STANDARDIZATION OF MODIFIED INARCHING IN MANGO, SAPOTA AND CASHEW

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MASTER OF SCIENCE IN AGRICULTURE
(HORTICULTURE)

BY

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1992

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CERTIFICATE

This is to certify that the thesis entitled **"Standardization of modified inarching in mango, sapota and cashew"** submitted in the partial fulfilment of the requirements for the degree of **Master of Science (Agriculture)** in the subject **Horticulture** to the Orissa University of Agriculture and Technology, Bhubaneswar, is a faithful record of bona fide and original research work carried out by **Sri Babaji Charan Sahu** under my guidance and supervision. No part of the thesis has been submitted for any other degree or diploma. The assistance and help received during the course of investigation have been fully acknowledged.

23/6/93

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23/6/93

CERTIFICATE-II

This is to certify that the thesis entitled **"Standardization of modified inarching in mango, sopata and chashew"** submitted by **Sri Babaji Charan Sahu** to the Orissa Universityof Agriculture and Technology, Bhubaneswar in partial fulfilment of the requirement for the degree of **MASTER OF SCIENCE IN AGRICULTURE** in the subject of **HORTICULTURE** has been approved by the Student's Advisory Committee after an oral examination on the same in collaboration with an External Examiner.

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STANDARDIZATION OF MODIFIED INARCHING IN MANGO, SAPOTA AND CASHEW

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Hanging inarching was done during 1992 in mango cv. Banganpalli and sapota cv. Cricketball using 45 days old mango seedlings and one year old Khirni seedlings packed in polythene bag containing 20 gm moist moss. The grafts were prepared at 5 days interval and detachment was done at a time to get grafts of 20, 25, 30, 35, 40, 45, 50, 55 and 60 days old. The survival was highest with 50 days detachment both in mango and sapota. However, sapota grafts can be detached 40 days onwards to get more than 90% success but not mango. No incompatibility symptom was noticed. Similarly ground inarching was done in cashew in offseason starting from Nov., 1st, 1992 to March, 1993 at monthly interval in cashew cv. 2/15. Highest success was observed with Nov. 1st inarching 93.75% initial survival.

CHAPTER I

INTRODUCTION

INTRODUCTION

Among tropical fruits mango, sapota and cashew are very important. They provide substantial food value as well as good economic return as compared to other fruits. Out of 26.6 million tonnes of fruits produced in India from an area of 2.9 million hectares mango occupies more than 50% area. Fresh and processed mangoes of 21,700 tonnes and 18,922 tonnes respectively were exported from India during 1988-89 and earned more than 45 crores of rupees as foreign exchange (Hindu Survey of Indian Agriculture (1990). In Orissa, mango is grown over an area of 48,000 hectares with a good production. On the other hand, cashew cultivation is increasing day by day and India earns nearly one thousand crores of rupees from cashew export every year. Sapota is an delicious fruit which thrives well in eroded coastal soils under rainfed condition. Recently, sapota has been exported from Gujurat State. Presently, area under mango, sapota and cashew are increasing very slowly. Important constraint in expansion of area in these crops is unavailability of quality planting materials.

At present mango and sapota are propagated by inarching. Both seed and vegetative propagation are used in cashew. Inarching is one of the most easier method in asexual method of plant propagation. To make the grafting time shorter new methods have been tried by Garg (1954), Bharat (1958), Bhan et al. (1969), Maity (1983), Desai and Patel (1984), Maharana et al. (1988), and Maharana and Sahu (1991). Manyothers have tried rapid multiplication methods in mango and sapota. Similarly new techniques have been employed to propagate cashew rapidly and effectively.

The present investigation entitled "Standardization of modified inarching in mango, sapota and cashew" was conducted keeping the following objectives.

1. To find out the effect of time of detachment of mango grafts produced in modified inarching on survival and growth .
2. To find out the time of detachment of sapota grafts produced in modified inarching on survival and growth.
3. To study the effect of time of inarching on survival and growth of cashew graft.

CHAPTER II

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Vegetative propagations are mandatory for multiplication of different economic heterozygous horticultural species. In the present investigation modified inarching method of propagation was studied in mango, sapota and cashewnut. In past, scientist have tried to produce quality grafts in these crops by conducting very useful research. In this chapter literatures from different sources have been collected and presented. The sources of these literatures have been acknowledged properly.

MANGO

Oliver (1911) reported stocks of 15 to 20 cm in height and 3 weeks old were lifted along with cotyledon and roots and wrapped in moist moss and grafted in hanging position. The union completed within 4 to 5 weeks. He concluded that younger root stocks are superior than old root stocks.

Verma (1942) reported that mango stones germinated in moist moss and approach grafted. More than 90% successful grafts were obtained within 10 weeks.

In Kodur research station it was found out that the best inarching time is July to September and root stock of 16.5 months old gave the best result (Naik, 1947).

Singh (1951) reported that grafts on young rootstocks out grow the ordinary grafts after 2-3 years.

Garg (1954) reported cheaper method of inarching by lifting one year root-stock wrapping with moist moss in polythene bag and inarched in hanging position gave good success after 6 weeks.

Rao and Rao (1956) obtained 70% success in inarching when the seedling is lifted and wrapped in polythene pocket before inarching.

Bharath (1958) recommended inarching with 6 weeks old seedlings wrapped with wet moss and tied to the scion. Union was completed within 4 weeks. Both the grafts are to be hardened for one month in partial shade.

Hayes (1960) reported mango grafts can be separated in 2-3 months after inarching but some variety required more than 2 months.

Ram & Sahai (1962) reported rapid multiplication of mango through inarching at Sabour by using one year old potted rootstock. The mother plants planted at 15'-20' distance and trained properly.

Rangacharlu et al. (1962) stated that mango grafts as high as 10,000 can be produced from one acre starting from second year of planting of mother plants.

Teaotia (1962) reported a rapid improved method of mango inarching. Five week old root-stocks were grafted to mother plants in hanging position. These grafts caught up growth after one year of planting.

Nair & Chacko (1962) reported that the best time for inarching in Kerala is July to September, grafts can be separated from mother plants at monthly interval upto 3 months.

FAO (1967) reported that inarching is widely practiced in India for mango propagation but recommended to make it less tidious and inexpensive.

Madhava Rao (1967) advocated for inarching with healthy and vigorous scions at bearing age and he stressed that the rootstock should be 10-12 mm in diameter.

Singh et al. (1967) reported the importance of active growing period of root-stock and sap movement and success in inarching. He concluded that end of monsoon was the suitable period for inarching in heavy rainfall areas of West Bengal and Keral.

Bhan et al. (1969) reported the standardised stone grafting in mango at Horticultural Research Station,

Krishnanagar and they claimed 75-80 per cent success by using germinating seed as root-stock and semimature terminal shoot as a scion.

George & Nair (1969) claimed that polyembroynic root-stocks are superior to monoembroynic root-stock.

Hartmann and Kester (1972) reported that approach grafting provides a successful union in many species.

Tiwari & Rajput (1972) reported that application of 1000 ppm of IBA accelerated callus formation in Veneer grafting in mango.

Singh and Sironi (1972-74) compared inarching, budding, Veneer grafting and marcoting in mango and reported budding is the best method but in inarching stock thickness became superior to budding method.

Gowda (1974) reported that when mango seedlings were raised in coconut husk become ready for airlayering after 2-3 months.

Rao (1975) reported a novel method of grafting the excised scion to the stocks grown in polybags. The end part of scion was maintained in water held in an separate polybag.

Singh & Srivastav (1980) tried several methods of mango propagation and the best result of 84% was obtained with inarching and softwood grafting during July.

Chakrabarty & Sadhu (1983) reported that graft success was more or less uniform in June, July and August when epicotyl grafting done in mango. Forced scions gave better results than nonforced scions. Regardless of treatment and time of grafting Langara performed best followed by Bombai and Himsagar.

Maity (1983) reported a new method of epicotyl grafting. well filled mango stones were germinated in sand on floor penetration and lifted with minimum root injury still with half folded pinkish or reddish leaves was tied in polythene bag containing moist sphagnum moss. It's top was removed with slanting cut to form a tongue and grafted to a scion shoot irrespective of age but nearly equal to the seedling, in thickness was selected. The graft was ready for separation in another 2 to 3 weeks. Both union and survival of the grafts were nearly 100 per cent. This method took much less time as compared to inarching to prepare a mango graft.

Desai & Patel (1984) reported that local mango stones were germinated and Alphonso scions defoliated 7 days earlier were grafted with 7 days old seedlings (soft wood grafting) at 15 days intervals between 1st July to 15th September in a green house or in the open. Soft wood grafting in 1st July in green house gave the highest (70%) success followed by 40% for both from softwood and hardwood grafting on 1st July in open.

Maharana & Sahu (1991) reported 66% success in hanging inarching of cricket - ball variety of sopata on Manilikara hexandra stock.

CASHEW

Rao (1957) conducted approach grafting in cashew at Mangalore and reported success of 100% in November, 80% in March, 70% in June and July, 60% in October and april and in rest months the success was only 30%.

Rao (1957) reported pencil thickness 10 cm long terminal shoots precured for one week and side grafted on one year old seedlings during the month of April gave 55% and 50% during March but the result was not encouraging.

Peixoto (1960) recommended 10 months old seedlings for budding in cashew.

Peixoto (1960) recommended grafting should be done in cashew by the end of dry season.

Albergeria (1967) used 10-20 cm long shoots already started new flush for grafting but he recommended not to use too young shoots.

FAO report (1967) suggested improved vegetative propagation in cashew for overcommings the great variation observed in seedling production owing to cross pollination.

in Florida and good success was obtained by grafting in early spring.

Cheema et al. (1954) advocated vegetative propagation in Chiku for true to the type, earliness in bearing, dwarf or easily manageble size of the trees. They also belived that they may influence and improve bearing.

Goswami (1954) reported from a seven years trial that inarched sopata plants yielded higher than layered plants.

FAO report (1967) recommended inarching is the most successful method in sopata propagation, however, the influence of root-stock may be eliminated by selection of propagation, however the influence of root-stock may be eliminated by selection of proper root-stock from proper locality.

Singh (1969) found Khirni - Manilikara hexandra - to be most suitable root-stock for sapota.

Krochmal (1972) tried modified approach grafting in hanging position in many tropical fruit trees including sopata which gave good result.

Cheema et al. (1954) claimed that grafted sapota plants bear fruits with granular pulp.

Maharana & Sahoo (1991) reported packing the root-stock with 20 gram moss and approach grafting in hanging position gave a success of 86.66% and new flush appeared 96 days after grafting.

Araque (1968) indicated that veneer grafting is best method of vegetative propagation for cashew using six month old seedlings of 1 cm diameter.

Argles (1969) reported lower cost in graft production with 2 to 3 months old seedlings when used as root-stock instead of one year old seedlings.

Sahani et al. (1970) recommended good success in side grafting of cashew during the month of October.

Nagbhusanm & Rao (1971) reported side grafting of cashew in 6 months old seedlings gave the success of 50-96%. In 20 months seedling the success was 20-49%.

Phadnis et al. (1972) conducted veneer grafting in cashew and reported it as the most successful one with a success of 60% and 53% respectively during July and June. But the success was dependant on growth of root-stock.

Ascenso and Melheiro (1973) obtained 100% success by using 10 weeks old stock and following cleft method of grafting.

Bhandari et al. (1974) used 3 weeks old seedling of 0.3 cm diameter and obtained 62% success in cleft grafting of cashew.

Ferraz et al. (1974) recommended 8 months old cashew seedlings and they were better than six months seedlings for higher success in budding respectively (99.7% and 69%).

CHAPTER III

MATERIALS AND METHODS

MATERIALS AND METHODS

The present investigation entitled "Standardization of modified inarching in mango, sapota and cashew" was conducted during the month of May, 1992 to May, 1993. The materials and the methods used in this investigation are described below.

Experimental site

The experiment was conducted in Government Progeny Orchard, Khandagiri, Horticultural Research Station, OUAT, Bhubaneswar and Cashew Research Station, Ransinghpur.

Climate

Bhubaneswar is situated 62 km from the west of the Bay of Bengàl and in the state of Orissa. The latitude and longitude are 20-15° N 85-55' east respectively with an altitude of 25.5 mts above the sea level. The mean annual rainfall is 1493 mm out of which 1326 mm are usually received during May to October. The weather data obtained from meteriological observatory of the University Research Station, Bhubaneswar covering the entire period of experiment presented in Table 1.

Table 1. **Monthly meteorological data from May 1992 to May 1993**

Months	Temperature °C			Relative humidity %			Rainfall mm	Number of rainy days	Sunshine hours per day
	Maximum	Minimum	Mean	Morning	Afternoon	Mean			
1992									
May	36,3	25,5	31,0	87	60	74	251.4	9	7.6
June	35.4	26.4	30.9	89	64	76	138.2	13	5.7
July	32.4	25.2	28.8	90	79	85	354.0	19	3.0
August	32.1	24.7	28.4	91	78	84	356.3	21	4.2
September	32.9	24.5	28.7	92	74	83	225.9	13	4.9
October	32.7	22.5	27.6	90	64	77	163.9	8	7.1
November	30.9	19.7	25.3	83	53	68	1.3	5	6.6
December	29.2	13.6	21.4	92	37	64	-	-	8.5
1993									
January	30.5	15.6	23.0	89	39	63	-	-	8.5
February	32.6	17.8	25.2	89	37	63	-	-	8.7
March	36.1	21.6	28.4	87	43	64	9.7	5	8.7
April	36.9	24.4	30.7	84	48	66	9.6	5	8.7
May	37.6	26.6	32.1	85.7	53.1	69.4	1.8	5	9.6

Courtesy - Meteorological observatory, University Research Station, Bhubaneswar

Number of experiments

The present investigation includes three sets of experiment as described below.

(1) Studies on the effect of detachment time on modified inarching in mango variety Banganpalli.

(2) Studies on effect of detachment time on modified inarching in sapota variety Cricketball.

(3) Studies on effect of inarching time on survival and growth of cashew graft.

Variety used

Mango cv. Banganpalli

It thrives well in dry areas but in humid areas performances are not very encouraging. It is an early variety, stands transport to distant market. The tree is medium, moderately vigorous crown round. The trunk is medium, shoots medium thick, leaves medium, slightly reflexed in midrib, ovate, lanceolate, emerging leaves colour green, fruits are large obliquely ovate in shape and golden yellow colour on ripening.

Sapota cv. Cricketball

It is grown in West Bengal, Tamilnadu and Madras. Leaves are light green, fruits are large round in shape, it is shy bearer grows well in arid climate upto 300 m elevation.

Cashew cv. 2/15

Cashew 2/15 is released from Bapalala. It can grow in costal tract as well as inland districts in any type of soil. It is a dwarf medium plant. Flowering period January - February, Duration of the flowering period about 86 days. Fruit can matured from February to April, Avarage numberdfruits per bunch 2 nos & nut size 8.6 gms. It bears yellow colour apple & weighs about 85 gms.

Freshly collected mango stones were germinated and lifted at 45 days stage without any damage in root system. No soil was allowed to adhere around the roots. Twenty gms of moist moss (kept in water for 24 hours and treated with 0.1% Bavistin before use) was kept in polythene bags of 15 cm x 7.5 cm size. The uprooted seedlings were placed inside the moss and tied near the neck of polythene pockets with a rubber string and 4 small holes were made in the bottom of polythene bags to facilitate aeration. Thereafter packed root-stocks were kept under the shade of a mango tree for a period of 15 days before used in hanging inarching.

For experiment No.2 one year old seedlings of Khirni were up-rooted along with roots and packed in moistmoss in polythene packets as done in mango seedlings and kept for a period of 15 days under the shade. Seedlings were packed as per the requirement.

Particulars of the experiments

Experiment No. 1

Crop - Mango

Design - Complete randomised block design (C.R.B.D.)

Treatment - 9

Replication - 3

Details of experiment

(a) Number of rootstock prepared for each treatment = 30.

(b) Total number of rootstocks prepared 30 x9 x 3 = 810 nos.

(c) Number of grafts prepared under each treatment = 20

(d) Total number of grafts prepared in this experiment 20 x 9 x 3 = 540 nos.

Date of seedling preparation	Date of inarching
19.6.92	4.7.92
24.6.92	9.7.92
29.6.92	14.7.92
4.7.92	19.7.92
9.7.92	24.7.92
14.7.92	29.7.92
19.7.92	3. 8.92
24.7.92	8. 8.92
29.7.92	13.8.92

Date of detachment - 2.9.91

Details of treatment

T_1	Graft detached	20 days after inarching
T_2	Graft detached	25 days after inarching
T_3	Graft detached	30 days after inarching
T_4	Graft detached	35 days after inarching
T_5	Graft detached	40 days after inarching
T_6	Graft detached	45 days after inarching

T_7	Graft detached	50 days after inarching
T_8	Graft detached	55 days after inarching
T_9	Graft detached	60 days after inarching

Experiment No.2

Crop - Sapota

Design - Complete randomised block design

Treatment - 9

Replication - 3

Details of experiment

Date of seedling preparation	Date of inarching
20.6.92	5.7.92
28.6.92	10.7.92
30.6.92	15.7.92
5.7.92	20.7.92
10.7.92	25.7.92
15.7.92	30.7.92
20.7.92	4.8.92
25.7.92	9.8.92
30.7.92	14.8.92

Date of detachment - 3.9.92

Details of treatments -

T_1	graft detached	20 days after inarching
T_2	graft detached	25 days after inarching
T_3	graft detached	30 days after inarching
T_4	graft detached	35 days after inarching
T_5	graft detached	40 days after inarching
T_6	graft detached	45 days after inarching
T_7	graft detached	50 days after inarching
T_8	graft detached	55 days after inarching
T_9	graft detached	60 days after inarching

Details of experiment

(a) Number of rootstock prepared for each trement = 30

(b) Total number of rootstocks prepared 30 x 9 x 3 = 810 nos.

(c) Total number of grafts prepared in each treatment = 20 nos.

(d) Total number of grafts prepared = 20 x 9 x 3 = 540 nos.

Experiment - 3

Crop - Cashew

Design - Complete randomised block design

Treatment - 5

Replication 4

Details of experiment

(a) Seedling raising : Cashew seedlings were raised in polythene pockets of 15 cm x 75 cm size starting from September to November 1992 to provide seedlings of 2 to 4 month old to maintain uniformity. The soil mixture was prepared in the ratio of 1:1:1 - soil, sand and F.Y.M. Disease and insect free seedlings were used in this experiment.

(b) Rootstock raised for each treatment = 30 nos.

(c) Total number of seedlings raised at monthly interval = 120 no.

(d) Total seedlings raised 120 x 5 = 600 nos. in five months.

(e) Total seedlings inarched = 400 nos.

Details of experiments

T_1 Inarching in the 1st of November, 1992
T_2 Inarching in the 1st of December, 1992
T_3 Inarching in the 1st of January, 1993
T_4 Inarching in the 1st of February, 1993
T_5 Inarching in the 1st of March, 1993

Time of detachment - 45 days after each grafting

Selection of rootstock

Three to four month old comparable seedlings were selected in respect their height, girth, number of leaves etc. Only insect and disease free seedlings were used for inarching.

Selection of scion

Desired number of scion branches of equal girth to that of rootstock selected at their dormancy without any flush development.

Grafting method

Inarching method of grafting was used. A thin slice of bark and wood was removed by means of a sharp grafting knife from the stem of stock as well as from the scion branch. The cut was absolutely flat clean even and smooth. The cut surface of both stock and scion were made to facing each other in intimate contact so that there was no hallow space between the two. They were tied firmly by polythene strips of 1.5 cm width and 200 gauge thickness. During the process of union the stock was kept in hanging position (for mango and sapota)&reared in moist moss. But in experiment No.3 cashew seedling were raised in polythene pockets. Seedlings were kept on the ground and inarched to the scion. During the process of union i.e. 45 days the rootstocks were

watered regularly and the grafts were maintained carefully.

Care of the grafts

After detachment in different dates mango and sapota grafts were potted in 15 cm x 7.5 cm polythene packets filled with soil and compost in the ratio of 2:1. Detached grafts were kept under shade for 10 days and later on removed to partial shade.

Maintenance of the grafts

After this the grafts were removed from the shade and arranged in trenches to record different observations. During these periods all cares were taken to maintain the grafts.

Observations

Several biometric and biochemical observations were recorded during the course of investigation. The procedure followed to record these observations are described below.

(a) Height of the rootstock : Before grafting the height of the rootstock was taken and the average recorded in centimeter.

(b) Diameter of the rootstock : The diameter of individual root stock under each treatment recorded by a dial micrometer and average was expressed in cm.

(c) Number of leaves present in rootstock : Number of leaves leaves present in each rootstock under each treatment was noted before grafting and average was recorded.

(d) Leaf area of the rootstock : Leaf area of a representative leaf in the rootstock was recorded by the help of a graph paper and the average was expressed in cm^2.

(e) Scion length : The length of the individual scion from the point of grafting was measured and average length recorded in cm at the time of grafting.

(f) Diameter of the scion : The girth of the scion at the time of grafting was measured by dial micrometer and expressed in cm.

(g) Number of leaves in the scion : Number of leaves present in the scion was counted at 60 days after grafting and recorded.

(h) Leaf area of the scions : Leaf area of a centrally located leaf in the scion was recorded by the help of a graph paper and the average was recorded in cm^2.

Survival of the grafts at detachment

In each treatment 20 numbers of plants were grafted under 3 replications. At the time of detachment the number of grafts survived was counted and expressed in percentage.

Post detachment success

The rate of survival of grafts was recorded at the time of detachment at 15 days interval upto 60 days and recorded in percentage.

Diameter of the graft

The diameter of the graft above the point of union was measured at 15 days interval in case of sapota and mango upto 60 days after detachment and average was expressed in cms.

Leaf area of grafts

The leaf area of a centrally located leaf in graft was recorded by the help of a graph paper and the average was expressed in cm^2.

Thickness of old leaf

The thickness of a centrally located matured leaf was measured and recorded in cm.

Dry matter in the leaf

The dry matter was calculated by taking a representative leaf samples from grafts. Leaves were made small pieces, weighed and kept in a oven at 60° C till it reached a constant weight and dry matter expressed in percentage.

Number of days taken to produce 1st flush

(a) Growth of 1st flush produced was recorded in all the crops from the date of grafting till the appearance of the new flush.

(b) Number of leaves in new flush. Number of leaves produced in new flush was counted and average was recorded.

(c) Length of the new flush : Linear growth of new flush was recorded after 60 days from the date of detachment and average length was recorded in cm.

(d) Diameter of new flush : The diameter of new flush was measured at the middle of the new flush by a dial micrometer at 60 days after detachment and average was recorded in cm.

(e) Thickness of new leaves : The thickness of centrally located leaves from new flush was measured and expressed cm^2.

Biometric observation in cashew grafts

(a) Survival percentage was recorded from the date of detachment till 45 days after detachment at 15 days interval as per the method indicated earlier and calculated in percentage.

(b) Diameter of the scion stick was recorded after 45 days.

(c) Length of new shoot was measured in cm 45 days after detachment.

(d) Number of leaves in new shoot was recorded 45 days after detachment.

(e) Total leaf area was recorded at 45 days after detachment of graft.

Statistical analysis

The standard error of means (S.E.M.) a critical difference (CD) were calculated byusing the following formula.

$$S.E.(m) \pm \text{ for treatment} = \sqrt{\frac{EMS}{r}}$$

$$CD(0.05) = SEM \times \sqrt{2} \times t \text{ 5\% at error degree of freedom.}$$

Where,

EMS = Error means square

CD = Critical difference

r = Replication

df = Degree of freedom

CHAPTER IV

EXPERIMENTAL FINDINGS

RESULTS

Results of the presen investigation entitled "Standardization of modified inarching in mango, sapata & cashew" have been presented in table 2 to 16 and illustrated in the figure from 1 to 3 plate from 1 to 7. The results are presented separately for 3 sets of experiments.

Ecperiment - 1

Studies on the effect of detachment time on modified approach grafting in mango variety Banganpalli.

Table 2. **Growth parameters of root-stock & scion of mango at the time of approach-grafting (average of 20)**

1.	Diameter of the root-stock (cm)	o.45
2.	Diameter of scion (cm)	0.55
3.	Number of leaves in root-stock	5.60
4.	Number of leaves retained in the scion	11.5
5.	Height of the root-stock (cm)	24.70
6.	Length of scion from the point of union (cm)	15.40
7.	Leaf area of root-stock (cm^2)	52.75.
8.	Leaf area of scion (cm^2)	41.20

Growth parameters of rootstock and scion (Table 2)

Mango seed-lings of 45 days old were observed for several growth parameters like diameter, number of leaves height of stock, leaf area. The value was 0.45cm, 5.60, 24.70 cm & 52.75 cm^2 respectivelly for the above characters. Similar

observations were also recorded for the scion, the data were 0.55 cm, 11.5, 15.40 cm & 47.20 cm^2 respectively for the characters noted above.

Survival of the grafts (Table 3)

The percentage of survival of grafts were recorded at the time of detachment & subsequently at 15-days interval up to 60 days. The result was highly significannt at all stages. At the time of detachment highest survival was recorded with 35 days (93.33%) which was at par with 20 days(90%) 25 days (91.66), 30 days (90%), 40 days (88.33%) & 50 days (88.33%) where as 45 days (88%) 55 days (85%) & 60 days (81.66%) significantly recorded lower percentage of success as compared to 35 days. The percentage of success maintained at a higher level up to 35 days i.e., above 90% where as below 35 days the percentage remained below 90%.

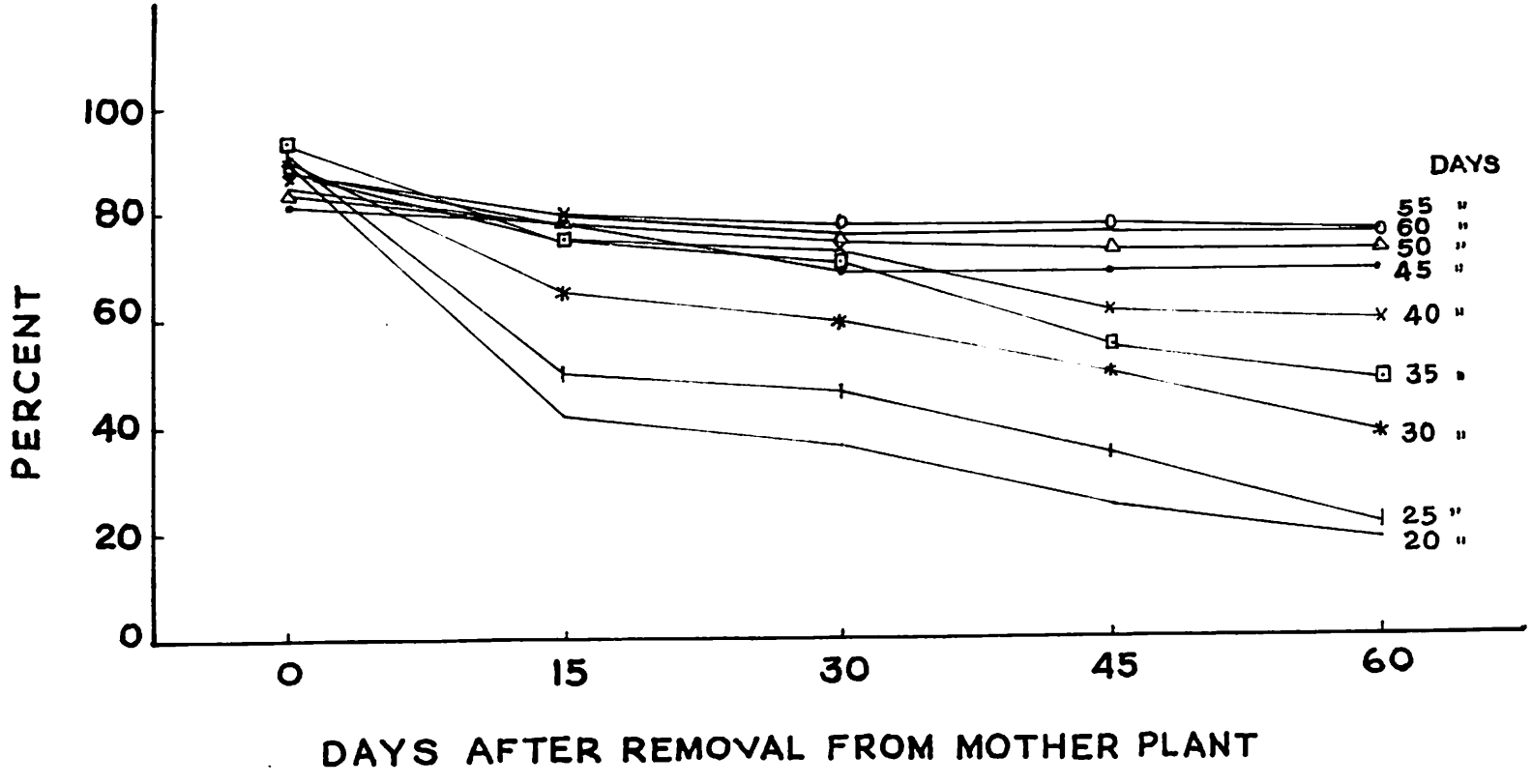
At 15 days the percentage of success was lowest with 20 days (41.66%). The 35 days (75%), 40 days (75%), 45 days (78.33%) and 50 days (75.33%) were at par. At 30 days after removal of from mother plant highest percentage survival was observed with 50 days detachment (78.33%). The survival percentage decreased slowely with 55 days (76.66%) and 60 days (75%) and these two were at par with 50 days. As the detachment time was shortened the survival percentage reduced conspicuously to 75% in 45 days, 73.33% in 40 days,

Table 3. **Effect of detachment time on survival of mango graft at different dates after detachment (in per cent)**

Detachment time (days after grafting)	Initial	15 days	30 days	45 days	60 days
T-1 20 days	90.00 (71.95)	41.66 (40.197)	36.66 (37.257)	25.00 (29.923)	18.33 (25.30)
T-2 25 days	91.66 (73.40)	50.00 (45.00)	47.66 (43.087)	35.00 (34.567)	21.66 (29.92)
T-3 30 day	90 (71.95)	65.00 (54.03)	60.00 (50.79)	50.00 (45.01)	38.33 (38.24)
T-4 35 day	93.33 (75.29)	.75 (60.077)	70.66 (57.86)	55.00 (47.88)	48.33 (44.33)
T-5 40 day	88.33 (70.50)	75.00 (60.077)	73.33 (59.007)	61.66 (53.763)	60.00 (50.79)
T-6 45 day	85 (67.21)	78.33 (62.29)	75.00 (60.007)	73.33 (58.93)	73.33 (58.93)
T-7 50 day	88.33 (70.11)	78.33 (62.29)	78.33 (62.29)	78.33 (62.29)	76.66 (61.47)
T-8 55 day	83.66 (65.95)	80.00 (63.55)	76.66 (61.147)	76.66 (61.147)	76.66 (61.147)
T-9 60 day	81.66 (64.70)	80.00 (63.55)	75.00 (60.077)	75.00 (60.08)	75.00 (60.077)
'F' test	Sig*	Sig*	Sig**	Sig**	Sig**
S.E.(m)±	1.96	1.70	1.52	1.71	1.66
C.D.(0.05)	5.87	5.09	4.55	5.12	4.99

(Data in parenthesis are angular values)

SURVIVAL PERCENTAGE OF MANGO GRAFTS



70.66% in 35 days, 60% in 30 days, 46.66% in 25 days and lowest survival (36.66%) was recorded with 20th day detachment. 20 days, 25 days, 30 days, 35 days differed significantly among themselves.30 and 35 days remained at par.

The survival percentage recorded at 45 days after removal of the grafts exhibited a high rate of mortality in early dates of detachment but at latter dates the survival percentage was almost stable. The highest percentage of survival was recorded with 50 days detachment (78.33%) which was significantly higher to all previous days starting from 20 days to 45 days, whereas, detachment at 55 days (76.66%) and detachment at 60 days (75%) remained at par. At this date lowest percentage of success was recorded with detachment at 20 days (25%).

the survival percentage of grafts at 60 days after removal of grafts from month plant was highest with 50 days and 55 days (76.66%) and lowest was recorded with 20 days (18.33%). The survival percentage with 50 and 55 days was significantly higher over detachment at 20 days. Detachment at 50 days, 55 days and 60 days remained at par.

Diameter of mango graft (Table 4)

The diameter of the graft just above the point of union was measured at 15 days, 30 days, 45 days and 60 days after removal from the mother plant. At all stages significant result was obtained. At 15 days stage the diameter was

Table 4. **Effect of detachment time on diameter of mango graft (in cm) in different dates after detachment from mother plant**

Detachment time (after grafting)	15 days	30 days	45 days	60 days
T_1 20 day	0.543	0.570	0.583	0.600
T_2 25 days	0.553	0.577	0.593	0.627
T_3 30 days	0.563	0.593	0.607	0.623
T_4 35 days	0.553	0.573	0.593	0.613
T_5 40 days	0.603	0.630	0.643	0.663
T_6 45 days	0.560	0.577	0.600	0.620
T_7 50 days	0.573	0.603	0.613	0.623
T_8 55 days	0.590	0.617	0.633	0.640
T_9 60 days	0.607	0.647	0.650	0.670
'F' test	Sig*	Sig*	Sig*	Sig*
S.E.(m)±	0.013	0.015	0.013	0.014
C.D.(0.05)	0.039	0.045	0.039	0.042

highest with 60 days (0.607 cm) and lowest was with at 20 days (0.543 cm). The diameter at 60 days was significanntly higher over others except detachment at 40 days, 50 days and 55 days. Detachment at 25 days to 35 days, 45 days and 50 days remained at par.

At 30 days stage highest diameter was with 60 days (0.647 cm) and lowest with 20 days (0.510 cm), Detachment at 40 days, 50 days, 55 days remained at par with 60 days on the other hand 20 days, 25 days 30 days, 35 days, 45 days all remained at par.

At 45 day stage the highest diameter was recorded in 60 days (0.650 cm) followed by 40 days (0.643 cm.), Detachment at 40 days, 50 days, 55 days and 60 days remained at par. On the other hand 20 days, 25 days, 30 days, 35 days, 45 days, 50 days also remained at par.

At 60 day stage the highest diameter was recorded in grafts detached at 60 days (0.670 cm) which remained at par with 40 days (0.663 cm) and 55 days (0.640 cm). Lowest was recorded with 20 days detachment which remained at par with all other treatments except 40 days and 60 days. No regular trend was observed for diameter with the increase in detachment time.

Days taken to produce the new flush (Table 5)

New flush appeared at the earliest in 20th day detachment (60,33 days) which was at par with 50th day (65 days) detachment and 55th day detachment (64.67 days). Longest time was taken to produce the new flush with 35 days detachment (73.67 days) which was at par with 30 days detachment (70 days), 40th day detachment (71 days) and 45th day detachment (70.67 days).

Number of leaves in new flush (Table 5)

Number of leaves in the new flush was highest in grafts detached at 60 days (13.72) which is significantly superior over other treatments but reamined at par with 55 days (13.37). However, 55 days detachment remained at par with 50 days detachment (12.94). Lowest number of leaves was produced with 20 days detachment (19.63).

Diameter of the new flush (Table 5)

The diameter of the new flush was recorded 0.553 cm with 60 days detachment which was at par with 55 (0.540 cm). 55 days was par with 50 days. The lowest diameter was recorded in 20 days detachment (0.447 cm) and this was at par with 25 days, 30 days and 35 days. With the increase in the detachment time the diameter of the new flush increased proportionately.

Table 5. **Number of days taken to produce the new flush from the date of grafts, after detachment later early over 60th day detachment, number of leaves in new flush, diameter of new flush, and length of new flush**

Time of detachment (from date of grafting)	Days taken to produce new flush after grafting	Days taken to produce new flush after detachment	Time taken over 6th day detachment (days)	No. of leaves in new flush	Diameter of new flush (cm)	Length of new flush (cm)
20 day	60.33	40.00	8.44 E	9.63	0.447	7.57
25 day	68.33	43.00	0.34 E	9.90	0.450	7.80
30 day	70.00	40.00	1.33 L	10.27	0.473	7.80
35 day	73.67	38.67	5.00 L	10.72	6.473	7.97
40 day	71.00	31.00	2.33 L	10.89	0.493	8.07
45 day	70.67	25.67	2.00 L	11.69	0.513	8.10
50 day	65.00	15.00	3.67 E	12.94	0.533	8.30
55 day	64.67	9.67	4.00 E	13.37	0.540	8.30
60 day	68.67	8.67	-	13.72	0.553	8.50
'F' test	Sg**	-	-	-	Sig.*	Sig.**
SE(m) ±	1.656	-	-	-	0.006	0.080
C.D. (5%)	4.965	-	-	-	0.017	0.239

L=Late, E=Early

Length of new flush (Talbe 5)

Significnt difference was observed for length of new flush recorded at 60 days after detachment. Highest length was recorded with 60 days detachment (8.50 cm) which was significantly higher over rest of the treatments except 55 days (8.30 cm) and 50 days (8.30 cm) detachment. These two latter dates remained at par with 60 days. On the other hand 40 days, 50 days, 55 days detachment remained at par. Twentyfive days, 30 days, 35 days, 40 days remained at par. Twenty days detachment which recorded the lowest length of new flush (7.57 cm) remained at par with 25 days and 30 days i,e, 7.8 cm for both.

Leaf area (Table 6)

Leaf area of one representative leaf of the new flush was measured at 30th day &60th day after detachment from mother plant. At 30th day the leaf area varied from 50.33 cm^2 to 56.29 cm^2 in different treatments. The highest leaf area was observed in 45th day (56.29 cm^2) detachment & lowest was observed in 60th days detachment (50.26 cm^2). Detachment at 20th day (50.33 cm^2) 35th day (50.93 cm^2) & 25th day (51.83 cm^2) remaind at per with 60th day. On the other hand 45th day, 50th day & 55th day also remained at p r.

The leaf area measured at 60th days stage recorded slight increase in leaf area over 30th day. The highest leaf area was recorded 45 days detachment (56.58 cm^2) &

lowest was recorded with 55 day (50.05 cm^2). The 55th day remained at per with 60th day, 35th day, 25th day & 20th day. The 45th day remained at per with 50th day (56.10 cm^2).

Thickness of leaf (Table 6)

Thickness of old leaf & new leaf in the new flush were measured. New leaves were thinner than old leaves. Among the old leaves thickest leave was observed in 40th day detachment (0.045 cm) & thinest leaf in 20th day detachment (0.042 cm). No significant difference was observed among the treatments. However, significant difference was observed among the treatments for thickness of leaves in new flush. Leaves having 0.036 cm. thickness was recorded in treatments starting from 40th day to 60th day detachment & these two remained at par along with 25th & 35th day detachment. Twentyth and 30th day detachment which recorded the lowest leaf thickness also remained at par.

Dry-matter of leaf (per cent)

Significant difference for dry - matter content in the leaf was observed in different treatments. Higher dry - matter was recorded at 20th day detachment (49.617%) which was significantly higher than rest all other tratments. Lowest dry matter was recorded in 25th day detachment (45.763%) which was at per with 30th, 35th, 40th, 45th day detachment. All treatment starting 35th day to 60th day remained at par.

Table 6. **Effect of detachment time on leaf area, thickness of old and new leaf and drymatter of leaf in mango grafts**

Detachment time after grafting	Leaf are (cm^2) at 30 day	60 day	Thickness of old lead in (cm) at 60 day	Thickness of new leaf in (cm)at 60 day	Drymatter percentage in leaf at 30 day
T-1 20 day	50.33	50.53	0.042	0.034	49.617
T-2 25 day	51.83	51.96	0.043	0.035	45.763
T-3 30 day	53.50	53.66	0.043	0.034	46.147
T-4 35 day	50.93	50.99	0.042	0.035	46.720
T-5 40 day	53.11	53.23	0.045	0.036	46.293
T-6 45 day	56.29	56.58	0.044	0.036	46.720
T-7 50 day	56.24	56.19	0.044	0.036	47.100
T-8 55 day	56.00	50.05	0.044	0.036	47.103
T-9 60 day	50.26	50.34	0.043	0.036	47.677
'F' test	Sig*	Sig*	N.S.	SIg**	Sig**
S.E.(m)±	0.886	0.844	-	0.0005	0.332
C.D.(0.05)	2.656	2.531	-	0.0015	0.996

Experiment II

Studies on effect of detachment time on modified approach-grafting in sapota variety Cricketball

Growth parameters of rootstock and scion (Table 7). One year old Khirini (Manilikara hexandra) seedlings, the root-stock for sopata were observed for different vegetative characters i.e. the mean diameter, number of leaves, height & average leaf area. They were 0.61 cm, 6.7, 14.50 cm, & 23.6 cm^2 respectively for these above characters. On the other hand the diameter, number of leaves, length of scion &leaf area was respectively 67 cm, 16.70, 13.5 cm & 16.2 cm^2 in the sopata scion.

Table 7. **Growth parameters of Khirini root-stock & scion of sopata at the time of inarching (average of 20)**

1.	Diameter of rootstock (cm)0.61
2.	Diameterof scion (cm) 0.67
3.	Number of leaves in rootstock 6.7
4.	Numer of leaves in scion 16.70
5.	Height of rootstock (cm) 14.50
6.	Length of the scion from the point of union (cm) 13,57
7.	Leaf area of the rootstock (cm^2) 23.6
8.	Leaf area of the scion (cm^2) 16.2

Survival percentage (Table 8)

The survival of sopata grafts were recorded in percentage at the time of detachment & thereafter at 15 days interval up to 60 days. In all stages significant difference was observed due to the effect of time of detachment. At the time of removal of the grafts from the mother plants highest percentage of success was observed with 25th day detachment (100%) which was at per with the grafts detached starting from 20th day to 50th day. The percentage of survival was 90% per cent in 55th day & 93.33% in 60th day. These two remained at par.

After 15th days of removal of the grafts from the mother plant highest percentage of success (98.33%) was observed with 50th day detachment which remained at p r with 40th day, 45th day, 55th day &60th day detachment. Detachment at 30th day, 35th day remained at par. Lowest survival was observed with 20th day (55%) detachment.

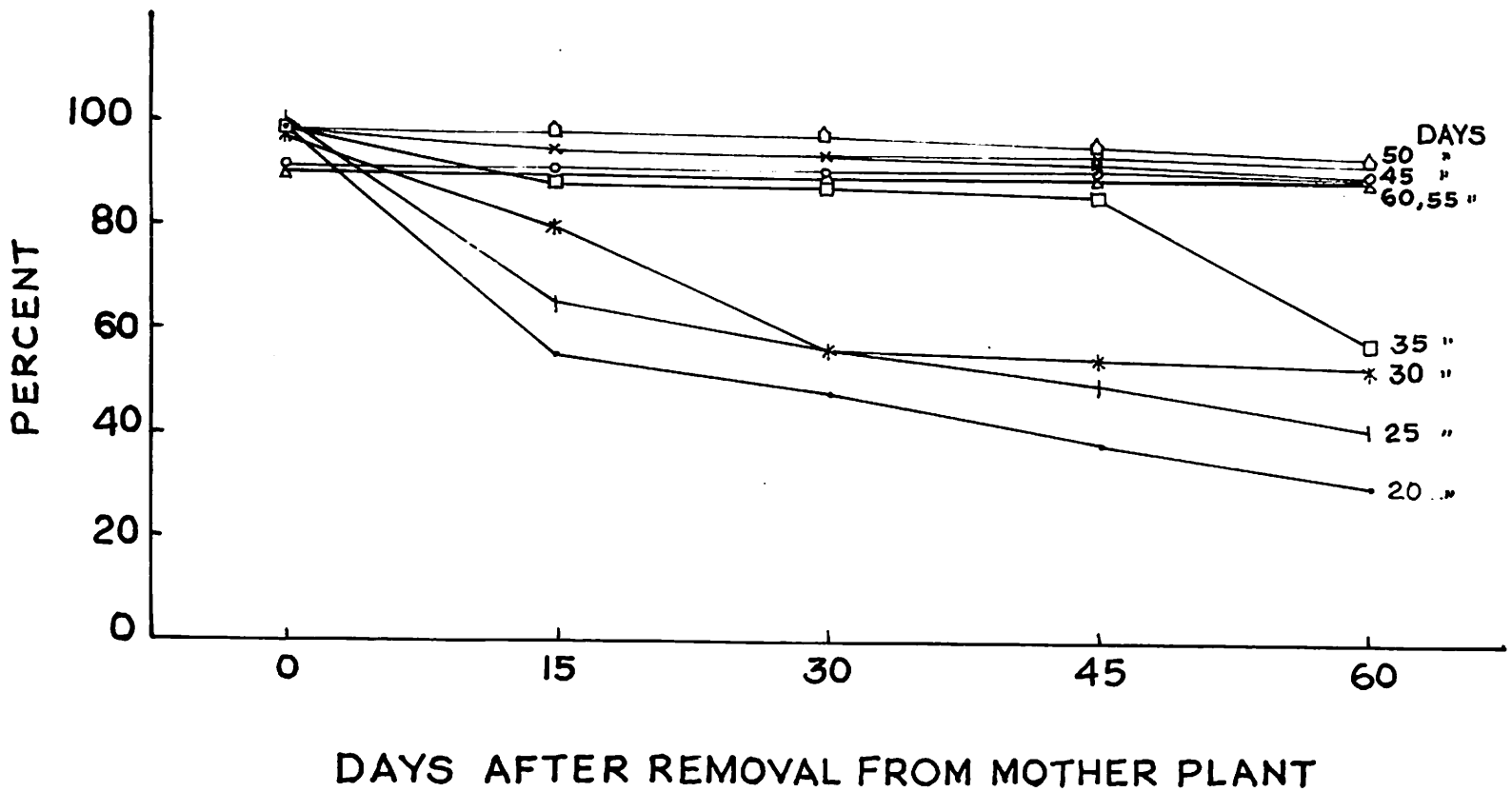
The observation recorded at 30 days after removal of graft exhibited a similar trend for 55th day and 60th day detachment whereas some percentage of mortality was observed with 20th, 25th &30th day detachment. At 45 days, highest survival was recorded with 50th day detachment (96.66%) & lowest with 20th day detachment (38.33%). At 60th day observation highest percentage of survival recorded with 50th day detachment (95%) which remained at par with 40th

Table 8. **Effect of detachment on survival of sopata (in percentage) graft at different dates after detachment**

Detachment time (after grafting)	Initial	15 days	30 days	45 days	60 days
20 days	98.33 (85.69)	55.00(47.88)	48.33 (44.04)	38.33 (38.09)	30.00 (33.16)
25 days	100.00 (90.00)	65.00(53.76)	56.66 (48.84)	50.00 (45.00)	41.66 (40.18)
30 days	96.66 (81.39)	80.00 (63.50)	56.66 (49.23)	55.00 (48.08)	53.33 (46.92)
35 days	98.33 (85.69)	88.33 (70.11)	88.33 (70.11)	86.66 (68.66)	58.33 (49.80)
40 days	98.33 (85.69)	95.00 (79.55)	95.00 (79.55)	93.33 (75.24)	91.66 (73.40)
45 days	98.33 (85.69)	95.00 (77.08)	95.00 (79.08)	95.00 (77.08)	93.33 (75.24)
50 days	98.33 (85.69)	98.33 (85.69)	98.33 (85.69)	96.66 (81.34)	95.00 (77.08)
55 days	90.00 (71.56)	90.00 (71.56)	90.00 (71.56)	90.00 (71.56)	90.00 (71.56)
60 days	93.33 (75.24)	93.33 (75.24)	93.33 (75.24)	93.33 (75.24)	90.00 (71.56)
'F' test	Sig	Sig	Sig	Sig	Sig
S.E.(m)±	1.470	2.788	3.472	3.090	1.660
C.D.(0.05)	4.406	8.357	10.422	9.264	4.976

(Figures in parenthesis are angulr values)

SURVIVAL PERCENTAGE OF SAPOTA GRAFTS



day, & 45th day detachment. Higher percentage of survival was also noticed in 55th day (90%) & 60th day (90%). The lowest percentage of success was observed with 20th day detachment (30%). The percentage of success was lower in 25th, 30th & 35th day detachment.

Diameter of the scion (Table 9)

The diameter of the graft was measured just above the point of union at an interval of 15 days up to 60 days. No significant result was observed for diameter of the scion in these stages of observation. However, the diameter was highest in 45th day detachment at 15th day stage (0.647 cm). At 30th day the highest diameter was recorded under 40th day detachment. At 45th day and 60th day observation highest diameter of scion continued to be observed in 40th day detachment.

Days taken to produce new flush (Table 10)

60th day detachment was earliest to produce the new flush (92 days) followed by 50th days (92.33 days) & the production of new flush was delayed in 20th day detachment (103.33) days. More the detachment time delayed the new flush appeared earlier as observed in 20th day (103.33 days) 30th (100.33 days) 40th day (96.30 days) 50th day (94 days) & 60th day (92 days).

Table 9. **Effect of detachment time on diameter of graft (cm) in different dates (sapota)**

Time of detachment (after grafting)	15 days	30 days	45 days	60 days
20 days	0.620	0.630	0.650	0.670
25 days	0.620	0.633	0,643	0.670
30 days	0.627	0.633	0.657	0.677
35 days	0.629	0.634	0.658	0.678
40 dyas	0.623	0.660	0.680	0.700
45 days	0.647	0.657	0.677	0.697
50 days	0.610	0.620	0.643	0.660
55 days	0.640	0.647	0.637	0.690
60 days	0.637	0.650	0.667	0.687
'F' test	N.S.	N.S.	N.S.	N.S.
S.E.(m)±	-	-	-	-
C.D.(0.05)	-	-	-	-

Table 10. **Effect of detachment time on days taken to produce new flush, number of leaves thickness of row leaf average leafarea & per cent of dry-matter**

Time of detachment (after grafting)	Time to produce new flush in days	Number of leaves in new flush at 120 days	Thickness at leaves in newflush at 120 days	Leaf area in cm^2	Drymatter in leaf percentage
20 days	103.33	12.00	0.029	15.97	33.18
25 days	101.33	12.00	0.0297	16.00	33.56
30 days	100.33	13.00	0.0306	14.59	33.51
35 days	98.00	13.66	0.0313	16.07	33.45
40 days	96.30	14.33	0.0316	17.08	33.88
45 days	95.33	15.33	0.0323	15.44	33.78
50 days	94.00	15.66	0.0330	15.04	34.00
55 days	92.33	16.33	0.0336	16.45	34.04
60 days	92.00	17.33	0.0340	16.09	35.02
	Sig	Sig	N.S.	N.S.	Sig**
S.E.(m)±	0.642	0.251	0.00051		0.239
C.D.(0.05)	1.925	0.752	0.0017		715

Number of leaves in new flush (Table 10)

The number of leaves in new flush was recorded after 120 days of removal of the graft from the mother plant. It was significantly highest with 60th day (17.33) detachment & lowest with 20th day detachment (12.00).

Thickenss of leaves (Table 10)

Significant difference was observed for thickness of leaves under different treatment. The thickness of leaves increased with the increase in the detachment time. The highest thickness was observed with 60th day detachment (0.0340 cm) which remained at per with 55th day, 50th day & 45th day detachment. Similarly 30th day, 35th day as well as 40th day remained at par. 25th & 20th day remained at par & lowest thickness was observed in 20th day detachment (0.0293 cm).

Leaf area (Table 10)

No signfiant result was observed for leaf area. However, leaves with higher leaf area was recorded under 40th day (17.08 cm^2) detachment & lowest with 30th day (14.59 cm^2).

Drymatter in leaf (Table 10)

The highest percentage in drymatter in leaves (35.02%) was observed at 60th day detachment which is significantly superior to rest other treatment. Lowest thickness was observed with 20th day detachment (33.18%) which remained at par with 25th,30th, 35th, 40th, 45th day detachment.

Experiment III

Studies on the effect of inarching time on survival and growth of cashew graft.

Survival of graft (Table 11)

The survival of cashew graft was recorded at the time of detachment i.e. 45 days after inarching and thereafter at 15 days interval up to 45 days after detachment. In all stages significant difference was observed due to treatments.

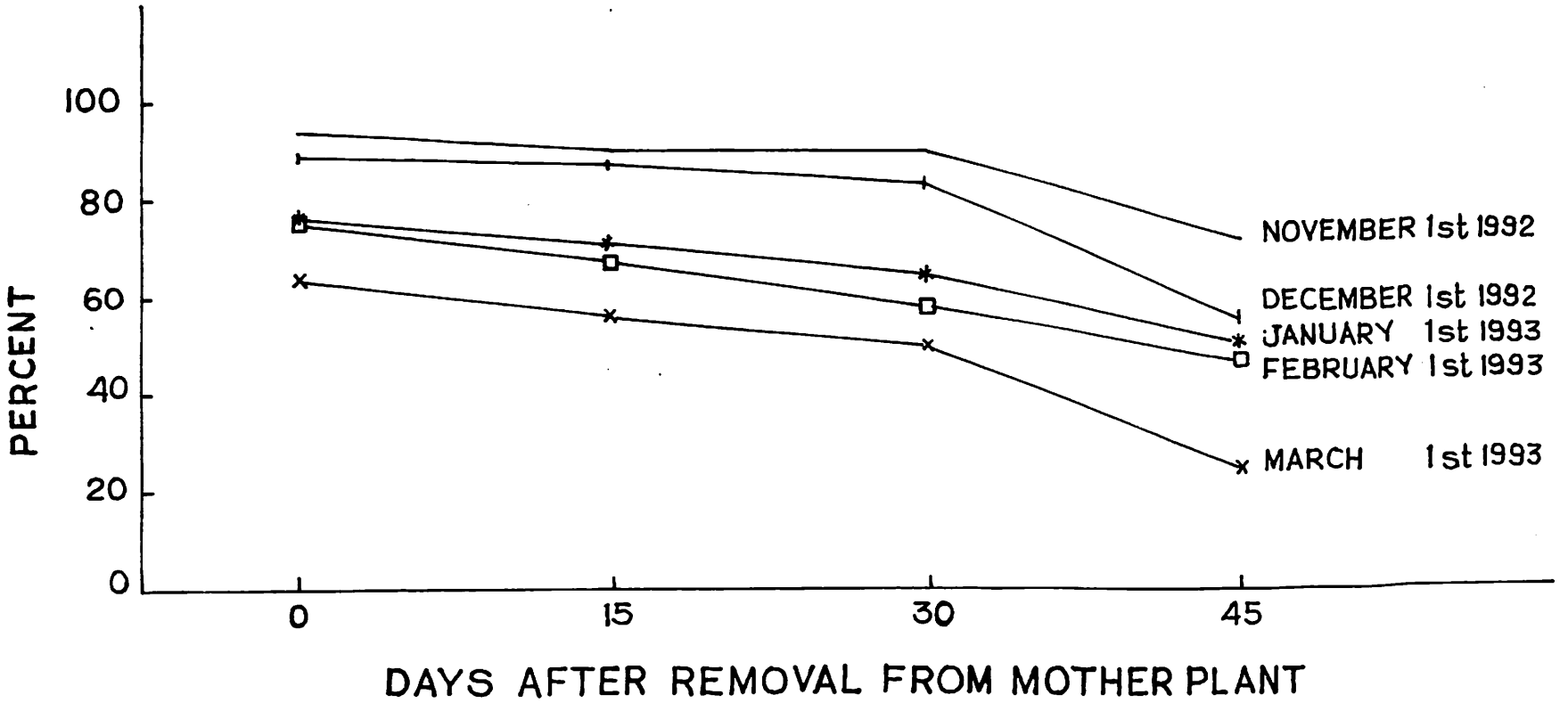
At the time of removal of grafts from mother plant i.e. 45 days after inarching highest success was observed in November 1st inarching (93.75%) which was significantly higher than inarching in January 1st (76.2%), February 1st (75%) and March 1st (63.75%) but remained at par with December 1st inarching (88.75%). Survival per cent during January 1st and February 1st inarching remained at par, and these were significantly superior over March 1st inarching. The observation recorded on survival percentage at 15 days of post detchment period recorded highest survival with No ember 1st grafting (90%) and the trend in success was similar to initial stage. November 1st remained at par with December 1st inarching (87.5%). The lowest percentage of success was observed with March 1993 (56.25%) which was signficantly lower than February 1st (67.5%) and January 1st (71.25%).

Table 11. **Effect of time of inarching on surivival of cashew grafts at the time of detachment 15th and 30th and 45th days after**

Time of grafting		0 day	15 days	30 days	45 days
T_1 November	1st	93.75 (77.85)	90 (71.85)	90 (71.85)	72.5 (58.49)
T_2 December	1st	88.75 (70.45)	87.5 (69.39)	83.75 (66.41)	56.25 (48.60)
T_3 January	1st	76.25 (60.86)	71.25 (57.59)	65 (53.76)	51.25 (45.73)
T_4 February	1st	75.00 (60.04)	67.5 (55.26)	58,75 (50.05)	47.5 (43,56)
T_5 March	1st	63.75 (53.02)	56.25 (48.62)	50 (45)	28 (29.44)
F (Test)		Sig	Sig	Sig	Sig
S.E.(m)±		2.344	1.579	2.017	1.817
C.D.		7.226	4.867	6.216	5.599

(Data in parenthesis are angular values)

SURVIVAL PERCENTAGE OF CASHEW NUT



Highest survival at 30th day observation was recorded with November 1st inarching (90%) which was significantly higher than rest other treatments. The trend was similar and delay in inarching time produced low success. Lowest survival was recorded with March 1st inarching (50%). Highest percentage of survival was recorded with Nobember 1st inarching (72.5%). December 1st January 1st remained at par. January 1st and February 1st remained at par. Lowest percentage of survival was recorded with March 1st inarching (25%) which was significantly lowest as compared to rest other treatments.

Diameter of the graft (Table 12)

The diameter of the graft above the point of union was measured at 45 days after removal of the graft from mother plant. Highest diameter was recorded with November 1st inarching (1.12 cm) which was significantly higher over other treatments i.e. December 1st (0.977 cm), January 1st (0.947 cm) , February 1st (0.915 cm) and March 1st (0.867 cm). Delay in inarching time the diameter of the stem proportionately became thinner. However, no significant difference was observed among the latter dates of inarching.

Length of new shoot (Table 12)

No significant difference was observed for length of new shoot in different treatments. Highest was recorded with December. 1st inarching (16.5 cm) followed by January 1st

Table 12. **Effect of times of inarching on diameter of graft, leaf number & leaf area (cm^2) in cashew graft. (at 45 days after detachment)**

Time of inarching	Diameter of scion (cm)	Length of new shoot (cm)	Number of leaves	Total leaf area (cm^2)
T-1 Nov. 1st	1.12	16.0	20.25	1647.46
T-2 Dec. 1st	0.977	16.5	19.75	1606.78
T-3 Jan. 1st	0.947	16.25	17.25	1403.39
T-4 Feb. 1st	0.915	15.5	16.25	1322.035
T-5 March 1st	0.867	13.25	13.5	1098.305
F test	Sig	N.S.	Sig*	Sig
S.E.(m)	0.043		0.644	52.516
C.D.	0.132	-	1.955	161.881

(16.25 cm), November 1st (16.0 cm), February 1st (15.5 cm) and lowest was recorded with March 1st inarching (13.25) cm.

Number of leaves (Table 12)

Highest number of leaves (20.25) was recorded with November 1st inarching which was at par with December 1st inarching (19.25) but significantly higher as compared to rest other treatments. No significant difference was observed between January 1st and February 1st inarching. Number of grafts produced during March 1st inarching had significantly lowest leaves as compared to rest other treatments.

Total leaf area (Table 12)

Significantly highest total leaf area was observed in grafts produced under November 1st inarching (1647.46 cm^2) when compared with other treatments but remained at par with December 1st inarching (1606.78 cm^2). No significant difference was observed between January 1st (1403.39 cm^2) and February 1st (1322.03 cm^2). As compared to all treatments significantly lowest (1098.30 cm^2) total leave area was observed in March 1st grafting.

CHAPTER V

DISCUSSION

DISCUSSION

The results of the present investigation entitled "Standardization of modified inarching in mango sapota & cashew" presented in preceeding chapter revealed some useful information. In this chapter, results are discussed below separately for each experiment.

Experiment I

Studies on effect of detachment time on modified inarching in mango variety Banganpalli.

Survival of the mango graft

At the time of collection of mango grafts from mother plant higher survival of 93.33% to 90% was recorded with younger grafts of 35 days old or below age, where as, with older grafts beyond 40 days old to 60 days old the survival was 88.33% to 81.66% (Table 3). Thirty five days old grafts clearly recorded the highest percentage of success (93.33%) and this was 12.33% higher over 60 day detachment. Healing process in a graft union includes several steps. They are development of parenchyma cell from stock & scion, intermingling and interlocking of these cells, formation of new cambium,

production of new phloem & xylem from freshly developed cambium & lastly connection of vascular system. In the earlier steps of a healing process intermingling and interlocking of cells allowed to live for some time. Possiably, within 35 days and other earlier dates this process has been completed & higher percentage of success have been exhibited. Maharana & Sahoo (1991) have reported higher success in 45 days old grafts. Further Maharana et al. (1988) reported mortality in older grafts due to moisture stress in the moss.

Table 13. **Mortality of mango grafts in different dates (per cent)**

Detachment time	Initial	Mortality at 15 days	Mortality at 30 days	Mortality at 45 days	Mortality at 60 days
20 days	90.00	49.34	5.00	11.66	7.67
25 days	91.66	41.66	3.34	11.66	13.34
30 days	90.00	25.00	5.00	10.00	11.67
35 days	93.33	18.33	4.34	15.66	6.67
40 days	88.33	13.33	1.67	12.33	1.66
45 days	85.00	7.33	3.33	1.67	0.00
50 days	88.33	10.00	0.00	0.00	1.67
55 days	83.66	3.66	3.34	0.00	0.00
60 days	81.66	1.66	5.00	0.00	0.00

Evans & Rasmussen (1972) & Bloch (1952) have reported the steps involved in a healing process. The survival percentage recorded at 15 days after removal of grafts from mother plant presented very interesting result. The mortality percentage was 48.4% with 20 day detachment but with 60 day detachment

Plt. No.I. Hanging inarching in mango.

the mortality was only 1.66%. With 35 days old grafts the mortality was 18.33% whereas in younger grafts it was higher and low with older grafts (1.66%).

The results established that removal of grafts below 45 days are not desirable. At 30 days of observation the mortality rate was around 5% & at 45 days the mortality was 15.66% (Table 13). On the other hand, the mortality was 1.67% in 45 days old detachment. No mortality was noticed in 50, 55, 60 days detachment. At 60th day observation, the mortality rate was higher side in 35 days and younger grafts. Therefore, graft should be retained in the mother plant for sufficient time to reduce the mortality percentage in post detachment period. Maharana & Sahoo (1991) have strongly advocated for retaining the grafts in hanging position for 45 days. Verma (1942) recommended 10 weeks for separation, Oliver (1911) recommended 4-5 weeks for detachment. Naik (1947) was in opinion to use 10-16.5 month old root-stocks for higher success.

Diameter of the graft

The diameter of the graft has been recorded at 15 days interval up to 60 days. The diameter of the graft increased with the age of the graft. The abnormal growth of the scion just above the point of union indicates early incompatibility but in this investigation at all stages of observation no abnormal growth in scion was noticed. With 20 days detachment increase

Table 14. **Increae of diameter in consecutive dates (cm.)**

Date of Detachment	15 day	Increase at 30 days	Increase at 45 days	Increase at 60 day	Total increase
20 days	0.543	0.027	0.013	0.017	0.057
25 days	0.553	0.024	0.016	0.034	0.084
30 days	0.563	0.030	0.014	0.016	0.060
35 days	0.553	0.020	0.020	0.020	0.060
40 days	0.603	0.027	0.013	0.020	0.060
45 days	0.560	0.017	0.023	0.020	0.060
50 days	0.573	0.030	0.010	0.010	0.050
55 days	0.590	0.027	0.016	0.007	0.050
60 days	0.607	0.040	0.003	0.020	0.063

in diameter was 0.057 cm within 60 days after detachment where as with 60 days detachment, it was only 0.063 cm. With 45 days detachment the increase was 0.06 cm & at 40 days detachment 0.063 cm. From this it can be said that the diameter growth was more or less uniform and there was no sign of incompatibility. However, at 25 days detachment the increase was up to 0.084 cm. which indicated a slight over growth. Amos et al. (1936) & Bradford & Sitton (1929) have reported over growth at the graft union is the sign of incompatibility.

Production of new flush

New flush appeared in the grafts within 60-74 days after grafting. Grafts detached earlier took more time for production of new flush. On the other hand, delayed detachment produced new flush in shorter time (Table 5). Actually flush production is earliest in grafts detached at 20 days (60.33 days) whereas longest time was taken with grafts detached at 35 days (73.67 days).

From the data it can be belived that new flush appearance depend on the age of graft not on the time of detachment (Table 5). Actually flush production was earliest with 20th day detachment (Table 5) i.e. 8.44 days earlier over 60 days detachment. Detachment at 25th day, 50th & 55th day were early to produce the new flush. On the other hand 30th, 35th, 40th 45th days detachment were late to produce

the flush as compared to time taken for 60 days. Flush production is an indication of successful union in a graft. Grafts healed properly produced new flush quickly. Grafts removed from mother plant after 30 day to 45th day were slow to produce the flush. This can be attributed for development of some unknown physiological disorder to delay the new flush production.

Oliver (1911) reported more success in grafting on to young seedlings whereas Naik (1947) advocated 10-16.5 months old seedlings for better success. In traditional inarching method one year seedling are better & give higher percentage of success. Maharana et al. (1988) & Maharana & Sahoo (1991) advocated detachment of graft after 45 days. All aimed to produce new flush at the earliest.

Number of leaves

Number of leaves in new flush, length of new flush & diameter of the new flush are proportionately increased with latter dates of detachment. During their attachment with mother plants grafts receive photosynthates from the mother plant to sustain and complete the union. Verma (1942) recommended removal of grafts after 10 weeks of grafting. Hayes (1960) reported that grafts can be separated 2-3 months after grafting. However, Nair & Chacko (1962) recommended removl of graft from mother plant at monthly interval up

to 3 months. Average leaf area was highest with 45 day detachment in both stages i.e. 30 and 60 days after removal of the graft. The leaf are was slightly decreased with grafts detached at 20th day and 60th day. No significant result was obtained for thickness of leaves. However, grafts removed in latter dates had thicker leaves than grafts detached at earlier dates. The drymatter content was highest in the grafts detached at 20 days. Production of less number of leaves & slow growth of leaves accumlated more dry-matter in these leaves.

Experiment II

Studies on effect of detachment time on modified inarching in sapota variety Cricket-ball.

Survival of sapota grafts

Grafts detached at 25th days recorded 100% survival at the time of removal from mother plant. The survival was 90% in 55th day detachment and 93.33% in 60th day detachment. Due to insufficient moisture in the moss and incomplete union in the latter dates resulted lower survival with latter dates in initial stage. On the other hand at earlier dates when the process of union was in full-swing the percentage of success was higher at the time of detachment. At 15th day of post detachment period when there was no change in survival percentage with 60th day detachment (93.33%) the survival dropped from 100% to 65% with 20 day detachment and 96.66%

to 80% with 25th day detachment and 98.33% to 88.33% in 30th day detachment. Sapota being a hardy plant and inarching done on to one year old Khirni sotcks (Manilkara hexandra) the percentage of survival remained at higher side in most of the dates. The decline in survival was less than that of mango. However, the mortality rate is indicated below at different dates.

Table 15. **Mortality percentage in Sapota graft in different dates over previous observation**

Days of detachment	Survival at detachment time	Mortality at 15th day	Mortality on 30th day	Mortality on 45th day	Mortality on 60th day
20th day	98.33	42.67	6.67	10.00	8.33
25th day	100.00	35.00	8.34	6.66	8.34
30th day	96.66	16.66	23.34	1.66	1.67
35th day	98.33	10.00	10.00	1.67	28.33
40th day	98.33	3.33	0.00	1.67	1.67
45th day	98.33	0.00	0.00	1.67	1.66
50th day	98.33	0	0	1.67	1.66
55th day	90.00	0	0	0	0
60th day	93.33	0	0	0	3.33

The mortality was higher side in 15th day in earlier dates of detachment i.e. 35 days & below & this trend continued up to 60 days, but in latter dates i.e. 40 days & above, the percentage of mortality remained within 0-3.33%. Singh (1969) recommended Khirini as the best root-stock for higher survival

in Sapota graft. Krochmal (1972) reported modified approach-grafting in sapota as the best method of propagation. The lower percentage of success in earlier date was not so spectacular except 20th, 25th day detachment. Maharana & Sahoo (1991) reported more than 76% success in haging inarching of sapota. The diameter of the graft when recorded just above the point of union revealed no significant result at 15th day, 30th day, 45th day & 60th day after detachment. The increase in growth was very negligible & no abnormal growth was noticed. This indicated no sign of early incompatibility in sapota grafts due to different dates of detachment. New flush was produced lately in earlier dates of detachment and it was 103.33 days with 20th day detachment. On the other hand, new flush appeared after 92 days with 60th day detachmnet. The number of leaves in new flush was lower in earlier detachment and increased in delayed detachment. Similarly, the thickness of leaves was higher in latter dates of detachment than earlier dates. Sapota on one year old Khirini root-stock is highly compatible. As a result better performance was noticed with delayed dates of detachment. No significant difference was observed for leaf area in different dates of detachment. The percentage of dry—matter in leaves was highest (35.02%) in graft detached after 60 days as compared to other earlier dates.

Experiment III

Studies on the effect of inarching time on survival and growth of cashew grafts

Cashew seedlings were inarched starting from November 1st to March 1st at monthly interval and grafts were detached at 45 days after each grafting. The success on these dates were inbetween 93% to 63.75%. November 1st grafts recorded significantly highest percentage of success (93.75%) and in subsequent dates the survival rate declined by 5%, 17.25%, 11.75% and 31% respectively in December 1st, January 1st, February 1st and March 1st grafting (Table 16).

Table 16. **Mortality rate over previous success in Cashew grafts at different dates (%)**

Month	Initial	Mortality at 15th day	Mortality at 30th day	Mortality at 45th day
Nov. 1st	93.75	3.75	0.00	17.50
Dec. 1st	88.75	0.75	3.75	27.50
Jan. 1st	76.25	5.00	6.75	13.75
Feb. 1st	75.00	7.50	8.5	11.25
March 1st	62.75	7.50	6.25	25.00

The decline in survival percentage though gradual but not uniform. The result was different due to different climatic condition. As per the meterological data presented in Table 1 during November the maximum & minimum temperature were 30.9°C & 19.7°C respectively. During the month of November to February the maximum temperature was in between 29.2°C to 36.1°C and minimum 21.4°C to 28.4°C. Relative humidity

during this period was 63% to 68% and sunshine hours was 6.62-8.7 hours Rao (1957) reported 100% success during Novemer 80% in March & 60% in October by conducting approach grafting in cashew at monthly interval. The present finding corroborate with the findings of Rao (1957), Albergeria (1967) suggested long shoot already with new flush for some time are good for grafting. Sahani et al. (1970) reported good success in Cashew by doing sidegrafting during October.

Higher percentage of success in cashew during the month of October hs been reported from cashew Research Station, Vengurula. The union in grafting is a healing process of wounds of stock & scion. In many plants the rate of callus formation increses with increasing temperature. But very high temperature during April desiccated the parenchyma cells formed during union. As a result, the percentage of success was low. During November to March relative humidity remained in between 63%-68% which is ideal for cell development & union.

In the post detachment period mortality rate was low at 15 days & 30th day but it was very high at 45 days stage. This can be attributed to unsuccessful union in cashew grafts during these months. There might have been intermingling & interlocking of cells in cashew grafts which helped to sustain them for a short time. Therefore, the success was high in the beginning but slowly the mortality increased during postdetachment period. The high mortality (27.5%) in the

CHAPTER VI

SUMMARY AND CONCLUSION

SUMMARY AND CONCLUSION

The present investigation entitled "Standardization of modified inarching in mango, sapota and cashew" was carried out in Bhubaneswar agroclimatic condition during May, 1992-May, 1993. Altogether 3 sets of experiments were conducted as stated below.

1. studies on effect of detachment time on modified approach-grafting in mango variety Banganpalli.
2. Studies on effect of detachment time on modified approach grafting in sapota variety Cricketball.
3. Studies on the effect of inarching time on survival and growth of cashew grafts.

The objectives of the investigation were as follows

1. To find out the effect of time of detachment of mango grafts produced in modified inarching on survival & growth.
2. To find out the time of detachment of sopata grafts produced in modified inarching on survival & growth
3. To study the effect of time of inarching on survival and growth of cashew grafts.

Methodology

Mango seedling of 45 days old, one year old khirini seedling & 3 to 4 monthes old Cashew seedlings were used as root-stock. Mango & Khirini seedlings were packed in polythene bags conntaining 20 gram moist moss treated with 1% bavistin. Cashew seedling were raised in polythene packets in soil mixture. Sapota Mango seedlings were kept under shade for 15 days. Inarching was done at 5 days interval starting from 4.7.92 to 5.7.92 & respectivelly for mango & Sapota. During the process of union the grafts were remained in hanging position nourished by moist moss. The mango & Sopata grafts were detached from mother plant on 2.9.92 & 3.9.92 respectively for mango & sapota to obtain grafts of 20 days, 25 days, 30 days, 35 days, 40 days, 45 days 50 days, 55 days & 60 days old. The grafts were maintained in nursery and observations were recorded on survival, diameter of the grafts, production of new flush, leaf area, leaf thickness etc. In case of cashew, inarching was done on 1st of November, December, January, February and March. Grafts were detached at 45 days after inarching observation were recorded on the characters as stated above. The salient research findings are as follows.

Mango

1. Highest survival was recorded with 50 day and 55 day detachment i.e. 76.66% survival.
2. Only 18.33% plants survived with 20 day detachment.

3. 60 day detachment seems to be undesirable.

4. With early detachment time the success was poor.

5. The diameter of mango grafts were uniform in different treatfments. No symptoms of incompactibility was noticed.

6. Time taken to produce the new flush was dependant upon age of the garft.

7. As compared to 60 days graft new flush production was earlier in 20, 25, 50, 55 day detached grafts.

8. Highest number of leaves were produced in new flush with grafts detached at 60 day.

Sapota

1. Sapota responded very well to modified inarching than mango.

2. The highest percentage of success was observed with 50 days detachment 95%.

3. To get more than 90% survival sapota grafts may be detached 40 days onwards after grafting.

4. There was not much abnormality in growth of diameter of the graft indicating symptoms of good compatibility.

5. New flush appeared at the earliest with 60 days grafts i.e. 92 days after grafting.

6. Number of leaves was highest (17.33) in 60 days detachment.

7. Much change was not noticed for several foliar characters indicating symptoms of good compatibility.

Cashew

1. Highest percentage of success was observed in November 1st inarching (72.5%).
2. Inarching during the months of December, January, February and March are unsuitable.
3. High mortality was observed by inarching during March (25%).
4. November 1st grafts continued with proper growth by higher diameter of the graft.
5. Longer new shoot of 16 cm was produced with November 1st inarching.
6. Highest number of leaves and total leaf area was observed in November 1st inarching.
7. February and March 1st inarching were not suitable.
8. The total leaf area was drastically reduced in March 1st inarching.

CONCLUSION

Since 1988 Moharana *et al.*, Maharana and Sahoo have tried the modified inarching or hanging inarching in mango and sapota. Earlier it was established by Moharana *et al.* that

mango cv. Banganpalli and sapota Cv. Cricketball are suitable for hanging inarching. During 1991 Maharana and Sahoo established that 20 grams moist moss is optimum to sustain mango or Khirni rootstock during the graft union and nutrient solution was beneficial for the growth of rootstock. In the present investigation it was established that in hanging inarching mango and sapota grafts should be detached at 50 days after grafting. However, detachment in sapota may start 40 days after but not in mango.. Further, in offseason inarching of cashew in November 1st inarching is highly encouraging. Lastly it can be recommended that commercial production of mango and sapota grafts may be done by hanging inarching and future study may be taken in cashew to get higher success in offseason inarching.

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APPENDIX

APPENDIX-I

Sources of variation	Degree of freedom	Effect of detachment on survial of mango grafts Mean sum of square				
		'0' day	15 D	30 D	45 D	60 D
Replication	2	25.211	10.7887	7.103	9.08	2.311
Treatment	8	37.146*	223.325*	239.977*	44.256*	589.107
Error	16	11.537	8.677	6.917	9.66	8.342
Total	26					

* Significant at 5%

APPENDIX-II

Sources of variance	Degree of freedom	Effect of detachment on girth of mango graft above the point of union Mean sum of square			
		15 D	30 D	45 D	60 D
Replication	2	0.0003	0.0001	0.0001	0.0001
Treatment	8	0.0016*	0.0023*	0.0017*	0.0016*
Error	16	0.0005	0.0007	0.0005	0.0006
Total	26				

* Significant at 5%

APPENDIX-III

Sources of variation	Degree of freedom	Leaf area of mango grafts after detachment Mean sum square	
		30 D	60 D
Replication	2	2.709	0.486
Treatment	8	18.983*	21.328*
Error	16	2.355	2.139
Total	26		

* Significant at 5%

APPENDIX-IV

Source of variation	Degree of freedom	Effect of detachment on survival of sapota grafts				
		Mean sum of square				
		0 D	15 D	30 D	45 D	60 D
Replication	2	6.481	5.552	28.485	16.767	22.609
Treatment	8	30.093*	453.195*	704.66*	783.213*	926.932*
Error	16	6.482	23.314	36.264	28.653	8.272
Total	26					

* Significant at 5%

APPENDIX-V

Source of variation	Degree of freedom	Effect of detachment on girth of sapota graft			
		Mean sum of square			
		15 D	30 D	45 D	60 D
Replication	2	0.0007	0.00058	0.00016	0.0004
Treatment	8	0.0006 NS	0.00058 NS	0.00078 NS	0.00059 NS
Error	16	0.0006	0.00051	0.00091	0.00064
Total	26				

NS - Not significant

APPENDIX-VI

Source of variation	Degree of freedom	Leaf area of sapota graft after detachment	
		Mean sum of square	
		30 D	60 D
Replication	2	0.030	
Treatment	8	1.660 NS	
Error	16	1.230	
Total	26		

NS - Not significant

APPENDIX-VII

Source of variation	Degree of freedom	Success of cashew grafts after detachment Mean sum of square '0' D	15 D	30 D	45 D
Replication	3	11.504	1.898	7.26	6.60
Treatment	4	370.64*	384.92*	511.24*	423.95*
Error	12	21.98	9.976	12.20	
Total	19				

* Significant at 5%

APPENDIX-VIII

Source of variation	Degree of freedom	Mean sum of square Shoot length	Stem girth	Leaf No.	Leaf area
Replication	2	0.733	0.0078	1.33	8824.197
treatment	8	6.875 NS	0.032*	30.20*	199887.36*
Error	16	2.108	0.0073	1.66	11031.765
Total	26				

NS - Not significant

* .- Significant at 5%