad conical panicle upto 45cm. The colour of panicle may be light green, yellowish green with patches on branches. Panicle bears flowers about 500 - 6000 but only 1 to 70% are bisexual and other are male flowers. There are both male and Hermaphrodite flower produced in mango. Size of these flowers lies between 6 - 8mm in diameter. Pedicels are very small & missing (Bafod, 1988). The petals are yellowish

and their another colour is pink, which turns to purple after some time. The pollen-grains used for pollination are different in shape with size of 20 -35 microns (Mukharjee, 1950 Singh 1954) In *magnifera Indica* only small amount of pollen is produced.

Mango fruit have different colour, shape, size, presence of fibre, taste, flavour and have great character variation in each variety. The fruit is fleshy drupe. The most common characteristic in mango is formation of beak at the end of fruit. Some varieties have fruit of oblong shape, longish with length varying from 2.5 to 30cm. At the time of maturity there is formation of shoulders and colour of fruit changes from green to yellow, also many chemical changes takes place like conversion of starch into sugar, decrease in acid ratio, acid content etc. Immature fruit is hard. Mango pulp is very perishable in nature so it needs to be treated with aqueous solution 0.5%, 1%, 2% Chitosan (Chien, 2007).

There are large number of varieties of mango. Most of the varieties are produced as chance seedling selection. In India about 30 varieties are commercially grown but they have narrow adaptability and yield is low. (Yadav and Rajan 1993). Dashehri, Chausa, Langra, Neelum, Alphonso, Bombay Green, Tapatari, Malika varieties are mainly grown in different states.

These varieties have some specific characteristics: Alphonso variety is used for canning purpose, export purpose due to its superior quality. Bombay Green is early mature variety and grown in North India known as an alternative name Malda. Fruit quality is good. Another variety is dashehri which is mid seasonal. It is leading and commercial variety of India. Neelum is late season variety & mainly grows in Tamilnadu. Many hybrids are introduced in mango like Amrapalli, Arka-puneet, Arka Anmol, Ratna etc.

The mango fruit is utilized in different forms like in ripe or unripe form. It is used for making pickle, candies, chatney, Murabba etc and in ripe form it is consumed directly as desert fruit. The leaves of mango are used for cooking purpose in various parts of world like Java and Philippines (Munde, 2011). It has also many medicinal value. It is used to cure many diseases and remedies such as diabetes, Burns, Teeth problem, asthma, Nose bleeding etc. The leaves of mango used to control diabetes. The smoke of burning leaves is very effective against the throat problems. To cure the teeth problems dry leaves are used to make tooth powder. The kernel of mango is good source of protein. It use to grind with flour to

make bread. Seed of mango is also used to make hair dyes. Ripe fruit of mango helps in reduction of weight and eradicate many bacterial infections.

Mango has wide adaptability in Indian soil under various climate conditions. It can be grown in Alluvial soil to Lateritic soil except in black cotton soil. It requires deep and well drained soil for growth. Alkaline, water logged and soil with rocks are not desirable for cultivation of mango. Soil with hard nature are avoided the vigour yield and productivity of mango depends upon type of soil. In India soil of Indo Gangetic plain are fertile and best for mango growth. Soil which have more salt content are used to reclaimed by giving more irrigation so that concentration of salt decreased by leeching. The water table depth suitable for mango is 1.80 to 2.40m. If water table is too high than it damage the plants and sometimes reduce the yield. The pH range for mango is 5.5-7.5. Rainfall timing is important is mango production.

Mango is grown in both tropical & sub-tropical region. It can tolerate wide range of climatic conditions. During growing season from June to October it requires good rainfall from November onward it needs clear sunny days. the frost is limiting factor for mango as it cause chilling injury to the plant. Rainfall during flowering time is not desirable as it effects the pollination and directly effect the fruit setting. High temperature during post pollination stage inhibit the fruit set and also effect the fertilization (Erickson and Markhart 2002). the temperature requirement for mango is 24 - 27^oc. High temperature & adverse climatic conditions cause reduction in yield of fruit & disorders.

The production has been increasing since Independence contributing 39.5% of total fruit production. Andhra Pradesh is top in total Production, while in terms of area Uttar Pradesh is at the top. The annual production of mango in India is 151.9 Lac tonnes with area of 22.97 lac hectare (NHB) 2011.

The main mango producing state in India in Uttar Pradesh (23.86%) Andhra Pradesh (22.14%), Karnataka (11.71%) etc. Total export of mango from India is 59.22 thousand tonnes. Mango occupies over 4946 thousand hectare with production of 37.12 million tonnes 2010 position of India is at the top level than other countries. The other mango producing countries Thailand, Pakistan, Mexico, Indonesia as respectively (Yadav, 2016)

In Punjab the sub-mountainous zones are suitable for its growth. The area under mango production in Punjab is 6744 hectares, with 119322 metric tonnes production (Package and practice PAU) The agroclimatic conditions of other states like Bihar, west Bengal, Tamilnadu, and Gujarat are also suitable for mango production. In Punjab there is great scope to increase the production in coming years by rapid multiplication and selection of superior clones.

Mango have two types of seed one is mono embryonic and second poly-embryonic. When seed contain single embryo is called mono-embryonic. In this type embryo is result of sexual reproduction. The seedling of mono-embryonic mango varies from its parents in term of growth, maturity and uniformity of character. The mangoes that have originating in South Asia have multiple embryo called poly-embryonic. In this one embryo carries from sexual and other from asexual. They are Identical in their mother plants. The seedlings take longer time for growth so they don't generally preferred.

In ancient years/times the mango was mainly propagated by stones but nowadays different grafting methods are developed and utilized in cultivation of mangifera Indica. Grafting is a process in which parts of two or more plants are joined together so that they appear to grow as a single plant. (Santamour, 1988 and SA 2005) The upper part is scion grows on the root system (Rock stock) of an other plant. Grafting can only done between closely related species. The main advantage of grafting is that it change the characteristics of plant and make it superior than its mother plant. Other is that it increase the production by giving fruits in short time as compare to a sexual method of propagation. In case when the plant is raised from seed it gives non-uniform bearing and fruits are inferior. Grafting also play major role in improvement of Inferior varieties. It is common and preferred method of propagation (Bally 2006). The main factor in grafting is compatibility. If both root stock and scion are compatible with each other, then growth of new shoot is started. The root stock are selected on the basis of desirable characters. (Simons, 1987)

Seedling with good trait such as rapid growth (in diameter or in height) could reduce the waiting period to grafting time. The proper alignment of root stock and scion cambium tissues estimate the graft success (Pina & Errea, 2005) Many soil born diseases are controlled by grafting. It develops resistance power prevent them from damage (Oda 1999 LEE and Oda 2010). By vegetative propagation there is less effect of climatic conditions on the crop and

increase yield (Oda, LEE, 2010) Scions are collected when the tree is in active in growth stage. About 5-7.6cm of twig whose terminal bud s beginning to enlarge is taken. After taken the scions all leaves removed then scions are placed in a plastic bag and stored in temperature range 10°C. The veneer cut is shallow so that it expose the cambium then two cut surfaces are joined and wrapped together. The graft starts to begin after 10-21 days.

The performance of graft compatibility between different scion and stock for commercial mango varieties for subtropical regions of Punjab is not available. So this experiment comes with a solution for selection of suitable graft combinations for commercial nursery production targeting mango industries.

The scope of mango Industry is more in India but due to compatibility among varieties the yield of mango is very low and varieties don't perform. well there is no any special type of graft compatible varieties available to get good yield in short time. Farmers of India facing challenges as they spent lots of money in planting mango orchard but they do not get high return value. Thats why most of the farmers do not adopt horticultural crops. They prefer to grow organic crops. Every variety have some specific character. The compatibility among the varieties of mango differ based on varietal potentiality. So it is necessary to Identify suitable graft combinations for commercial nursery production.

OBJECTIVES

1. To assess the performance of self graft combinations of Dashehari, Langra, Amrappali, Malta, Surkha and Fazli for morphological traits
2. To study that which variety shows high graft survival and takes less time to sprout
3. To analyze the impact of environment on performance of self grafted mango cultivars.

Chapter-2

Review of Literature

2.1 Days of sprout

Sabeky (2005) studied to determine the best time and method for mango grafting in Bahokalate, Sistan Balouchestan Province, Iran. He reported that highest percentage of grafting success (67.2%) was obtained with grafting on 4 April. Side and softwood grafting produced higher success rates 65.8 and 63.7%, respectively than shield budding (47.5%), after 90 days. The percentage of grown scions and scion lengths of those grafted on 4 th April after 180 days were 55% and 57.9 cm, respectively, and these values increased to 65.6% and 60.6 cm after this period

Prasanth, J. M *et. al.*, (2007), conducted a research experiment to check the soft wood grafting in mango to evaluate which variety takes less time by using., Khader, Mallika and Baneshan. The grafting are done at different time, September grafting showed early sprouting (24.50 days). Significantly maximum percentage of sprouting (82.50) and graft take (54.56%) was observed in I fortnight of September grafting. Poor sprouting was observed during the December grafting with respect to sprouting and survival of grafts. Among the three cultivars Mallika showed the highest percentage of sprouting (68.90%).

Kudmulwar *et. al.*,.(2008) preformed an experiment on Softwood grafting from 1 January 2005 to 15 May 2005 on a local rootstock of custard apple (*A. squamosa*), using one-year-old seedlings of uniform growth (Pericil thickness). The custard apple cultivar Balanagar was used as the scion. The grafting performed on 15 February showed the more success percentage (88.87), maximum length of scion (2.38 cm), highest number of leaves (21.93) etc.

Patel *et. al.*,(2010) reported that the minimum number of days taken for sprouting was recorded in Khasi mandarin grafted on Rough lemon rootstock at North Eastern Hill Region, Meghalaya.

Verma *et. al.*,(2010) carried out an experiment to standardize the rootstock in grapes. The grape cultivar Pusa Urvashi was grafted on different rootstocks viz., Pusa Navrang, Dogridge A, SO4 and H-144. The days required for sprouting of grafted plants was 19.40

days. Pusa Navrang as rootstock was proven the most compatible with Pusa Urvashi as scion partner for growth parameters.

Mandal *et. al.*,(2012) conducted a study on mango cultivars reported that maximum sprout initiation days 12.11 and 12.13 were registered under cultivation of Dudhia Maldah and when performed at 25 cm. grafting height. The maximum success and survivability percentage were noticed in Maldah followed by Amrapali. Conversation opened. 1 read message.

Gurudutta *et. al.*,(2012) conducted an experiment to compare the effect of cultivars and length of scions on sprouting of grafts and number of days taken for sprouting in mango by using the experiment use methodology of Factorial completely randomized designs with 3 replications and 16 treatment the final result showed that the Dashehari variety gives higher success followed by langra. Scions of various length were taken. Bud of lengths 8 cm and 6cm took minimum time for first sprouting and 4 cm bud lengths took maximum time on the other hand 6 cm bud length took less time and 4 cm bud length took maximum time for last sprouting. For the days taken for first and last sprouting from final result observation made as no significant difference was observed among different varieties.

Islam *et. al.*, (2013) conducted an experiment to study the effect of scion diameter on the success, survivability and growth of grafts in three varieties of mango. The study showed that the less time required for bud breaking (9.53 days) and leaf opening (15.19 days) with higher graft height (57.35cm), number of leaves (8.33), graft success (56.67%) and survivability (53.34%) were observed in thick sized scion while thin sized scion required the higher time for bud breaking (11.08 days) and leaf opening (19.85 days) with the lower graft height (54.96cm), number of leaves (5.67), graft success (48.89%) and survivability (44.45%).

Mohona Banik (2014) stated that lemon seedlings were grafted with BAU-3 lemon which recorded the minimum number of days taken for sprouting (11.64 days) produced after grafting under Bangladesh conditions.

Harshavardhan *et. al.*, (2014) conducted a study on days taken for sprouting of Jackfruit (*Artocarpus heterophyllus* Lam.) grafts by using the scion sticks of two cultivars viz., Singapore and Palur were grafted on Jackfruit seedlings by two methods of grafting (Veneer and Soft wood method) in different months starting from July to October under two

environmental conditions . From his research work it is concluded that Veneer method of grafting recorded less number of days for scion sprouting (20.4 days) and more number of days were recorded for softwood method (23.63 days).

Sivudu *et. al.*, (2014) conducted an experiment to study the effect of time on veneer grafting success and survival of mango grafts. The results revealed that among the studied five structural conditions, naturally ventilated polyhouse recorded significantly highest increment in sprout length (6.06 cm), graft height (17.92 cm), number of grafts sprouted (71.27%), minimum days required for sprouting of grafts (12.11 days), number of leaves per graft (17.34) and maximum survival percentage (67.18%) at 90 DAG (days after grafting). The lowest number of days to sprouting was recorded in plants grafted on 1 and 15 February.

2.2. Graft success percentage

Singh and Srivastava (1980) conducted study on softwood grafting in mango and recorded highest success (84%) in July. They use to studied softwood grafting for two years from July to September and March to April. Great success was recorded in August (90%) followed by July (64.85%).

Prasad *et. al.*,(1990) made a study on various aspects of veneer grafting in mango by taking Banganapally the final observation made was that the Precured scions gave higher success (78.96%) than non-precured scions (52.75%). Success was highest (71.08%) with 100 days old scions and lowest (62.67%) with 120 days old scions. The mean graft survival after potting was 75.39% with precured scions and 52.28% with non-precured scions that high mortality often occurs when material grafted in the nursery is lifted and potted after grafting.

Nayak and Sen (2000) made a research study and concluded that the time taken to bud break was greater when grafting was done in January (55 days) as compared to July-August (26 days). Also percentage of success was greater, 78.8% when it was done in July-August compared with 75% in January-March. However, overall rate of growth was greater in winter grafted plants.

Shaban (2010) carried out an experiment on comparative study of some polyembryonic mango rootstocks. Sukkary, Zebda, Sabre and 13-1 rootstocks were used for grafting. Cultivars of mango like Zebda, Ewais and Keitt were grafted on Sukkary, Zebda, Sabre and 13-1 rootstocks. The maximum success percentage was recorded (96.6 %) in plants

produced by grafting of Zebda grafted on Zebda rootstock. Among all the rootstocks, Zebda rootstock was found to be best rootstock.

Verma *et. al.*,(2010) *et. al.*, conducted experimental study to standardize different root stocks for pusa urvashi. Various types of grafting and budding methods have been tried in grape.by using different rootstocks (Dogridge A, Salt Creek, 1613 and H-144) involving different grafting methods (wedge, side and bench grafting) were tried. The highest graft take success was registered in wedge followed by side in all the three months, while for bench grafting, the highest graft take was recorded in the month of February. The graft take was the maximum at the height of 30 cm, while the minimum was noted at 15 cm. Of the three grafting months, February was found the best with respect to percentage graft success and survival. Dogridge A as rootstock was proven most compatible with Pusa Urvashi as compared to other rootstocks.

Ram *et. al.*, (2012) conducted a research to know highest grafting success. The study was done uptaking six cultivars viz. Amrapali, Dashehari, Mallika, Langra, Chausa and Lucknow Safeda The study was done in Randomized Block Design. Results showed that the more success per cent and overall performance of stone grafting operations was inspected by using scion stick cultivar Amrapali, where lowest success per cent was in cultivar Lucknow Safeda under Lucknow condition.

Gurudutta *et. al.*,(2012) reported that different cultivars of scions like Langra, Dashehari, Amrapali and Mallika were grafted on Kurukkan rootstock under Raipur conditions. The maximum success percentage (93.33 %) was recorded in Dashehari variety followed by Langra.

Kumar and Thakur (2012) conducted a study on stone grafting different treatments are made and the stone grafting on 10 days old seedling rootstocks resulted in great success in sprouting, survival, vegetative and root growth in comparison to grafts grafted on 13 day old seedling rootstocks. The study the soil + 14 sawdust was found to be the best growing mixture in respect of sprouting, survival and overall performance of stone grafts over other growing mixtures

Dinakara *et. al.*, (2014) reported that scions like Ullal-3, VRI-3, NRCC selection-2, Vengurla-4 were grafted on Vengurla-4, NRC-492 and Taliparamba-1. The maximum

success percentage was obtained in Vengurla-4 grafted on NRC-492 followed by VRI-3 grafted on Vengurla-4.

Jadhav *et. al.*, (2014) studied the percentage of grafting in twelve varieties of mango on local rootstock. The maximum success percentage was recorded (95 %) in Totapuri cultivar of mango.

Kalalbandi *et. al.*, (2014) conducted an experiment by selecting randomized block design with three reapplication and twelve treatments. The results analysed that the propagation of sapota var. Kalipatti by softwood grafting using 15 days prior defoliated scion stick of 8 cm length and 8 mm in diameter on 18 months old uniform khirni seedling stock undertaken in the months of August and September in 50% shadenet house gave maximum graft success percentage.

2.3. Graft survival percentage

Geetha *et. al.*,(1997) conducted an experiment to study the grafting success and survival in one month old polyembryonic seedling rootstocks (cultivars Muvandan, Chandrakaran, Puliyan, Olor or Tholikaipan) and a monoembryonic seedling rootstock (cv. Bangalora) were grafted in June, July or August in Kerala, with the mango cultivars Neelum or Banganapally. Grafting success was highest (96.67%) in Muvandan and Chandrakaran grafted with cv. Neelum during June and survival was highest (76.67%) in Puliyan grafted with cv. Banganapally during August

Islam *et. al.*,(2004) stated that the maximum survival percentage of Amrapali was 52.98 per cent than Gopalbhog (38.58 %) under Bangladesh conditions. Nalage *et. al.*,(2010) reported that the maximum survival percentage was recorded in Kesar variety of mango grafted on local variety rootstock.

Karim (2004) conducted an experiment on the effect of leaf and node retention in rootstock on success and growth of epicotyl grafting in 10 varieties of mango and found that the highest success was in Sindhu (80.12%) followed by Fazli and Hybrid- 10 (73.05%) and (68.32%) respectively and the lowest was in Gopalbhog (55.25%). He also found maximum percentage of survival in Sindhu (69.85%) followed by Fazli and Hybrid-10 (63.11%) and (64.26%), respectively while Gopalbhog gave the lowest (49.14%) survivability

Alam *et. al.*,(2006) studied the effect of length and variety of scion in stone grafting of mango. They recorded maximum number of successful grafts (66.67%) with cultivar Langra grafted on 15 days old seedlings followed by the same cultivar grafted on 20 days old seedlings (53.33%). The tallest shoots (25.07 and 24.73 cm consecutively) were produced by Langra grafted on 15 and 20 days old seedlings. They evaluate Langra shows best in all categories of scion length whereas BARI Aam-3 succeeded the least. greater final success (76.67%) was recorded in 10.0 cm long scions followed by 7.5 cm long ones (70.00%) in variety Langra. Mvery few final success was (23.33%) when 5.0 cm long BARI Aam-3 scions were used for stone grafting. Scions of 15.0 cm length in the grafts of all the varieties produced the longest shoots.

Bharad *et. al.*, (2006) conducted a research to study the effect time and method of vegetative propagation in Jamun . The method used in research work were ., softwood grafting and patch budding. The experiment was laid out in split plot design with four replications. Studies revealed that, the bud-take per cent, days required for bud-sprouting, bud sprouting percentage, linear scion growth, number of leaves and final survival recorded maximum values under softwood grafting over the patch budding. In respect of time of propagation, March propagation gives the good results with bud-sprouting, scion diameter and final survival of grafts/buddlings. While, softwood grafting done during March recorded maximum vegetative growth with highest bud sprouting and final survival percentage of grafts/buddling. In respect of age of rootstock, the seven months old seedling showed the maximum survival in patch budding, while, nine months old showed the highest survival in softwood grafting.

Patil *et. al.*, (2008) conducted research to assess the effect of different rootstocks (seedling progeny, Amrapali, Sindhu, Sindhura, Beneshan and Nekkare) on the success of softwood grafting using mango cv. Alphonso as the scion. Alphonso grafted on Sindhura showed significantly the highest graft success (77.80%) and Nekkare recorded the maximum graft survival (64.77%), which was on par with Sindhura. Growth parameters such as sprout height, graft diameter and leaf number were maximum on Sindhura and Beneshan

Simon *et. al.*, (2010) carried out an experiment on rootstock growth and development for increased graft success in mango. The maximum survival percentage of rootstock after grafting was about 73.5 percent.

Nalage *et. al.*, (2010) reported that the maximum survival percentage was recorded in Kesar variety of mango grafted on local variety rootstock

Sivudu *et. al.*, (2014) reported that Banganapalli grafted on Bangalora rootstock recorded the maximum survival percentage (67.18 %). The experiment was carried out in Anantharajupet conditions.

Singh N (2014) conducted research study on stone and cleft grafting in mango. Stone grafting was done by using cleft method on seedling rootstocks (Mango seedlings) in July and August on different four age groups i.e. 5 days, 10 days, 15 days and 20 days using Amrapali as scion stock. The main focus was to check age effect of mango seedling rootstock after stone grafting of cultivar Amarpali. Statistically data was analyzed with randomized block design replicating single interval five times. The height (24.4 cm) and sprouting percentage (83%) of scion, girth of rootstock and scion (6.3 mm) was significantly higher on grafts made on 10 days old rootstocks and minimum-sprouting percentage was recorded with 20 days old rootstocks. In vegetative parameters length (17.12 cm) and width (4.80 cm) of leaf was recorded maximum on 10 days old and minimum on 5 days old rootstock. The more survival percentage was exhibited by 5 days and 10 days old rootstock, which shows suitability for this method. It was cleared that epicotyl grafting performed better in terms of growth and survival when rootstocks up to 10 days old were used for grafting.

2.4. Height of Rootstock

Barakat *et. al.*, (2005) experiments were conducted to investigate the use of cleft grafting technique for mango propagation, where the scion is detached from the parent tree. The treatments were rootstock diameters of 1.5, 1.5 to 0.5 and 0.5 cm; scion hardening methods in which the leaves were either removed or trimmed to half leaves; scion lengths of 8-9 or 15-16 cm; glasshouse and nursery shed conditions and two cultivars, namely Galbeltor and Abusamaka. The most viable scions with the highest number of successful grafts were obtained when scions in which all the leaves were removed were grafted on rootstocks of 0.5 cm in diameter. There were no significant differences between the two mango cultivars, but Galbeltor tended to have higher values. Longer scions resulted in significantly higher percentage of successful grafts than shorter ones. Grafted seedlings kept under glasshouse conditions resulted in 100% successful grafts as compared to those kept in the nursery shed due to the high relative humidity levels maintained in the glasshouse

Alam *et. al.*, (2006) study was conducted for rapid multiplication of mango through stone grafting in RHRS, Chapai Nawabganj during last week of July, 2002. Mango seedlings of 5, 10, 15, 20, 25 and 30 days were grafted with three varieties of scion viz. BARI Aam-1, BARI Aam-3 and Langra. Maximum number of finally successful grafts (66.67%) was recorded in variety Langra grafted on 15 days old seedlings followed by the same variety grafted on 20 days old seedlings (53.33%). BARI Aam-1 grafted on 15 or 20 days old seedlings gave moderate success (46.67%). Minimum success (10.0%) was got in BARI Aam-3 grafted onto 5 and 30 days old seedlings. The tallest shoots (25.07 and 24.73 cm consecutively) were produced by Langra grafted on 15 and 20 days old Seedlings.

Chandan *et. al.*, (2006) carried out an experiment at Rahuri. The results showed that the performance of Dashehari on Bappakai rootstock exhibited significantly the maximum height (86.00 cm) followed by Muvandan (83.98 cm) and Ec 95862 (81.35 cm) respectively.

Kumar *et. al.*, (2006) conducted a study to check growth of Dashehari mango after grafting on different heights of seedling rootstock. The final result concluded as higher grafting height on the rootstock increases scion growth. There was small variation between veneer and cleft grafting with respect to their effects on scion growth.

Shantagouda *et. al.*, (2008) reported that the Alphonso variety grafted on Nekkare rootstocks showed the maximum graft survival percentage (64.77%) whereas Alphonso grafted on Baneshan rootstocks showed the maximum graft height and graft diameter under Karnataka condition.

El-Zaher (2008) reported that the nine-month-old rootstocks were superior in terms of grafting success (37.5%), time taken for getting highest scion bud sprouting (35.8 days), number of sprouted buds per scion (1.7), length of new shoots (2.9 cm), number of leaves per scion (4.6), and length of scion (12.5 cm). Top-cleft grafting using seedlings as source of scions, girdling under the graft union region, and covering of the graft union area with black polyethylene bags resulted in the highest percentage of successful grafts (75%), number of sprouted buds per scion (3.6), length of new shoots (6.6 cm), number of leaves per scion (8.2) and length of scion (16.6 cm), and in the very little time to report great scion bud sprouting (22.5 days).

Nalage *et. al.*, (2010) conducted an experiment at Ratnai college of Agriculture, Akhri, T.q. Malshiras, Solapur (M.S.) Indian. The experiment was carried out with twelve

treatments comprising four heights (4, 6, 8 and 10 cm.) of rootstock. The maximum number of sprouted grafts maximum sprouting percentage minimum days for leaf emergence maximum number of leaves per graft, girth (above the union) minimum mortality (%) and maximum survival (%) of grafts were recorded in grafts made on 10 cm height of rootstock.

Sivudu *et. al.*, (2014) stated that Banganapalli grafted on Bangalora rootstock recorded the maximum graft height (17.92 cm) under Anantharajupet conditions.

2.5. Diameter of graft

Gurudutta *et. al.*, (2004) made a research on 4 mango varieties Langra, Dashehari, Amrapali and Mallika to analyze the response on eicotyl grafting in mango. Six months after grafting, Dashehari reported vigorous nature and gives the highest values for scion length and height of new graft, while the highest scion girth was noted in malika as compared with the other varieties.

Bhuiyan *et. al.*,(2010) stated that girth was highly influenced by the different combinations of rootstock and scion from 42 to 52 months. The highest girth (24.65 cm) of scion was recorded in plants produced by grafting of Amarpali scion onto Amarpali rootstock followed by Gopalbhog scion onto Gopalbhog rootstock. Thus, the results revealed the superiority of plants produced by grafting of same scion onto the rootstock of same variety of mango.

Shaban (2010) carried out an experiment on comparative study of some polyembryonic mango rootstocks. Sukkary, Zebda, Sabre and 13-1 rootstocks were used for grafting. Cultivars of mango like Zebda, Ewais and Keitt were grafted on Sukkary, Zebda, Sabre and 13-1 rootstocks. The maximum scion diameter was recorded (1.1 cm) in Zebda cultivar grafted on Zebda rootstock.

2.6 Number of leaves

Jana (2007) conducted a study to determine the response of various mango cultivars to top-veneer grafting .The maximum leaf number were analyzed in Tommy Atkins (26.95) and Amrapalli (2.36), respectively. All the varieties grow equally with respect to their height and girth. Flowering started from the third year after planting. All the cultivars were in bloom in the fourth year, where as maximum (83.84%) flowering observed in malika variety.

Kudmulwar *et. al.*, (2008) performed grafting under Parbhani condition using local variety rootstock of custard apple (*Annona squamosa* L.) with Balanagar scion and reported the highest number of leaves (21.93) in plants produced after grafting.

Ram *et. al.*, (2012) recorded the maximum number of leaves on Amrapali scion at 30 and 60 days after stone grafting on different cultivars of mango under Lucknow conditions.

Kalalbandi *et. al.*,(2014) reported that the maximum number of leaves was recorded (14.44) in Kalipatti variety of sapota grafted on Khirni rootstock under Marathawada conditions.

Chapter— 3

Material and Method

The present investigation entitled ‘**Studies on performance of self grafted mango cultivars under nursery and field condition in Punjab region**’ was carried out during 2016 to 2017 in farmers field in village zaffarwal block dhariwal district Gurdaspur to evaluate which variety shows higher success in terms of days of sprouting, number of leaves, height and diameter of scion and root stock and the details regarding experimental soil, weather conditions, materials and methods and the methodologies adopted in the investigation are briefly described in this chapter

Experimental Site

Field experiment will be carried out during the year 2016-17 at farmers field in village Zaffarwal district Gurdaspur, Punjab to evaluate the performance of different varieties to develop suitable graft combination by evaluating some parameter in nursery and other parameter in field condition

Geographical Site

Location

The district name Gurdaspur is situated in the northern most part of Punjab. The latitude is 31⁰-36' and 32⁰-34' and longitude is 74⁰-56' and 75⁰-24'

Topography

The slope of this area is plain. Its elevation ranges from about 305 to 381 meters above sea level. It is composed of number of choas and has an undulating topography.

The flood plains of the Ravi and the Beas are separated from the up land plain by sharp river cut bluffs. They are low lying, with slightly uneven topography. Sand dominates in the soil structure of the flood plains, but it diminishes in both quantity and coarseness in the upland plain. The up land plain covers a large part of the district particularly. Its elevation ranges from about 305 metres above sea level in the north-east to about 213 metres above sea

level in the south west, with a gentle gradient of about 1 metre in 1.6 km. This is the most important physiographic unit in the district.

River System & Power Resources

The two main rivers which flow through the district are Ravi and Beas. Like other rivers of the Punjab the water of the Beas and the Ravi fluctuate from season to season and from year to year.

Climate

There are mainly two seasons i.e. summer and winter. The summer season takes place between the April to July and the winter November to March. The temperature is at highest level during summer 44°C . June is the very hot month and January is the coldest month. The rain falls occurs mostly in the month of July. The winter rains takes during January and February. The dust storm occurs in the month of May and June.

Rainfall

The south-west monsoon generally arrives in the first week of July and continue up to the end of August. 70% of the rainfall occurs during this period.

Ecology

The changes in ecology system are common, consequences of development process. The denudation of forests due to increasing population, urbanisation industrialization have accelerated the process of environmental degradation in the district. Therefore preservation of the ecology is one of the most important goals of the district planning.

The vegetation differs in the district depending on the soil, topography and elevation. In the Plain, large scale of afforestation has been under taken by the forest department. Where water facilities are available, Shisham, mulberry, eucalyptus and poplar are being planted. In the Kallar area, kinar prosopis and eucalyptus has been planted. Besides mango and mulberry, other fruit trees cultivated in the district include orange, Kinnow Lemon tree etc.

Hydrology

The ground water in this region is suitable for irrigational and domestic uses. The depth ranges of water lies from 5 to 8 metres in most part of the district.

Soils

The soils of this barea are loamy with a clay content below 10 percent. They contain small quantities of lime but the magnesia content is high. They are well rich in potash and phosphoric acid but the quantities available are low. The agriculture is dependent to a large extent on the nature of its soils which in turn, is influenced materially by climatic factors. The soil quite alluvial and fertile.

Experimental Details

Name of crop	: Mango (<i>Mangifera india</i> L.)
Scion	: Langra,Daseheri, Surkha ,Malta ,Fazli ,Amrapalli
Experimental design	: Randomized Block Design
Number of factors	: 6
(a) Grafting time	: August 2016
(b) Grafting methods	: SIDE VENER GRAFTING
Number of replication	: 3
Treatment combination	: 6
Treatment unit (tree/treatment)	: 5
Total number of plants	: 90

Treatment Details

The experiment was laid out in Randomized Block Design with 6 treatment combinations In each block about five plants are planted with three replications which were replicated three times. The Treatment details are given in Table

Details of Treatments

R1	R2	R3
T1	T6	T4
T2	T5	T3
T3	T4	T2
T4	T3	T1
T5	T2	T6
T6	T1	T5

TREATMENTS –T

T1 -Daseheri

T2 -Amrapalii

T3 -Surkha

T4 - Langra

T5- Malta

T6- Fazli

Rootstock used for grafting - Desi /local root stock

Replication - R

Number of plants /treatment -5

Experimental Material

The one factor experiment consisting of six treatment combinations was laid out in Randomized Block Design (RBD) with three replications. For each treatment combination grafting operations were performed on five rootstocks.

Description of grafting methods

Side grafting

A mode of grafting in which the scion is cut quit across very obliquely, so as to give it the form of a slender wedge, is thrust down inside of the bark of the rootstock into which it is inserted. It is commonly used to convert the inferior established plants into the superior or desired once

Preparatory work for grafting

According to the design and objectives of the experiment the following works were done:

1. Selection of rootstock
2. Selection of scion mother plants for scion collection
3. Selection and collection of scion materials
4. Performing grafting operation
5. Tools and accessories used for propagation

Preparation of field

First of all I select a site where I have to start my project. I select my own farm in my village zaffarwal as there are resources like irrigation facilities are present and site according to agro climatic conditions are suitable then I measure the plot area with measuring tape as 35 feet in length and 30 feet wide.

Ploughing of field

I use to plough the field with cultivator and collect all previous weeds from the field , I collect all unwanted plants like parthenium ,chemopodium album etc and place out of field then give light irrigation .

Collection of stones

I collect fruits of varieties as mentioned in my project .i contact to orchard and take about fifteen fruits of each variety then extract the stones of each fruit and keep in polythene by labeling with tags by writing name for variety . Mango stones lose their viability as they not sown in correct or less time I remove the stones put in water and then keep in shade for some time



Preparation of beds

Beds are made with the help of spade stones are sown in lines which are 40cm apart and distance of 60cm is left after every two rows to facilitate the cultural practices and better care of seedlings. The stones are sown at 15 to 20cm apart with in the line at the depth of 5cm. The stones are placed in the soil with plumule up as it avoid seedling from to be destroyed. After sowing I use to cover with the mixture of sand and farmyard manure. The mulching is done with sarkanda and rice straw then after sowing I apply light irrigation in plot it helps to keep the soil moist.

After three weeks stones started to germinate and about one and half month later true leaves starts to appear then o give subsequent irrigations at weekly interval and in winter the frost will cause damage in order to prevent seedling from damage I cover all seedlings

In summer these seedling attain height of 45 cm and attain the thickness of 0.75 cm and then these plants are ready to be grafted as they attain pencil thickness.

Rootstock side grafting

Nearly 8-11 months or one year old seedling rootstocks of wild cultivars of mango were selected for side grafting which were raised in polybags at the Horticulture Research cum Instructional station Gurdaspur were used in this experiment. Selected seedlings were healthy, vigorous, pest and disease free, uniform in size and growth.

Selection of mother plant

Selection of scion mother plant is the important factor for the propagation of fruit plants by grafting. Quality scion mother plant with appropriate growing conditions assures higher percentage of graft success. Considering this fact, pest and disease free, healthy, and uniform bearing 4-5 years or more old mother plants of mango variety Langra were selected.

Selection and collection of scion materials

Scion is the key factor in successful vegetative propagation of fruit plant. Therefore, the non-flowering shoots of fresh growth having dark green colored leaves, about 10-15 cm long, straight, smooth, healthy, pest and disease free and also of same thickness of rootstock were selected. The scion shoots were of about 3-4 months old containing sufficient reserved food materials. The selected scion shoots were detached from the mother plants about one week before the grafting operation with the help of sharp secateurs and were defoliated and leaving one-fourth of the petiole just after their detachment. The collected scion shoots were then carried in a poly bag to the experimental plots and kept in shady or cool place to avoid desiccation.

Preparation of scion

Scion is the key factor in successful vegetative propagation of fruit plant. Therefore, the non-flowering shoots of fresh growth having dark green colored leaves, about 10-15 cm long, straight, smooth, healthy, pest and disease free and also of same thickness of rootstock were selected. The scion shoots were of about 3-4 months old containing sufficient reserved food materials.

In grafting process the other part of plant are use to join to gather on root stock are called scion first of all I visit all orchards and collect scions of required varieties .Then I select healthy and disease free plants I take fresh and young shoot I defoliated the shoots before 7 to 10 days before time of detachment all un desirable nodes and branches are removed after shoot is detached and keep in moist place if shoots becomes dry then all sap is removed from the plant.

Each scion from the mother plant tagged properly and kept in bundles scions sticks of 7cm are taken for grafting.

Then I go for grafting, it is process by which two different parts of plant are join to gather to form a complete plant, there are two terms used as compatibility and in compatibility when root and scion starts to grow as a plant this called as compatible whether scion is not grows on root stock then this known as incompatible . In my research work I have to check that which variety is more compatible with root stock

Then I select grafting tools to make cuts on scion and root stock tools like secateurs, grafting knives, union tape ,thread, etc I take a proper tag and marker to label each row of variety properly

After selection of tools I have to go for study of best method of grafting that is side veneer grafting which is commercial and world wide method used in mango

The processes are same as the top grafting method, however, grafting is done on the upward side of the limb. The stocks are then taken with a diagonal cut about 3-4 cm long and 1/2 cm deep and are joined with the scion at the stock. The next step is to tie and wax the graft. The scion must be covered with a small, thin plastic polythene that prevent the scion from drying up. This polythene can be removed after 7-10 days. When the scion will begins shooting, cut the limb closest to the grafting point. All this process are carried by me in month of August.

Grafting operation

Procedure of side grafting

The scion was inserted into the side of the rootstock, which is generally larger in diameter than the scion. First, cut a long sloping cut (2.5-3cm) on the side of the rootstock at about 15-20 cm above soil level. Cut the scion into a wedge with one side slightly longer as

much as made a cut on the rootstock. Insert the scion laid up the cambium layers. Bind the graft with wrapping material. **The grafting operation carried in nursery and then after one month of sprouting these plants planted to the main field**

Plates



Rootstocks in nursery condition



Preparation of rootstock





Planting of grafted plants in the main field plots



After care of grafts

Irrigation

Plants as well as planted mango stones were watered immediately after planting in the polybags. In rainy season plants were not artificially irrigated and in winter days irrigation was done at 4 days interval whereas during summer, at 1-2 days interval.

Weeding

Weeding was done generally at an interval of 15 days. The bags free from weeds and give suitable environment for the proper growth and development of the grafted plants. Weeding and mulching operations are practiced at the period of research.

Removal of polythene strip

Polythene strips, used for wrapping the graft joint, were removed after 2 months of grafting for the better growth and union development of graft.

Disease and insect pest control

There are different preventive measures taken to prevent from insect pest and diseases, spraying with insecticides and fungicides were done at regular interval. Sumithion 2 ml/litre of water and Dithane M-45 @ 2 gm/litre of water were sprayed at 7-10 days intervals from two to four weeks after grafting and done until up to the last date of recording final data.

Observations Parameters

The data on different parameters were recorded at one month interval except the times required for bud sprouting and leaf opening, percentage of graft success and percentage of graft survivability. Data were recorded daily on bud breaking and leaf opening. The data were collected by taking the following parameters:

1. Days taken for sprouting
2. Number of leaves per graft
3. Diameter of rootstock

4. Diameter of scion

5 Height of grafted plant

Days taken for sprouting

The sprouting of the grafts as influenced by methods and seasons of grafting was observed critically and data were collected every day. The days required for leaf opening from the date of grafting was taken very carefully. From them average time required for first leaf opening was calculated

Number of leaves per graft

The total number of new leaves per graft was counted at an interval of 30 days starting from 30 days after grafting and was continued upto 120 DAG. The number of leaves per graft was calculated as a cumulative number.

Diameter of rootstock

For recording the girth of rootstock a circle was made on the rootstock just below the union point with oil paints. Subsequent observations were recorded at the marked paint to avoid error. Thickness of rootstock was measured with the help of vernier calipers and measurement were expressed in millimeter at the interval of 30 days and was continued upto 120 DAG.

Diameter of scion

Diameter of the scion was measured at 5 cm above the graft union. For recording the girth of scion a circle was made on the scion just above the union point with oil paint. Girth was measured with the help of vernier calipers. The measurement were recorded at an interval of 30 days and expressed in millimeter. The data were recorded from 30 DAG to 120 DAG.

Height of grafted plants

The total height of grafted plants were recorded at an interval of 30, 60, 90, 120 days after grafting. The height of grafted plant was measured in centimeter from the base of rootstock to the terminal end of the graft. A meter scale was used for this purpose. Height of all the plants of each treatment was recorded and the mean values were calculated.

Statistical analysis

Data were analyzed statistically adopting the technique of analysis of variance (ANOVA) using Factorial Randomized Block Design. The level of significance of the treatment mean square at 5 per cent probability was tested with 'F' test value. The significant differences of the treatment means were further tested by using significance of critical difference at 5% level of respective degree of freedom of 'T' values. The skeleton of ANOVA for Factorial Randomized Block Design is given below.

Source of variation	Ds	SS	MSS	Fcal	Ftab(5%)
Reapplication	r-1	SSr	MSr	MSr/MSE	
Factor (a)	a-1	SSa	MSa	MSa/MSE	
Factor (b)	b-1	SSb	MSb	MSb/MSE	
Interaction (a*b)	a-1*b-1	SSab	MSab	MSAB/MSE	
Error	(r-1)(ab-1)	SSE	MSE		
Total	Rab-1	TSS			

Chapter---4

Result and Discussion

The present investigation entitled “**Standarazation of suitable graft combination in subtropical condition of Punjab**” was conducted at Farmers Field in Dhariwal Gurdaspur Punjab by the student of Lovely Professional University, Jalandhar in the period 2016-2017 with the following objectives:

1. To assess the performance of self graft combinations of Dashehari, Langra, Amrappali, Malta, Surkha and Fazli for morphological traits.
2. To study the physiological factors influencing the growth and development of elite self graft combinations of mango and,
3. To analyze the impact of environment on performance of self grafted mango cultivars.

The observations recorded on various aspects during the study are briefly discussed in this chapter. Some analysis on parameter are noted in nursery while rest of observations are recorded in main field The experimental findings are statistically analyzed and are presented in appropriate tables, graphs and few are also depicted through figures. The experimental findings of present work have been discussed under the following headings:

4.1 Number of days for sprout

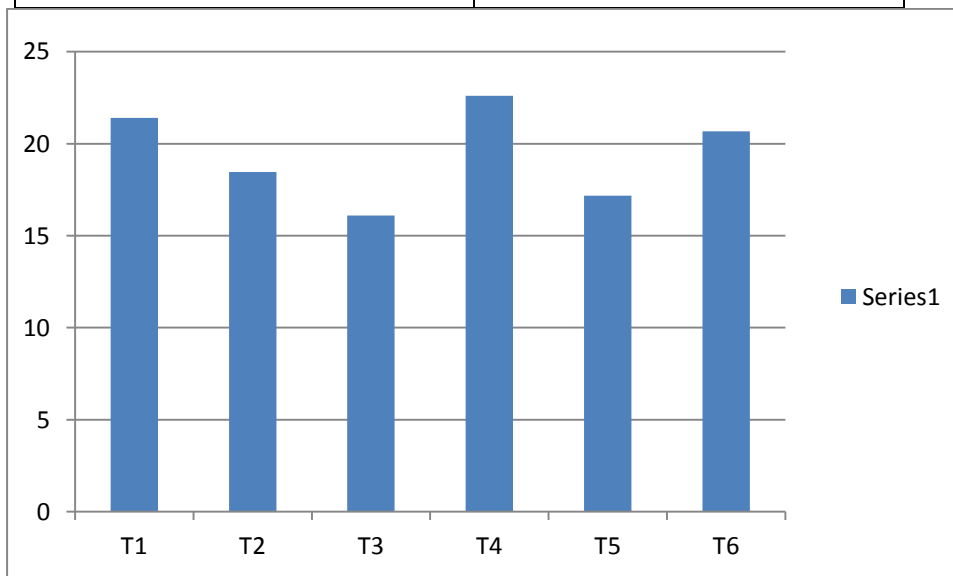
The minimum number of days for sprout was found in Treatment 3 (Surkha) (16.10 DAS) followed by Treatment 5 Fazali (17.16 DAS), Treatment 2 Amarpalli (18.46 DAS), treatment 6 Malta (20.66 DAS), treatment 1 Dasheari (21.40 DAS), treatment 4 Langra (22.60 DAS). Data was significant to treatments 1 , 4 and 6. The maximum number of days for sprout was taken in treatment 4 Langra (22.60 DAS) and minimum number of days for sprout was found in Treatment 3 (Surkha) (16.10 DAS).

The perusal of data revealed that all these early sprouting showed moderate to high yielding potential. Variability in days of sprouting have also been reported by Verma *et. al.*,(2010) carried Pusa Navrang as rootstock was proven the most compatible with Pusa Urvashi as scion partner for growth parameters. Mohona Banik (2014) stated minimum number of days taken for sprouting (11.64 days) produced after grafting under Bangladesh

conditions. Sivudu *et. al.*,(2014) reported Banganapalli grafted on Bangalora rootstock recorded the minimum days required for sprouting of grafts (12.11 days).

4.1 Days of sprouting

	NO OF DAYS FOR SPROUT
Treatment	Mean
Dashehri	21.400
Amrapalli	18.467
Surkha	16.100
Langra	22.600
Fazli	17.167
Malta	20.667
C.D.	1.733
SE(m)	0.543
SE(d)	0.768
C.V.	4.848



Graph 4.1

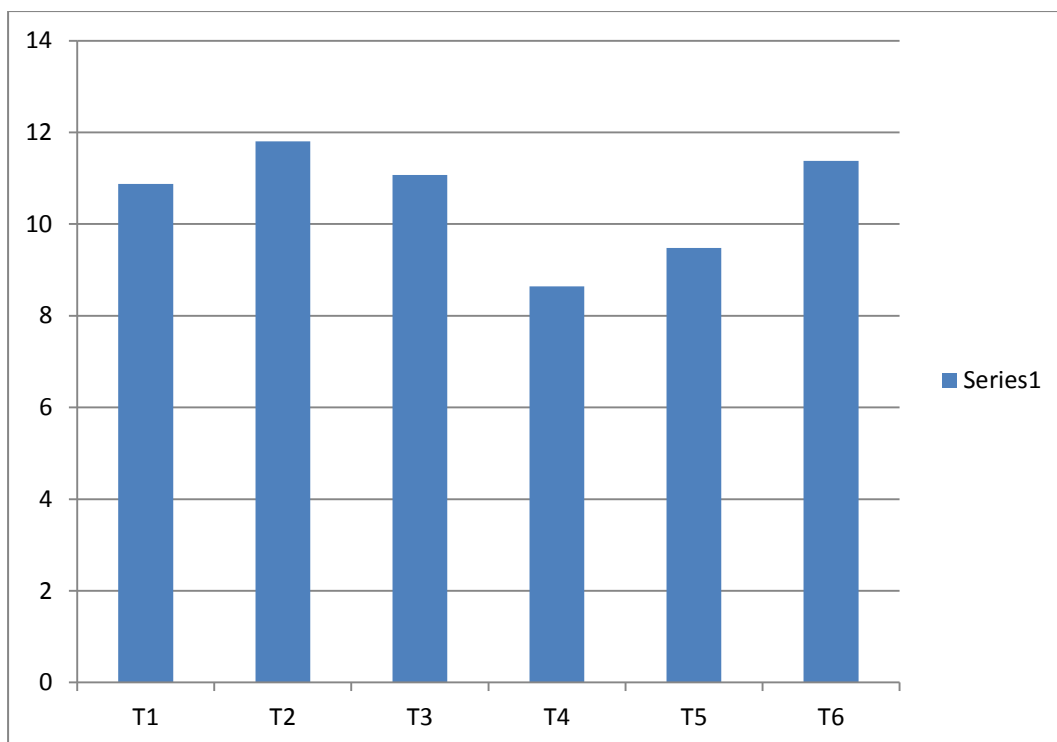
4.2 Height of the Root Stock 30 Days

The data pertaining to plant height has been given in Table 2 was found to be significant. Maximum plant height (19.26cm) was observed in treatment 5 (Fazali) which was followed by Treatment 4 (langra) (18.40 cm) with at par value. Other genotypes with significant differences were treatment 2 (18.26 cm), treatment 4 (18.40 cm), Treatment 5 (19.26 cm), Treatment 6 (18.13 cm), and the other treatments were non significant. The lowest value of plant height (15.80cm) was found in treatment 3 (surkha), and the highest value was found in treatment 5 (19.23).

A significant varietal differences were also observed Chandan *et. al.*,(2006) carried maximum height (86.00 cm) followed by Muvandan (83.98 cm) and Ec 95862 (81.35 cm) respectively. Shantagouda *et. al.*,(2008) reported Alphonso variety grafted on Nekkare rootstocks showed the maximum graft survival percentage (64.77%).

4.2 Height of root stock after 30 days

TREATMENT	Height of root stock 30 days
Treatment	Mean
Dashehri	16.467
Amrapalli	18.267
Surkha	15.800
Langra	18.400
Fazli	19.267
Malta	18.133
C.D.	1.505
SE(m)	0.472
SE(d)	0.667
C.V.	4.609



Graph 4.2

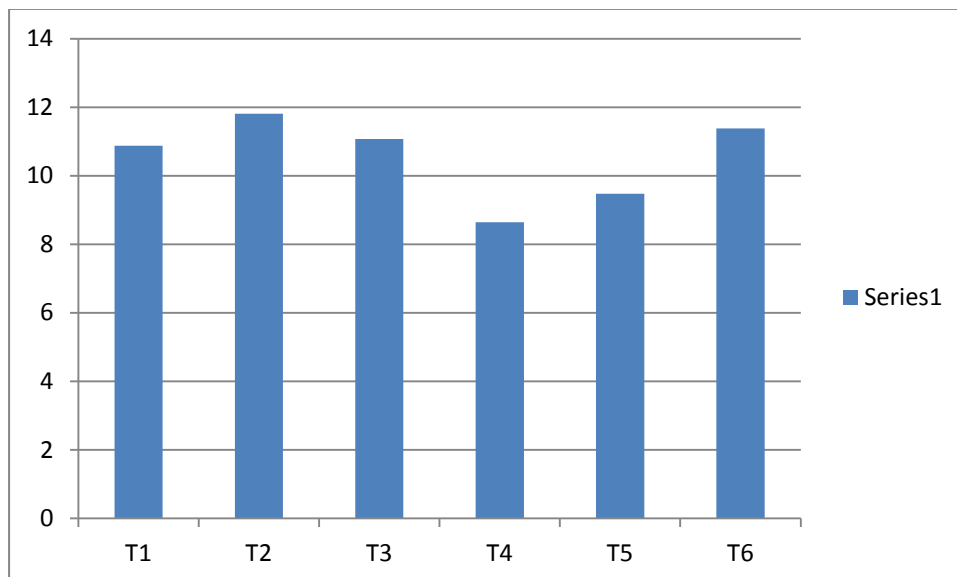
4.3 Height of the Root Stock 60 Days

The data presented in the Table 3 . The maximum height of Rootstock was reported in the T5 (20.80) (Fazali) which was followed by Treatment 4 (langra) (19.93 cm) with at par value. Other genotypes with significant differences were treatment 2 (Amarpali) (19.80 cm), treatment 6 (Malta) (19.66 cm), Trearment 1 (Deshari) (18.00 cm), Treatment 3 (surkha) (17.33 cm), and the other treatments were non significant. The lowest value of root stock was found in treatment 3 (surkha), and the highest value was found in treatment 5 (fazali) (19.23).

A significant varietal differences were also observed Sivudu *et. al.*,(2014) stated that Banganapalli grafted on Bangalora rootstock recorded the maximum graft height (17.92 cm) under Anantharajupet conditions. Kumar *et. al.*,(2006) conducted a study to check growth of Dashehari mango after grafting on different heights of seedling rootstock The final result conluded as higher grafting height on the rootstock increases scion growth.

4.3 Table

	Height of root stock 60 days
Treatment	Mean
Dashehri	18.000
Amrapalli	19.800
Surkha	17.333
Langra	19.933
Fazli	20.800
Malta	19.667
C.D.	1.589
SE(m)	0.498
SE(d)	0.704
C.V.	4.479



Graph 4.3

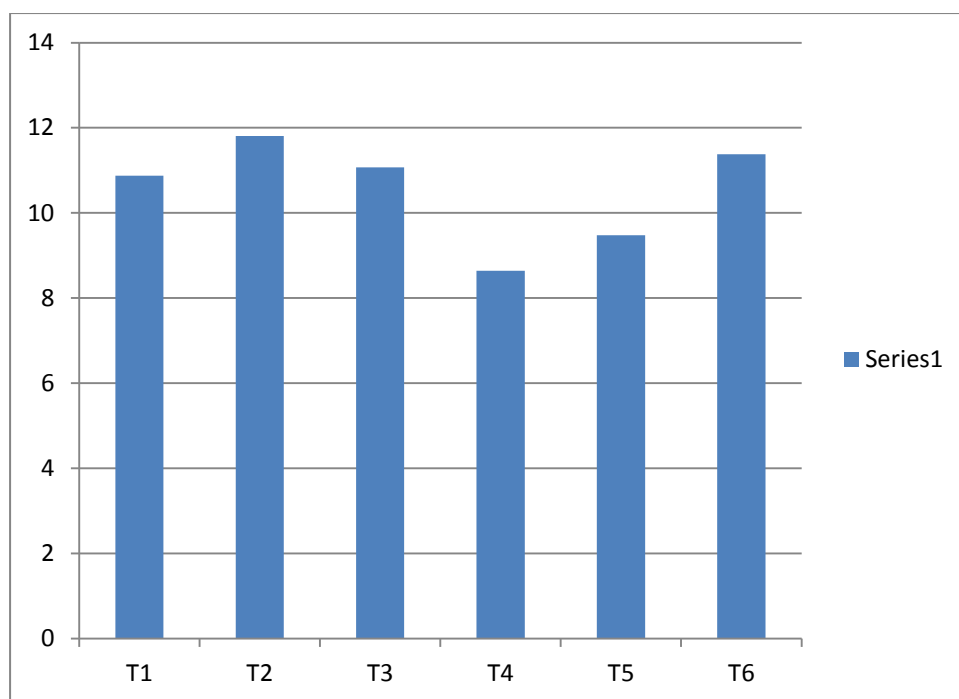
4.4 Height of the Root Stock 90 Days

The data presented in the Table 4 . The maximum height of Rootstock was reported in the T5 (22.23) (Fazali) which was followed by Treatment 4 (langra) (21.60 cm) treatment 2 (Amrapali) (21.50 cm), treatment 6 (Malta) (21.30) cm with at par value. Other genotypes with significant differences were treatment), Treatment 1 (Deshari) (19.63 cm), Treatment 3 (surkha) (18.96 cm), the lowest value of root stock was found in treatment 3 (surkha) (18.96), and the highest value was found in treatment 4 (22.23).

The research worker have also reported the observation. Chandan *et. al.*,(2006) carried out an experiment at Rahuri. The results showed that the performance of Dashehari on Bappakai rootstock exhibited significantly the maximum height (86.00 cm) followed by Muvandan (83.98 cm) and Ec 95862 (81.35 cm) respectively. Shantagouda *et. al.*,(2008) reported that the Alphonso variety grafted on Nekkare rootstocks showed the maximum graft survival percentage (64.77%) whereas Alphonso grafted on Baneshan rootstocks showed the maximum graft height and graft diameter under Karnataka conditions.

4.4 table

	Height of root stock 90 days
Treatment	Mean
Dashehari	19.633
Amrapalli	21.500
Surkha	18.967
Langra	21.600
Fazli	22.233
Malta	21.300
C.D.	1.606
SE(m)	0.503
SE(d)	0.711
C.V.	4.174



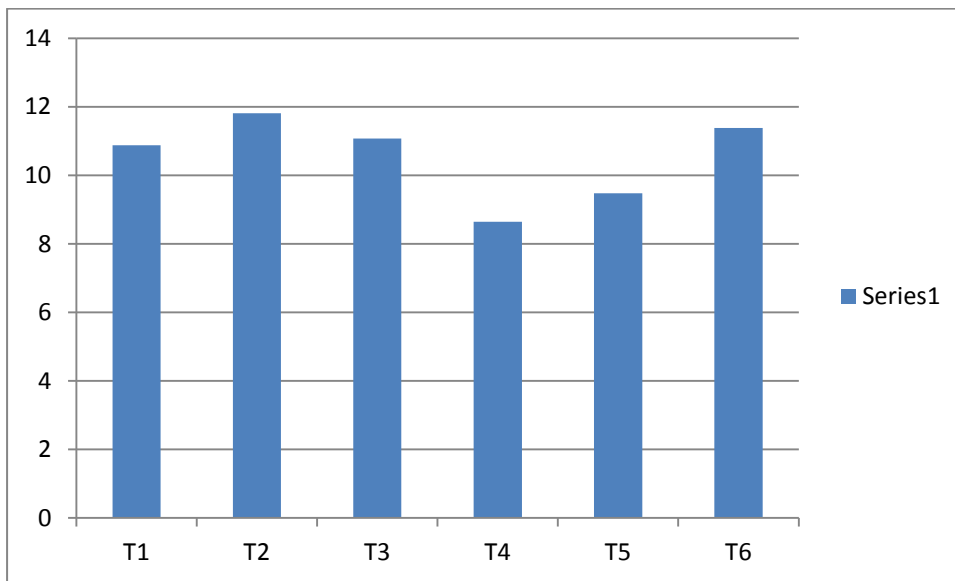
Graph 4.4

4.5 Height of the Rootstock 120 Days

The data presented in the Table 4 . The maximum height of Rootstock was reported in the T5 (22.23) (Fazali) which was followed by Treatment 4 (langra) (21.60 cm) treatment 2 (Amarpali) (21.50 cm), treatment 6 (Malta) (21.30) cm with at par value. Other genotypes with significant differences were treatment), Trearment 1 (Deshari) (19.63 cm), Treatment 3 (surkha) (18.96 cm), The lowest value of root stock was found in treatment 3 (surkha) (18.96), and the highest value was found in treatment 4 (22.23).

The research worker have also reported the observation. Geetha *et. al.*,(1997) observed that grafting success is dependent on the speed of graft union formation. One month old polyembryonic seedling rootstocks (cultivars Muvandan, Chandrakaran, Puliyan, Nalage *et. al.*,(2010) obtained the maximum number of sprouted grafts, maximum sprouting percentage, minimum days for leaf emergence, maximum number of leaves per graft, girth (above the union), minimum mortality (%) and maximum survival (%) of grafts when grafts were made on 6 cm height of rootstock.

	Height of root stock 120 days
Treatment	Mean
Dashehri	21.167
Amrapalli	23.000
Surkha	20.500
Langra	23.133
Fazli	23.767
Malta	22.700
C.D.	1.720
SE(m)	0.539
SE(d)	0.762
C.V.	4.171



Graph 4.5

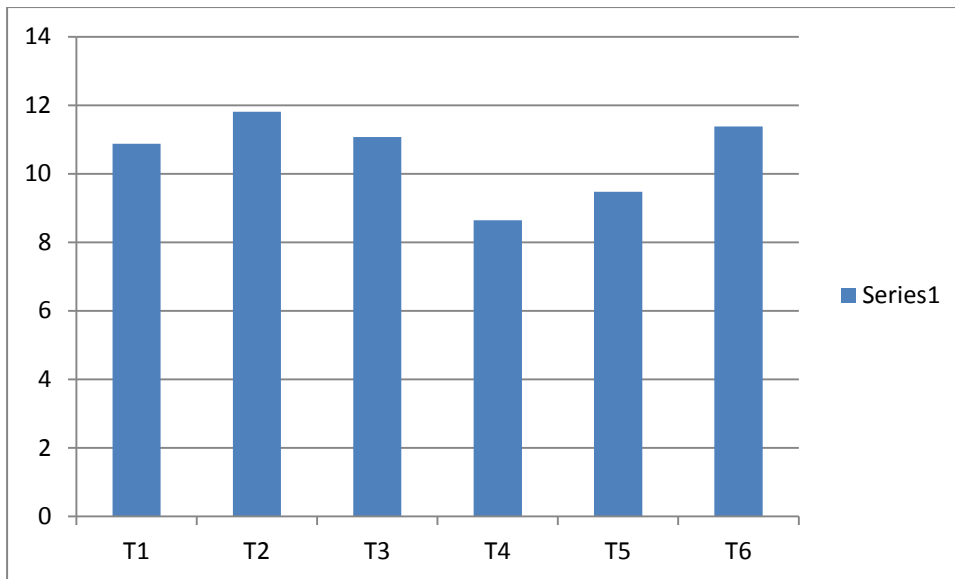
4.6 Diameter of root stock 30 days

The maximum diameter of root stock 30 days was found in T4 (Langra) 8.12 followed by T6 (Malta) 7.66 T1 (DDushehri) 7.36 T3 (Surkha) 7.37 T2 (Amarpali) 6.74 T5 (Fazali) 6.40. the data is presented in table 5. Most of the varieties are significantly at par.

The research worker have also reported the observation Bhuiyan *et. al.*,(2010) stated that girth was highly influenced by the different combinations of rootstock and scion from 42 to 52 months. The highest girth (24.65 cm) of scion was recorded in plants produced by grafting of Amarpali scion onto Amarpali rootstock followed by Gopalbhog scion onto Gopalbhog rootstock. Gurudutta *et. al.*, (2004) made a research on 4 mango varities Langra, Dashehari, Amrapali and Mallika to analyze the response on epicotyl grafting in mango . Six months after grafting, Dashehari reported vigorous nature and gives the highest values for scion length and height of new graft, while the highest scion girth was noted in malika as compared with the other varieties .

4.6 table

	Diameter of root stock 30 days
Treatment	Mean
Dashehri	7.633
Amrapalli	6.740
Surkha	7.370
Langra	8.123
Fazli	6.407
Malta	7.667
CD	0.259
SE(m)	0.081
SE(d)	0.115
CV	1.922



Graph 4.6

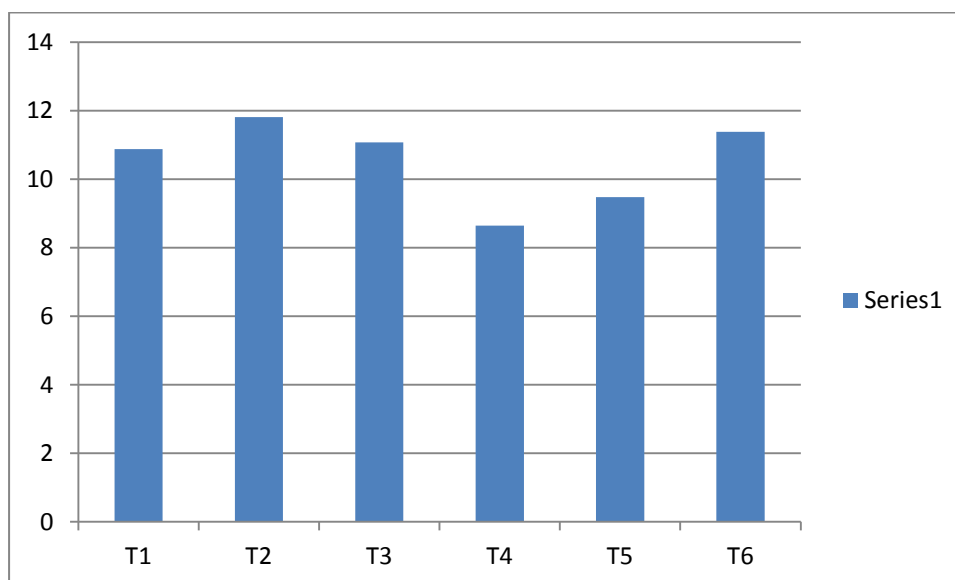
4.7 Diameter of root stock 60 days

The maximum diameter of root stock 30 days was found in T4 (Langra) 8.67 followed by T6 (Malta) 8.21 T1 (Dushehri) 8.18 which was significant than other varieties T3 (Surkha) 7.92, T2 (Amarpali) 7.29 , T5 (Fazali) 6.95. The data is presented in Table 6. The highest and lowest was found in T4 (Langra) and T5 (Fazali).

The research worker have also reported the observation, Majumder *et. al.*, (1972) reported that scion diameter, which varied from 5.5 to 6.5 mm did not affect the success of veneer grafting in mango, but subsequent growth was greater with the thicker scions. Grafting with scions from non-flowering shoots had 90% success, compared with 70 % from flowering shoots. Singh and Srivastava (1979) conducted several trials on factors affecting success in veneer grafting in mango. They stated that the best results were obtained from 6 months old scions, grafted on 2 years old rootstocks in July/August.

4.7table

	Diameter of root stock 60 days
Treatment	Mean
Dashehri	8.183
Amrapalli	7.290
Surkha	7.920
Langra	8.673
Fazli	6.957
Malta	8.217
CD	0.593
SE(m)	0.186
SE(d)	0.263
CV	4.090



4.7 graph

4.8 Diameter of rootstock 90 days

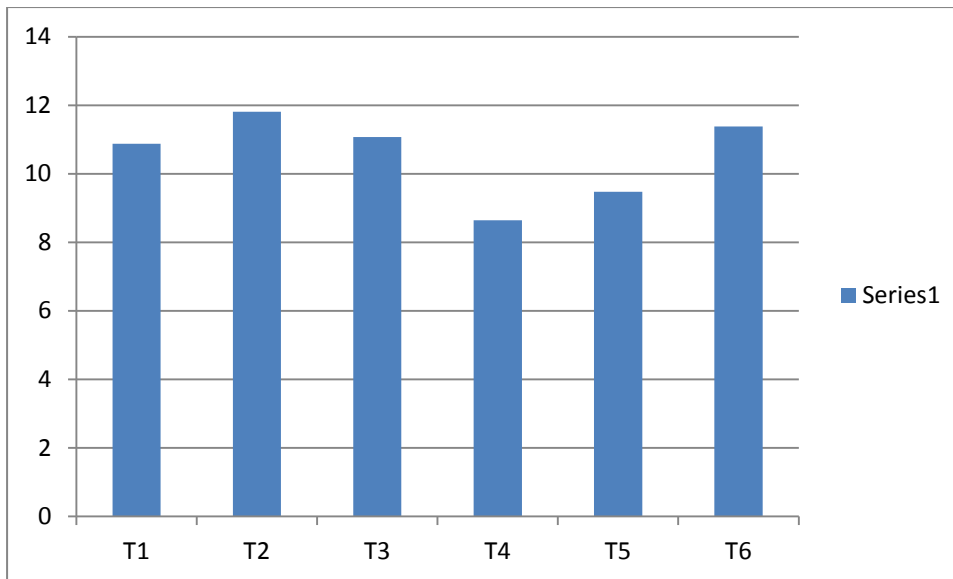
The data is presented in Table 7. The maximum diameter of root stock 30 days was found in T4 (Langra) 9.08 followed by T6 (Malta) 8.64 T1 (Dushehri) 8.60 which was

significant than other varieties T3 (Surkha) 8.34, T2 (Amarpali) 7.71 , T5 (Fazali) 7.55. The highest and lowest was found in T4 (Langra) and T5 (Fazali).

The research worker have also reported the observation, Gupta *et. al.*, (1988) carried out study on stone grafting in mango under Jammu, Indian conditions. Grafting was carried out with 5, 5.5, or 6 mm diameter of scion on several dates between 25 July and late September. Ram and Bist (1982) conducted an experiment to determine the effect of defoliation, diameter of scion and grafting time in mango. They used 5 to 6.5 mm large scion shoots of mango cv. Dashehari, defoliated 15 days before, or immediately before grafting.

4.8 table

	Diameter of root stock 90 days
Treatment	Mean
Dashehari	8.607
Amrapalli	7.713
Surkha	8.343
Langra	9.087
Fazli	7.553
Malta	8.640
CD	0.626
SE(m)	0.196
SE(d)	0.277
CV	4.079



4.8 graph

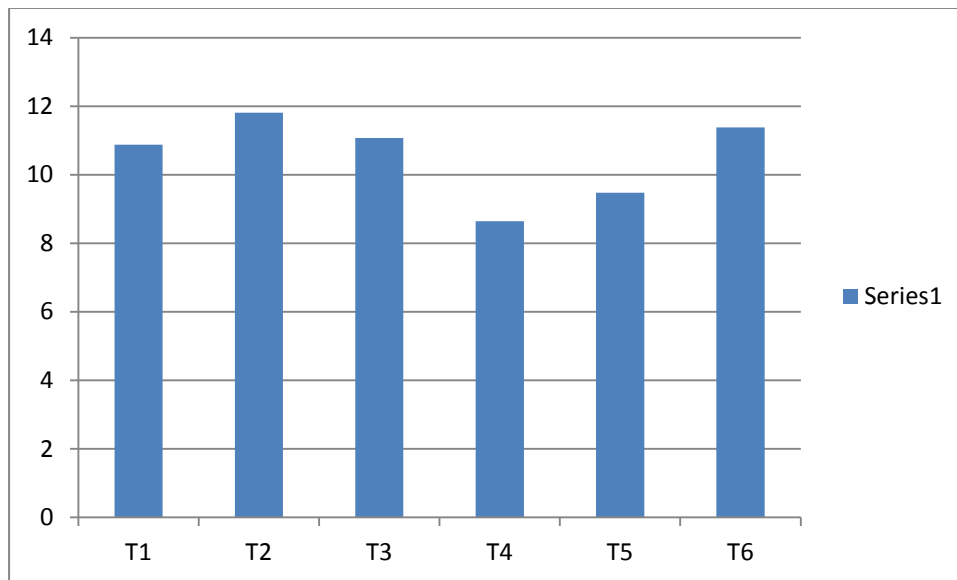
4.9 Diameter of root stock 120 days

The data is presented in Table 8. The maximum diameter of root stock 30 days was found in T4 (Langra) 9.61 followed by T6 (Malta) 9.16, T1 (Dushehri) 9.13 which was significant than other varieties T3 (Surkha) 8.86, T2 (Amarpali) 8.23 , T5 (Fazali) 8.07. and other were significantly at par the highest and lowest was found in T4 (Langra) and T5 (Fazali).

The research worker have also reported the observation, Mishra (2012) conducted on experiment to study the effect of scion length, duration of defoliation and poly tube capping on success of wedge grafting in mango cv. Dashehari was conducted at Horticulture Farm, Department of Horticulture, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.) during the year 2011-2012 in kharif and rabi season. The result on individual effects indicated that 21 cm scion length significantly increased early sprouting, sprout length, number 12 of leaves per graft, plant height, higher establishment and survival percentage followed by 18 cm length of scion. In case of defoliation duration, 8 days duration performed best in all the growth characters. Ram and Bist (1982) conducted an experiment to determine the effect of defoliation, diameter of scion and grafting time in mango. They used 5 to 6.5 mm large scion shoots of mango cv. Dashehari, defoliated 15 days before, or immediately before grafting.

4.9 table

	Diameter of root stock 120 days
Treatment	Mean
Dashehri	9.130
Amrapalli	8.237
Surkha	8.867
Langra	9.610
Fazli	8.077
Malta	9.163
CD	0.728
SE(m)	0.228
SE(d)	0.322
CV	4.463



4.9 graph

4.10 Diameter of scion after 30 days

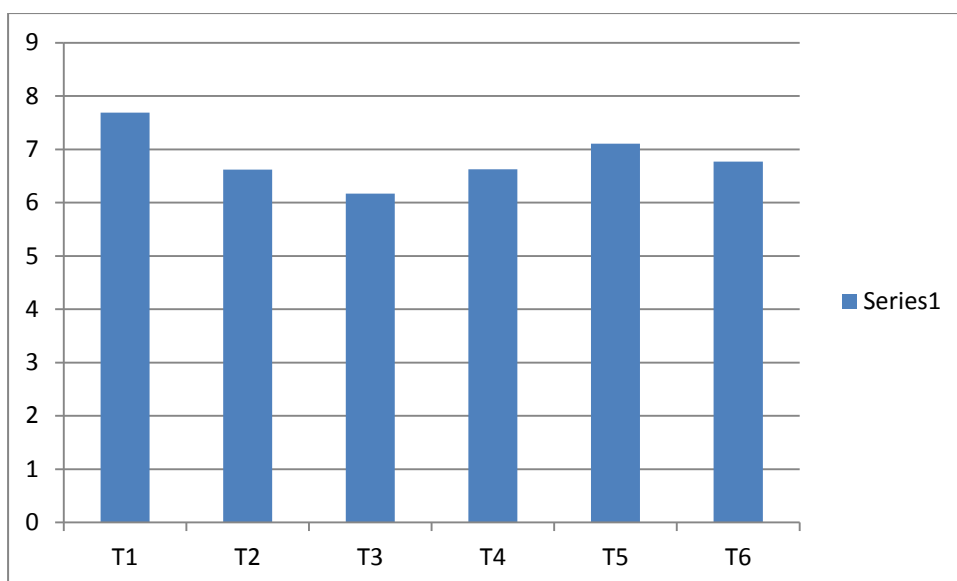
The data is presented in Table 9. The maximum Diameter of scion after 30 days found in T1 (Dusherri) 7.68 followed by T5 (Fazali) 7.10 T6 (Malta) 6.76 T2 (Amarpali) are the treatment significant and T4 (Langra) 6.62 T3 (Surkha) 6.16 but the other value are

significantly at par. The lowest diameter was found in T3 (Surkha) 6.16 and the highest value was found in T1 (Dusherri) 7.68.

The research worker have also reported the observation Radhamony *et. al.*,(1989) studied The cultivars Priur and Banganapally gave the highest percentage of scion growth, which continued to grow (84% in both cases). Use of 8 cm long scions gave the best results. The lowest survival (12-22%) was observed in the cultivar Mulgoa. Reddy and Melanta (1989) conducted They recorded highest percentage grafting success (90%) was obtained with Dashehari and Totapuri scions with both container grown and in-situ grown rootstocks.

4.10 table

	Diameter of scion 30 days
Treatment	Mean
Dashehri	7.687
Amrapalli	6.620
Surkha	6.167
Langra	6.623
Fazli	7.107
Malta	6.767
CD	0.425
SE(m)	0.133
SE(d)	0.189
CV	3.381



Graph 4.10

4.11 Diameter of scion after 60 days

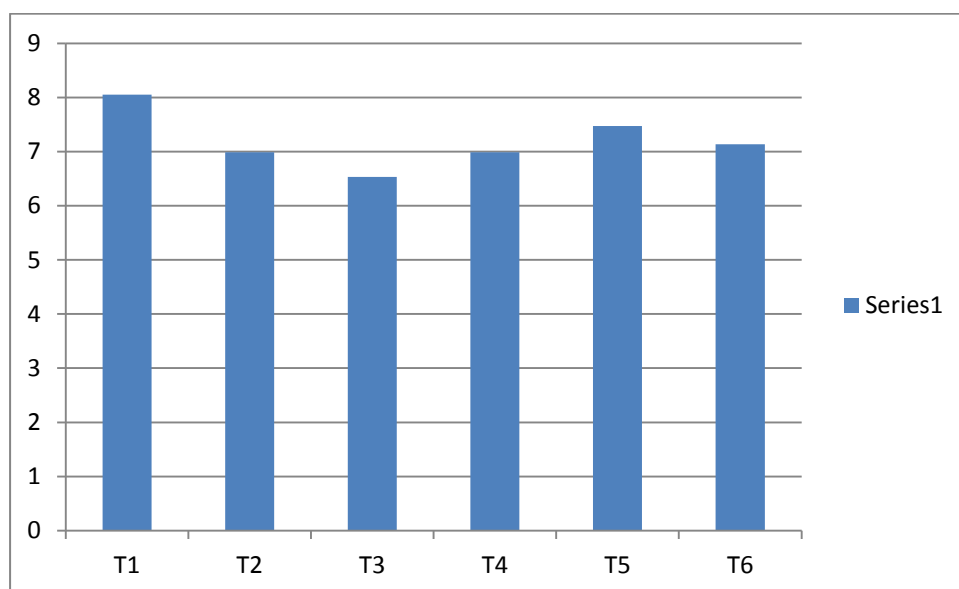
The data is presented in Table 10. The maximum Diameter of scion after 30 days found in T1 (Dusherri) 8.05 followed by the other treatment are significantly at par T5 (Fazali) 7.47 T6 (Malta) 7.13 T4 (Langra) 6.99, T2 (Amarpali) 6.98 and T3 (Surkha) 6.53

The research worker have also reported the observation Prasad *et. al.*,(1990) studied certain aspects of veneer grafting in mango (*Mangifera indica* L.) cv. Banganapally in Tirupati they recorded that the Precured scions gave higher success (78.96%) than non-precured scions (52.75%). Success was highest (71.08%) with 100 days old scions and lowest (62.67%) with 120 days old scions. Kumar *et. al.*,(2000) success of veneer and cleft grafting at different grafting heights of seedling rootstocks in Dashehari mango at Pantnagar. They obtained highest success (100%) in both veneer and cleft grafting methods. High success in veneer and cleft grafting (>85%) of mango was recorded when Dashehari scions were grafted at higher grafting heights (75 and 100 cm) on seedling rootstock and both the grafting methods were equally successful.

4.11 table

	Diameter of scion 60 days
Treatment	Mean
Dashehri	8.053
Amrapalli	6.987

Surkha	6.533
Langra	6.990
Fazli	7.473
Malta	7.133
CD	0.516
SE(m)	0.162
SE(d)	0.229
CV	3.893



4.11 graph

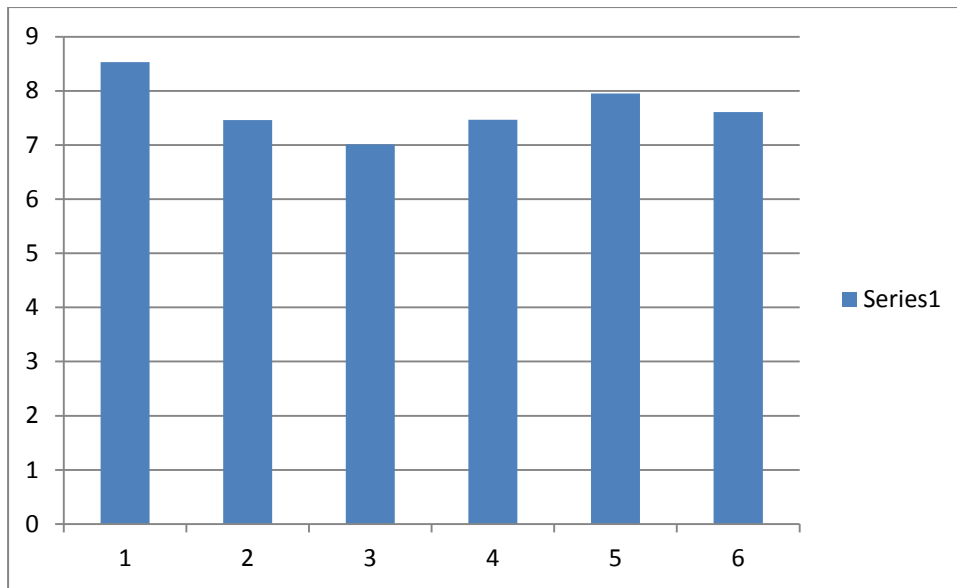
4.12 Diameter of scion after 90 days

The maximum Diameter of scion after 90 days found in T2 (Amarpali) T4 (Langra) showed the equal diameter as 7.46. While T1 (Dusherri) recorded the highest diameter 8.53 T5 (Fazali) 7.95 T6 (Malta) 7.61 T3 (Surkha) 7.01. The data is presented in Table 10.

The research worker have also reported the observation Gurudutta *et. al.*,(2004) conducted an experiment on 4 mango cultivars Langra, Dashehari, Amrapali and Mallika to see the response on eicotyl grafting in mango at Raipur, Chhattisgarh. Six months after grafting, Dashehari showed vigorous nature and recorded the highest values for scion length and height of new graft, while Mallika recorded the highest scion girth compared with the other cultivars. Alam *et. al.*,(2006) studied the effect of length and variety of scion in stone grafting of mango in Bangladesh. They recorded maximum number of successful grafts (66.67%) with cultivar Langra grafted on 15 days old seedlings followed by the same variety grafted on 20 days old seedlings (53.33%).

4.12 table

	Diameter of scion 90 days
Treatment	Mean
Dashehri	8.530
Amrapalli	7.463
Surkha	7.010
Langra	7.467
Fazli	7.950
Malta	7.610
CD	0.831
SE(m)	0.260
SE(d)	0.368
CV	5.875



4.12 graph

4.13 Diameter of scion after 120 days

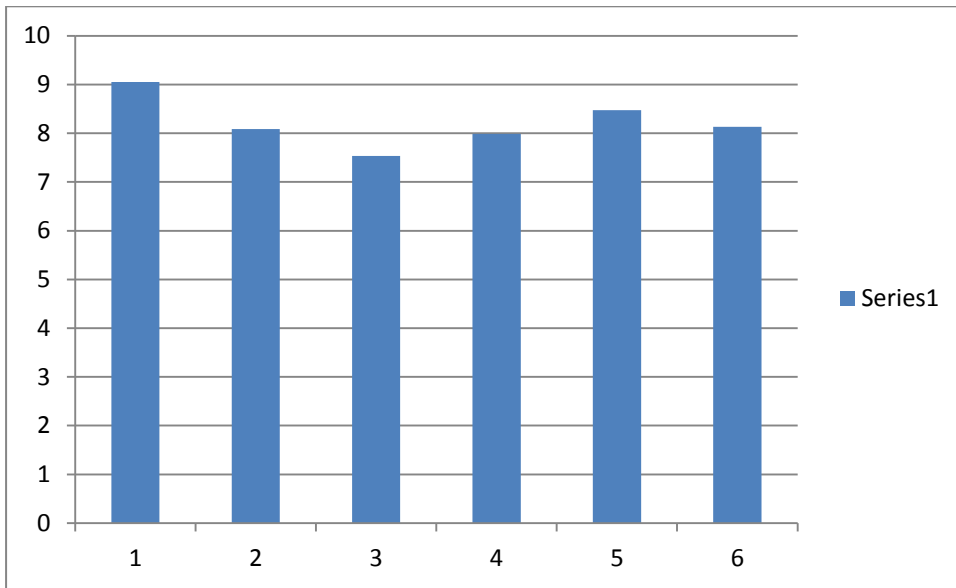
The maximum Diameter of scion after 120 days found in T1 (Dusherri) 9.05 followed by T5 (Fazali) 8.47, T6 (Malta) 8.13 T4 (Langra) 7.99 T3 (Surkha) 7.53 and T2 (Amarpali) 8.08 The data is presented in Table 10.

The research worker have also reported the observation Ram and Bist (1982) conducted an experiment to determine the effect of defoliation, diameter of scion and grafting time in mango. They used 5 to 6.5 mm large scion shoots of mango cv. Dashehari, defoliated 15 days before, or immediately before grafting. They performed veneer grafting on mango seedlings on the 15th day of each month between January to August. Islam (2013) at Bangladesh Agricultural University during the period from October, 2012 to March, 2013 to investigate the effect of scion diameter on the success, survivability and growth of grafts in three varieties of mango. In respect to scion diameter, the less time required for bud breaking (9.53 days) and leaf opening (15.19 days) with higher graft height (57.35cm), number of leaves (8.33), graft success (56.67%) and survivability (53.34%) were observed in thic sized

scion while thin sized scion required the higher time for bud breaking (11.08 days) and leaf opening (19.85 days) with the lower graft height (54.96cm), number of leaves (5.67), graft success (48.89%) and survivability (44.45%). Mishra (2012) conducted an experiment to study the effect of scion length, duration of defoliation and poly tube capping on success of wedge grafting in mango cv. Dashehari was conducted at Horticulture Farm, Department of Horticulture, College of Agriculture, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.) during the year 2011-2012 in kharif and rabi season.

4.13 table

	Diameter of scion 120 days
Treatment	Mean
Dashehari	9.053
Amrapalli	8.083
Surkha	7.533
Langra	7.990
Fazli	8.473
Malta	8.133
CD	N/A
SE(m)	0.289
SE(d)	0.408
CV	6.093



4.13 graph

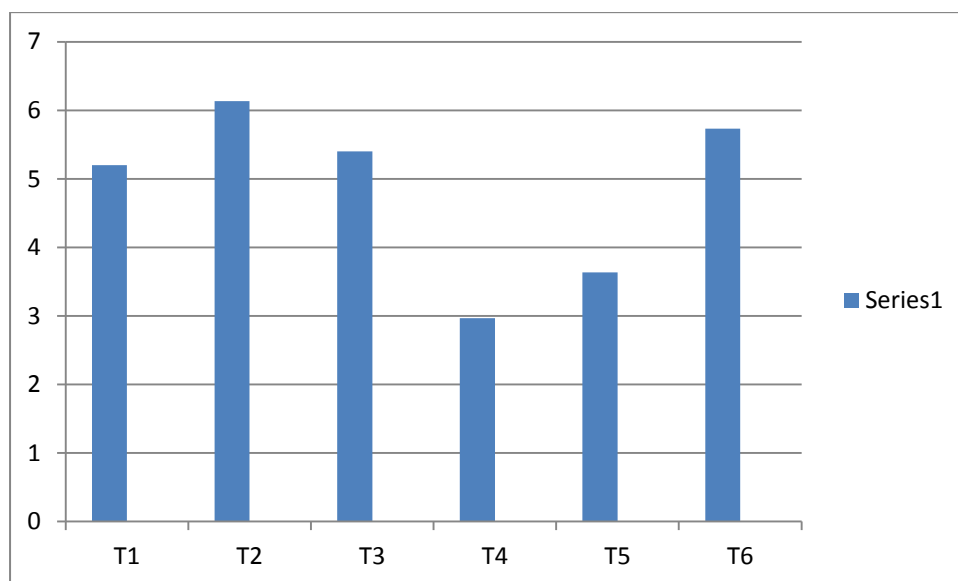
4.14 Number of leaves after 30 days

The data presented in Table 11. The maximum number of leaves was recorded in T2 (Amarpali) 6.13 followed by T6 (Malta) 5.73 T3 (Surkha) 5.40 T1 (Dushehari) 5.20 are highly significant and T5 (Fazali) 3.63 T4 (Langra) 2.96. The highest number of leaves was recorded in T2 (Amarpali) 6.13 and lowest leaves was found in T4 (Langra) 2.96.

The research worker have also reported the observation Jana (2007) conducted a study to determine the response of various mango cultivars to top-veneer grafting .The maximum leaf number were analyzed in Tommy Atkins (26.95) and Amrapalli (2.36), respectively Kudmulwar *et. al.*,(2008) performed grafting under Parbhani condition using local variety rootstock of custard apple (*Annona squamosa* L.) with Balanagar scion and reported the highest number of leaves (21.93) in plants produced after grafting.

4.14 table

	No.of leaves after 30 days
1Treatment	Mean
Dashehri	5.200
Amrapalli	6.133
Surkha	5.400
Langra	2.967
Fazli	3.633
Malta	5.733
CD	1.281
SE(m)	0.401
SE(d)	0.568
CV	14.349



4.14 graph

4.15 Number of leaves after 60 days

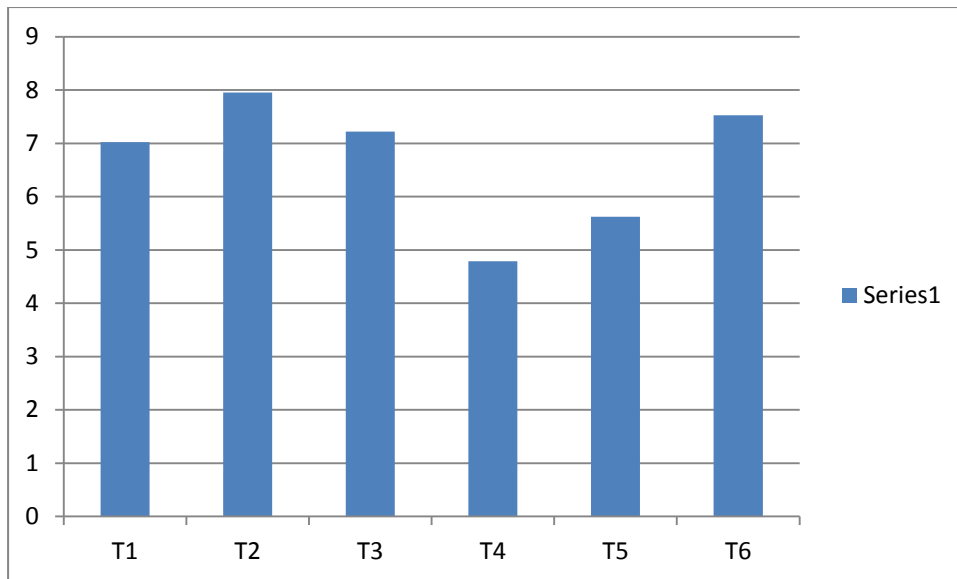
The maximum number of leaves was recorded in T2 (Amarpali) 7.95 followed by T6 (Malta) 7.52 T3 (Surkha) 7.22 T1 (Dushehari) 7.02 are highly significant and T5 (Fazali)

5.62 T4 (Langra) 4.78. The highest number of leaves was recorded in T2 (Amarpali) and lowest leaves was found in T4 (Langra) . The data presented in Table 12.

The research worker have also reported the observation Ram *et. al.*,(2012) recorded the maximum number of leaves on Amrapali scion at 30 and 60 days after stone grafting on different cultivars of mango under Lucknow conditions. Kalalbandi *et. al.*,(2014) reported that the maximum number of leaves was recorded (14.44) in Kalipatti variety of sapota grafted on Khirni rootstock under Marathawada conditions.

4.15 table

	No of leaves after 60 days
Treatment	Mean
Dashehri	7.020
Amrapalli	7.953
Surkha	7.220
Langra	4.787
Fazli	5.623
Malta	7.523
CD	1.410
SE(m)	0.442
SE(d)	0.625
CV	11.443



4.15 graph

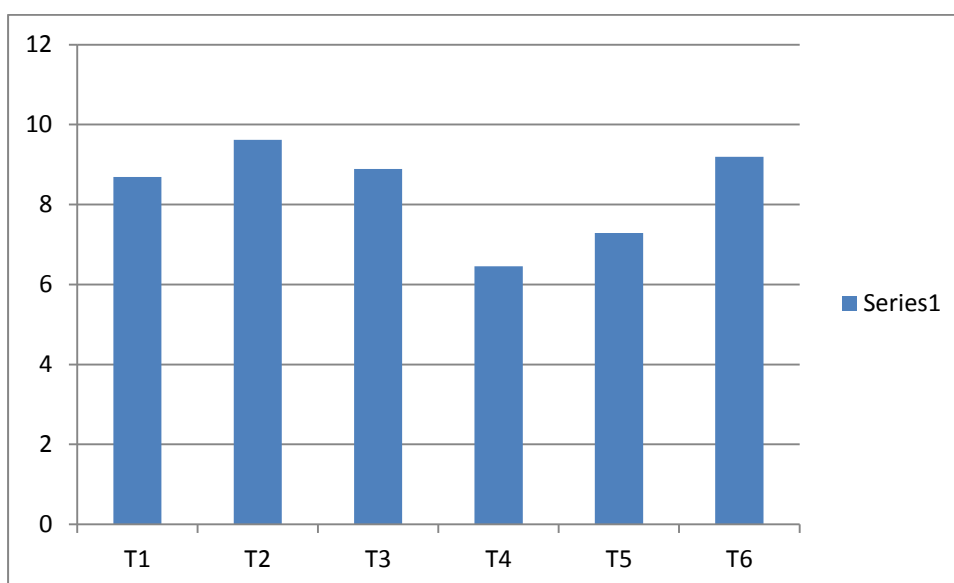
4.16 Number of leaves after 90 days

The data presented in Table 13. The maximum number of leaves was recorded in T2 (Amarpali) 9.62 followed by T6 (Malta) 9.19 T3 (Surkha) 8.88 T1 (Dushehari) 8.68 are highly significant and T5 (Fazali) 7.29 T4 (Langra) 6.45. The highest number of leaves was recorded in T2 (Amarpali) and lowest leaves was found in T4 (Langra).

The research worker have also reported the observation Gangwar *et. al.*,(2003) studied the compatibility behaviour of a plum rootstock with peach scions. They reported that the maximum leaf area was recorded in Flordasum and Kala Amritsari graft combination. Shaban (2010) conducted an experiment on comparative study of some polyembryonic mango rootstocks. Sukkary, Zebda, Sabre and 13-1 rootstocks were used for grafting. Cultivars of mango like Zebda, Ewais and Keitt were grafted on Sukkary, Zebda, Sabre and 13-1 rootstocks. The maximum leaf area was recorded (86.8 cm²) in plants produced by grafting of Keitt grafted on Zebda rootstock.

4.16 table

	No of leaves after 90 days
Treatment	Mean
Dashehri	8.687
Amrapalli	9.620
Surkha	8.887
Langra	6.453
Fazli	7.290
Malta	9.190
CD	1.422
SE(m)	0.445
SE(d)	0.630
CV	9.236



4.16 graph

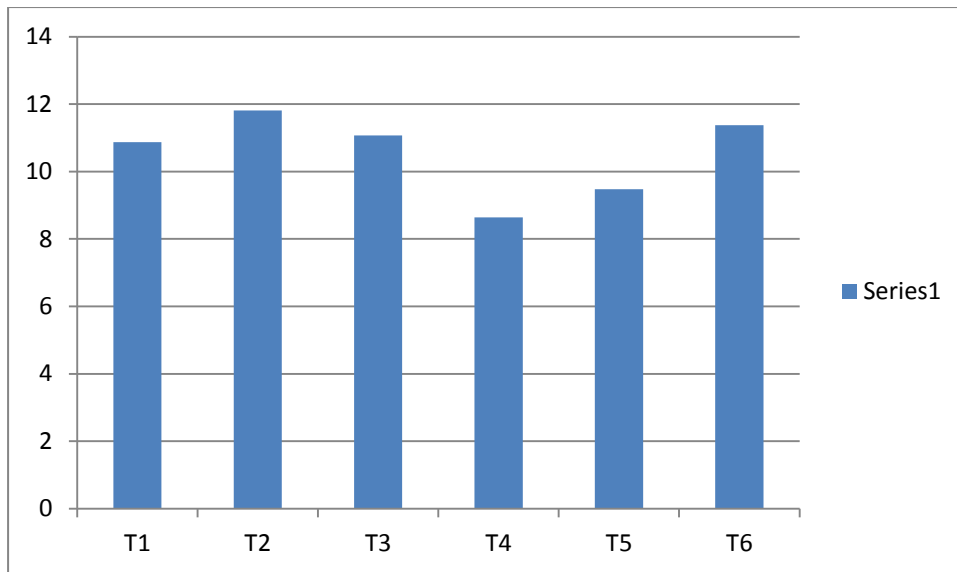
4.17 Number of leaves after 120 days

The maximum number of leaves was recorded in T2 (Amarpali) 11.80 followed by T6 (Malta) 11.37 T3 (Surkha) 11.07 T1 (Dushehari) 10.87 are highly significant and T5 (Fazali) 9.47 T4 (Langra) 8.64. The highest number of leaves was recorded in T2 (Amarpali) and lowest leaves was found in T4 (Langra) . The data presented in Table 14.

The research worker have also reported the observation Verma *et. al.*,(2010) stated that grape cultivar Pusa Urvashi was grafted on different rootstocks viz., Pusa Navrang, Dogridge A, SO4, H-144. The maximum leaf area was recorded (1.43 cm²) in plants produced by Pusa Uravashi grafted on H-144. Niranjan Singh *et. al.*,(2014) reported that the maximum leaf length was recorded (17.12 cm) in plants of Amrapali grafted on local variety rootstock under Kanpur conditions.

4.17table

	No of leaves after 120 days
Treatment	Mean
Dashehri	10.873
Amrapalli	11.807
Surkha	11.073
Langra	8.640
Fazli	9.477
Malta	11.377
CD	1.381
SE(m)	0.433
SE(d)	0.612
CV	7.111



4.17 Graph

Chapter 5

Summary and Conclusion

The present investigation entitled “Standarazation of suitable graft combination in subtropical condition of Punjab ” was conducted at Farmers Field in Dhariwal Gurdaspur Punjab by the student of Lovely Professional University, Jalandhar in the period 2016-2017 with the following objectives:

1. To assess the performance of self graft combinations of Dashehari, Langra, Amrappali, Malta, Surkha and Fazli for morphological traits
2. To study the factors influencing the growth and development of elite self graft combinations of mango and
3. To analyze the impact of environment on performance of self grafted mango cultivars.

The observations recorded on various aspects during the study are briefly discussed in this chapter. Some analysis on parameter are noted in nursery while rest of observations are recorded in main field. For that root stock of one year was taken first of all stones of mango were raised in nursery condition then these rootstocks are taken and operation of grafting is performed in nursery in month of August. The experiment was laid out in Randomized Block Design with 6 treatment combinations. In each block about five plants are planted with three replications. The parameter like number of days to sprout was recorded in nursery and other rest of parameter were analyzed under field condition by planting in main field. Observations were taken as 30, 60, 90, 120 days. The main objective to discover that which cultivar shows higher success after grafting in terms of diameter of scion, diameter of root stock, height of root stock, height of scion etc.

The minimum number of days for sprout was found in Treatment 3 (Surkha) (16.10 DAS) followed by Treatment 5 Fazali (17.16 DAS). The maximum height of Root Stock was reported in the T5 (22.23) (Fazali) which was followed by Treatment 4 (Langra) (21.60 cm) treatment 2 (Amarpali). The maximum diameter of root stock 30 days was found in T4 (Langra) 9.61 followed by T6 (Malta) 9.16, T1 (Dushehri) 9.13 which was significant than other varieties. The maximum Diameter of scion after 120 days found in T1 (Dusherri) 9.05 followed by T5 (Fazali) 8.47, T6 (Malta) 8.13. The maximum number of leaves was recorded in T2 (Amarpali) 6.13 followed by T6 (Malta) 5.73 T3 (Surkha) 5.40. The research shows that treatment surkha shows higher survival rate of graft and it takes minimum days to develop a new scion then all other varieties. This investigation that this variety is most compatible to graft in August by using side veneer graft.

SUGGESTIONS FOR FUTURE RESEARCH WORK

On the basis of the experience gained and results obtained, following suggestions are made for future line of work

1. The experiment should be conducted during different season also to see its effectiveness during different season
2. Treatment with different grafting time and grafting methods for different region needs more focus to cultivate mango successfully.
3. The response of different mango varieties to grafting time and grafting methods may further be studied under different agro-ecological.

References

- Abbasi, N. A., Hafiz, I. A., Qureshi, A. A., Ali, I., & Mahmood, S. R. (2014). Evaluating the success of vegetative propagation techniques in loquat cv. mardan. *Pak. J. Bot*, 46(2), 579-584.
- Adiga, J. D., Kalaivanan, D., Meena, R. K., & Mohana, G. S. (2014). Performance of Vigorous Cashew Cultivars as Influenced by Dwarf Rootstocks. *Vegetos-An International Journal of Plant Research*, 27(2), 233-239.
- Alam, M. A., Islam, M. S., Uddin, M. Z., Barman, J. C., & Quamruzzaman, A. K. M. (2006). Effect of age of seedling and variety of scion in stone grafting of mango. *International Journal of Sustainable Crop Production*, 1(2), 27-32

- Aloni, B., Cohen, R., Karni, L., Aktas, H., & Edelstein, M. (2010). Hormonal signaling in rootstock–scion interactions. *Scientia Horticulturae*, 127(2), 119-126.
- Baita, H., A. Manga, and Y. Mustapha. 2010. Evaluation of different morphotypes of mango (*Mangifera indica* L.) for use as rootstock in seedlings production. *Bayero Journal of Pure and Applied Sciences*, 3(1): 87-92.
- Banik, M. (2014). Effect of scion wood maturity and time on the grafting success survivability and growth of BAU-3 lemon (Doctoral dissertation)
- Bhadra, R. C. (2012). Effect of Off-season and Variety on the Grafting Success and Survivability of Carambola (Doctoral dissertation).
- Bally ISE (2006) *Mangifera indica* (mango) Anacardiaceae (cashew family). Species Profiles for Pacific Island Agroforestry www.traditionaltree.org. Accessed on 20 April, 2009
- Bhuiyan, M. F. A., Rahim, M. A., & Alam, M. S. Study on the growth of plants produced by epicotyl (stone) grafting with different rootstock-scion combinations in mango.
- Bharad, S. G., Rajput, L., Gonge, V. S., & Dalal, S. R. (2006). Studies on time and method of vegetative propagation in Jamun. In Proceedings of the national symposium on production, utilization and export of underutilized fruits with commercial potentialities, Kalyani, Nadia, West Bengal, India, 22-24 November, 2006 (pp. 96-99). Bidhan Chandra Krishi Viswavidyalaya
- Barfod, A. 1988. Inflorescence morphology of some South American Anacardiaceae and possible phylogenetic trends. *Nordic J. Bot.* 8:3–11
- Chandan, P. M., Kadam, J. H., & Ambad, S. N. (2006). Effect of different polyembryonic and monoembryonic rootstocks on performance of Dashehari mango. *International J Agric. Sci*, 2(2), 594-595.
- Chien, P. J., Sheu, F., & Yang, F. H. (2007). Effects of edible chitosan coating on quality and shelf life of sliced mango fruit. *Journal of Food Engineering*, 78(1), 225-229.
- Chattopadhyay, N. C., & Nandi, B. (1976). Peroxidase and polyphenol oxidase activity in malformed mango inflorescence caused by *Fusarium moniliforme* var. *subglutinans*. *Biologia Plantarum*, 18(5), 321-326.

- Dolgun, O., Yıldırım, A., Polat, M., Yıldırım, F., & Aşkın, A. (2009). Apple graft formation in relation to growth rate features of rootstocks. *African Journal of Agricultural Research*, 4(5), 530-534.
- Errea, P., Felipe, A., & Herrero, M. (1994). Graft establishment between compatible and incompatible *Prunus* spp. *Journal of Experimental Botany*, 45(3), 393-401.
- Gangwar, D., Arora, R. L., & Gaur, G. S. (2003, October). Compatibility Behaviour of Plum Rootstocks with Peach Scions. In VII International Symposium on Temperate Zone Fruits in the Tropics and Subtropics-Part Two 696 (pp. 177-180).
- Gurudutta, P. S., Jain, V., & Sahu, G. (2012). Effect of Varieties and Length of Scions on Sprouting of Grafts and Days taken for Sprouting in Mango (*Mangifera indica* L.). *Indian Horticulture Journal*, 2(1and2), 34-35.
- Gurudutta, P.S., Jain, V.,and Singh,P.N. 2004. Response of mango cultivars to grafting. *Indian J. Hort.*, 61 (3): 267
- Geetha, T.K.,Valsalakumari, P.K.,Geetha, C.K., Rajeevan, P.K. 1997. Influence of polyembryonic rootstocks on the success and survival of soft wood grafts on mango. *Journal of Applied Horticulture Navsari*. 3 (1/2): 85-88.
- Gurudutta, P. S., Jain, V., & Singh, P. N. (2012). Establishment of Grafts and its Survival in Mango (*Mangifera indica* L.). *Indian Horticulture Journal*, 2(1and2), 46-47.
- Harshavardhan, A., Rajasekhar, M., & Reddy, P. S. S. Effect of Condition, Variety, Method of Grafting in Different Months on Days Taken for Sprouting of Jackfruit (*Artocarpus heterophyllus* Lam.) Grafts.
- Islam, Rafikul.2013. Effect of scion diameter on the grafting success, survivability and growth of different mango varieties, M.Sc. Thesis, Bangladesh Agriculture University, Bangladesh
- Islam, M.N., Rahim, M.A. Naher, M.N.A., Azad, M.I. and Shahjahan, M. 2004. Effect of time of operation and age of rootstock on the success of inserted contact grafting in mango. *Asian Journal of Plant Sciences*, 3(5): 636-641.
- Jana, B.R. 2007. Response of different mango cultivars to top-veneer grafting. *Journal of Research Birsa Agricultural University*, 19(1): 91-94.

- Kumar,S., Sant Ram and Singh,C.P. 2000. Success of veneer and cleft grafting at 67 different grafting heights of seedling rootstocks in Dashehari mango. *Indian Journal of Horticulture*, 57 (3): 212-214
- Kumar, Prabhat and Thakur, Nidhika. 2012. Effect of age of rootstock and different growing media on the success of stone grafting in mango. *International Journal of Farm Science* 6 (1) : 255-261.
- Kudmulwar, R. R., Kulkarni, R. M., Bodamwad, S. G., Katkar, P. B., & Dugmod, S. B. (2008). Standardization of soft wood grafting season on success of custard apple (*Annona squamosa* L.). *Asian Journal of Horticulture*, 3(2), 281-282.
- Kalalbandi, B. M., Ziauddin, S., & Shinde, B. N. (2014). Effect of time of soft wood grafting on the success of sapota grafts in 50% shadenet under Marathwada conditions. *Agricultural Science Digest-A Research Journal*, 34(2), 151-153
- Karim, M. R. (2004). Effect of leaf and node retention in rootstock on epicotyl grafting in mango. M. Sc.(Ag.) thesis, Hort. Dept. BAU, Mymensingh, 30-53.
- Karimi, H. R., & Nowrozy, M. (2017). Effects of rootstock and scion on graft success and vegetative parameters of pomegranate. *Scientia Horticulturae*, 214, 280-287.
- Lee, J. M., & Oda, M. (2010). Grafting of herbaceous vegetable and ornamental crops. *Horticultural Reviews*, Volume 28, 61-124.
- Malhotra, S. K. (2017). Horticultural crops and climate change: A review. *INDIAN JOURNAL OF AGRICULTURAL SCIENCES*, 87(1), 12-22.
- Mng'omba, S. A., du Toit, E. S., & Akinnifesi, F. K. (2008). The relationship between graft incompatibility and phenols in *Uapaca kirkiana* Müell Arg. *Scientia horticulturae*, 117(3), 212-218.
- Mng'omba, S.A., Akinnifesi, F. K., Sileshi, G., & Ajayi, O. C. 2010. Rootstock growth and development for increased graft success of mango (*Mangifera indica*) in the nursery. *African Journal of Biotechnology*, 9(9): 275-284.
- Munde, G.R., Hingole, D. G. and Jahagirdar, J. E. 2011. Effect of single and double rootstock on grafting success in mango. *International Journal of Plant Protection*, 4(2): 330-332.

- Murti, G. S. R., & Upreti, K. K. (2003). Endogenous hormones and phenols in rootstock seedlings of mango cultivars and their relationship with seedling vigour. *European Journal of Horticultural Science*, 2-7. .
- Mandal, Jagannath, Kumar, Bipul, Singh, R.R. and Jaiswal, U.S. 2012. Effect of grafting height and cultivars on the performance of soft wood grafting in mango, *Asian J. Hort.*, 7 (1) : 171-174.
- Mishra, Poonam, 2012. Effect of scion length, duration of defoliation and polytube capping on success of wedge grafting in mango cv. Dasherari. M.Sc. (Ag.) Thesis, IGKV, Raipur
- Munde, G. R., Hingole, D. G., & Jahagirdar, J. E. (2011). Effect of single and double rootstock on grafting success in mango. *International Journal of Plant Protection*, 4(2), 330-332.
- Majumder, P.K., Mukherjee, S.K. and Rathore, D.S. 1972. Further researches on propagation techniques in mango. *Acta Hort.*24: 72-73.
- Nalage, N.A., Bhosale, S.S., Magar, S.D., Ghadge, P.U. and Mhetre, D.A. 2010. The effect of length of scion stick on success of epicotyl grafting in mango (*Mangifera indica* L.) cv. Kesar. *Asian Journal of Horticulture*, 5(2): 506-509.
- Nayak, G., Sen, S.K. 2000. Seasonal influence of veneer grafting of mango (*Mangifera indica* L.). *Environment and Ecology*, **18** (1): 156-158
- Pandey, V., Niranjana, A., Atri, N., Chandrashekhar, K., Mishra, M. K., Trivedi, P. K., & Misra, P. (2014). WsSGTL1 gene from *Withania somnifera*, modulates glycosylation profile, antioxidant system and confers biotic and salt stress tolerance in transgenic tobacco. *Planta*, 239(6), 1217-1231.
- Patil, S. D., Swamy, G. S. K., Kumar, H. S. Y., Thammaiah, N., & Kumar, P. (2008). Effect of different mango rootstocks on success of softwood grafting. *Asian Journal of Horticulture*, 3(2), 389-390.
- Prasad, P.V., Suryanarayana, V. and Naidu, N. 1990. Studies on certain aspects of veneer grafting in mango (*Mangifera indica* L.) cv. Banganapally. *South Indian Horticulture* **38** (1): 1-7

- Pawar, P. P., Bhosale, S. S., Gavali, A. V., & Yadav, D. B. (2016). World Mango Trade and Opportunities for India. *Indian Journal of Agricultural Economics*, 71(3), 310.
- Prasanth, J. M., Reddy, P. N., Patil, S. R., & Pampanagouda, B. (2007). Effect of cultivars and time of softwood grafting on graft success and survival in mango. *Agricultural Science Digest*, 27(1), 18-21
- Pina, A., & Errea, P. (2005). A review of new advances in mechanism of graft compatibility–incompatibility. *Scientia Horticulturae*, 106(1), 1-11.
- Parvin, N. (2014). Effect of scion wrapping system and time of grafting operation on success, growth and survivability of mango grafts (Doctoral dissertation).
- Patel, R. K., Babu, K. D., Singh, A., Yadav, D. S., & De, L. C. (2010). Soft wood grafting in Mandarin (*C. reticulata* Blanco): A novel vegetative propagation technique. *International Journal of Fruit Science*, 10(1), 54-64.
- Radha, T. and K. Aravindakshan. 1999. Differential response of mango varieties to epicotyl grafting on coRadhamony, P. S., Gopikumar, K. and Valsalakumari, P. K. 1989. Varietal response of scion to stone grafting in mango for commercial propagation. *South Indian Hort.* 37 (5): 298-299.
- Ram, S., Bist, L.D. 1982. Studies on veneer grafting of mango in Tarai. *Punjab Horticultural Journal*, 22 (1/2): 64-71. mmercial scale. In: VI International Symposium on Mango, 509:265-268.
- Ram, R.B., Kumar, D., Sonkar, P., Lata, R., and Meena, M. L. 2012. Standardization of stone grafting in some mango cultivars under Lucknow conditions. *Hort Flora Research Spectrum*, 1(2): 165-167.
- Rajan, S., Yadava, L. P., Kumar, R., & Saxena, S. K. (2009). Genetic divergence in mango varieties and possible use in breeding. *Indian J. Hort*, 66(1), 7-12.
- Reddy, C.V. and Melanta, K.R. 1989. Effect of different scion varieties on the success of softwood grafting of mango in relation to phenols content. *Mysore Journal of Agricultural Sciences*, 23 (3): 341-343.

- Sivudu, B. V., Reddy, M. L. N., Baburatan, P., & Dorajeerao, A. V. D. (2014). Effect of structural conditions on veneer grafting success and survival of mango grafts (*Mangifera indica* cv. Banganpalli). *Plant Arch*, 14, 71-75.
- Singh, N., Tripathy, S. M., & Ghumare, V. (2014). Studies on growth and survival of stone grafts as influenced by age of seedling rootstock in mango (*Mangifera indica* L.) cv. Amrapali. *Journal of Applied and Natural Science*, 1(6), 716-719.
- Shaban, A. E. A. (2010). Comparative study on some polyembryonic mango rootstocks. *American-Eurasian Journal of Agricultural and Environmental Science*, 7(5), 527-534.
- Sabeky, E. (2005). Study and Determenation of the Best Time and Method for Mango Grafting in Bahokalate, Sistan Balouchestan Province. *JWSS-Isfahan University of Technology*, 9(1), 91-101.
- Sivudu, B. V., Reddy, M. L. N., Dorajeerao, A. V. D., & Hussain, S. F. Seasonal variation in success of veneer grafting of mango under Andhra Pradesh (India) conditions.
- Singh, N. P. and Srivastava, R. P. 1980. A new approach towards double grafting in mango. *Current Sci.*,49 (17): 678-679 Singh, Niranjana, Tripathi S.M. and Gumare, Vikas, 2014. Studies on growth and survival of stone grafts as influenced by age og seeding rootstock in mango cv. Amrapali
- Singh. Lal Behari, 1954. Propagation of mango by air-layering for rootstock, *Proc. 70 Amer. Soc. Hortic. Sci.* 63 : 128-130. Singh, R.N. 1960. Studies in the differentiation and development of fruit buds in mango (*Mangifera indica* L.) IV. Periodical changes in the chemical composition of shoots and the relation with fruit bud differentiation. *Indian Journal Horticulture* 4:48.
- Verma, S. K., Singh, S. K., Krishna, H., & Patel, V. B. (2012). Comparative performance of different grafting techniques in grape cv. Pusa Urvashi. *Indian Journal of Horticulture*, 69(1), 13-19.
- Viéitez, F. J., & Merkle, S. A. (2005). 9.1 *Castanea* spp. Chestnut. General Editor: Gabrielle J. Persley, The Doyle Foundation, Glasgow, Scotland., 265.

Zarrouk, O., Testillano, P. S., Risueño, M. C., Moreno, M. Á., & Gogorcena, Y. (2010). Changes in cell/tissue organization and peroxidase activity as markers for early detection of graft incompatibility in peach/plum combinations. *Journal of the American Society for Horticultural Science*, 135(1), 9-17

Agro Metrological Data

Month	Temperature		Humidity		RF mm
	AT.MAX(°C)	AT.MIN(°C)	RH.(M%)	RH.(E%)	
June -2016	37.6	25.6	69.92	51.86	253.2
July-16	33.5	25.9	86.92	75.09	234.2
August -16	32.8	24.9	86.24	70.69	194.5
Sept-16	33.1	24.2	87.45	70.47	63.3
Oct-16	32.1	18.3	81.34	55.22	0.1
Nov-16	26.4	11.6	81.03	58.74	1.0
Dec-16	21.8	8.5	88.93	65.83	0.0
Jan-2017	17.9	7.5	69	69	111.4

Agro metrological data of location of research work Dhariwal district Gurdaspur Punjab during June 2016 to January 2017 data provided by Regional Research Station of PAU, Gurdaspur.