STANDARDISATION OF THE TECHNIQUE OF STONE-GRAFTING IN CASHEW (*Anacardium occidentale* L) AND MANAGEMENT PRACTICES FOR FIELD ESTABLISHMENT

By

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THESIS

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the requirements for the degree of

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DECLARATION

I hereby declare that this thesis entitled "Standardisation of the technique of stone-grafting in cashew (*Anacardium occidentale* L) and ~~budding~~ management practices for field establishment" is a bonafide record of research work done by me during the course of research and that the thesis has not previously formed the basis for the award to me of any degree, diploma, associateship, fellowship or other similar title of any other University or Society.

Shylaja 23/4/84

Vellanikkara,
23 -- 4 --1984.

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CERTIFICATE

Certified that this thesis entitled "Standardisation of the technique of stone-grafting in cashew (*Anacardium occidentale* L) and management practices for field establishment" is a record of research work done independently by Mrs. Shylaja, M.R. under my guidance and supervision and that it has not previously formed the basis for the award of any degree, fellowship or associateship to her.

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CERTIFICATE

We, the undersigned members of the Advisory Committee of Mrs. Shylaja, M.R. a candidate for the Degree of Master of Science in Horticulture agree that the thesis entitled "Standardisation of the technique of stone-grafting in cashew (*Anacardium occidentale* L) and management practices for field establishment" may be submitted by Mrs. Shylaja, M.R. in partial fulfilment of the requirements for the degree.

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To my parents

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Introduction

INTRODUCTION

In recent times, cashew has assumed the role of a chief dollar earning tree crop in the country. In spite of its agricultural, industrial and commercial importance, little attention has been paid till recently in the improvement of this crop. The expansion of area under cashew envisaged in the state of Kerala has necessitated the production of quality planting materials on large scale.

Selection and multiplication of high yielding types has been recognized as an important aspect of cashew improvement. The most desirable practice of multiplication of selected types is through vegetative propagation. Although vegetative propagation like air-layering has been found to be successful in cashew, the low percentage of establishment of layers in the field continues to be a major problem. The high mortality of cashew layers in the nursery and after planting in the main field has been the main impediment in the multiplication of cashew through air-layering. This has necessitated the search for alternative methods of vegetative propagation.

Stone-grafting which has met with high degree of success in mango has been reported to be successful in cashew in other cashew growing states of South India. This

method has been adopted on a commercial scale in the state of Maharashtra. Trials conducted in the state of Kerala has also shown that stone-grafting is feasible in cashew. However, standardisation of this method to suit the conditions prevalent in our state is necessary before this method can be recommended for wide scale adoption.

Under the above circumstances the present study was taken up at the College of Horticulture, Vellanikkara, Kerala with the following objectives.

1. To find out the best season of grafting under Kerala conditions.
2. To standardise the technique of stone-grafting.
3. To study the effect of precuring of scions on the ultimate take of the grafts.
4. To identify the proper size, thickness and age of the rootstock and scion material in order to get better results.

Review of Literature

REVIEW OF LITERATURE

The different factors that affect the success of grafting and budding in cashew and other related horticultural crops are briefly reviewed here.

2.1. Effect of season

2.1.1. Stone-grafting

Stone-grafting, also known as epicotyl grafting or bench grafting was standardised in mango by Bhan et al. (1969). They developed this new, simple and economic method of propagation of mango, utilising seedlings immediately after germination. Sprouting mango stones with developing epicotyl were used as rootstocks. Semi mature terminal shoots of about 12 to 15 cm long with leaves having passed the purple colouration stage were used as the scion for grafting. They suggested that for best results the scion and the rootstock should be plump, vigorous and of uniform thickness. Grafting could be undertaken either by cleft or whip method and they could obtain a success of 75 to 85 per cent.

The work on stone-grafting in cashew was started at different Cashew Research Stations in the country during 1978-79. From the initial trials conducted at Bhubaneswar, it was observed that stone-grafting using the emerging seedlings of VTH-174 and scions from four different accessions viz., VTH-155, VTH-164, VTH-169 and

VTH-170 gave very poor take of eight per cent (Anon, 1979). However, success of more than 50 per cent was reported from other Cashew Research Stations like Vittal in Karnataka and Madakkathra in Kerala. The work on epicotyl grafting was initiated at Vengurla in Maharashtra during 1980 and it was observed from two years trials that the period from February to May was most congenial and the success varied from 60.5 to 71.6 per cent on 10 days old seedlings (Anon, 1983). The work carried out at the Cashew Research Centre, Madakkathra, Kerala, also showed that maximum success in epicotyl grafting in cashew was in summer months especially during the months of March, April and May (Anon, 1983).

Nagabhushanam and Mohan (1982) obtained a success of 30 per cent for stone-grafting in cashew when done in July followed by the month of August at the Cashew Seed Farm, Shantigodu, Karnataka. They also observed that the success gradually declined from 15 per cent in September to five per cent in November. They concluded that high humidity and heavy precipitation occurred during June, July and August months had a beneficial effect on the success of epicotyl grafting in cashew.

In mango, the monsoon period was generally found suitable for stone-grafting. Upadhyay and Gupta (1979)

obtained a success of 80 to 85 per cent when grafting was done during July-August under Basti conditions. In Bihar the highest success of 60 to 90 per cent was reported during the months of July to October (Mandal, 1979). Dhakal (1979) and Dengale (1980) recommended the period from June to September as the best time for epicotyl grafting in mango under konkan conditions. Subsequent studies by Gunjate et al. (1982) also showed that the period from June to September is the most congenial period for stone-grafting under konkan conditions. They could obtain a success of 62.2 to 64.7 per cent during these months. The success was reduced to 55.6 per cent in October and to 35.5 per cent in November. They observed that the success in stone-grafting was positively related to humidity and minimum temperature. The positive correlation of success in stone-grafting in mango with relative humidity and temperature was also reported by Patel and Amin (1976).

Kolekar (1979) was of the opinion that epicotyl grafting could be successfully employed for vegetative propagation of jackfruit. In contrast to mango, the summer period was found to be most suitable for stone-grafting in jack. Under Konkan conditions he obtained a success upto 90 per cent in the month of April. Harnekar (1980) found that the month of June followed by March or April was best suited for epicotyl grafting in

jack under Konkan conditions. Thus the rainy season appeared to be unsuitable for epicotyl grafting in jack.

2.1.2. Veneer grafting

Work on veneer grafting in cashew was started at the Regional Cashewnut Research Station, Vengurla during 1972. A trial on in situ veneer grafting was conducted for a period of five years and it was observed that the month of September was most congenial for getting maximum success and about 86 per cent success was obtained during that month. Under Bapatla conditions veneer grafting in situ on six months old seedlings gave maximum success of 84 per cent in July followed by 80 per cent in August (Anon, 1983). Studies on the different methods of vegetative propagation of cashew viz., side grafting, veneer grafting, wedge grafting and patch budding were carried out at the Cashew Research Station, Madakkathra, Kerala during the year 1974-78. The highest percentage of success was obtained during the monsoon period for the different methods tried (Valsalakumari, et al. 1979). Rao and Nagabhushanam (1979) also found monsoon period as the most suitable time for veneer grafting under Karnataka conditions. They obtained 85 to 96 per cent take during the month of July. The rainfall and relative humidity were found to be highly correlated with per cent of success of veneer grafting. But under Konkan condition maximum success of 40 per cent was obtained during the

months of September and December (Harnekar, 1980). Monsoon period thus appeared to be unsuitable for veneer grafting in cashew in Konkan area.

In mango, Mukherjee and Majumder (1964) observed that March to July is the most successful period for veneer grafting under Delhi conditions. During this period growth of grafts was also found to be most vigorous. Prasad et al. (1973) conducted studies on the comparative performance of veneer grafting and patch budding. The results indicated that veneer grafting was significantly superior to patch budding in respect of percentage of success and vigour of sprouts. They found that July was the best period for veneer grafting in mango. Ram and Bist (1982) also observed that under Tarai conditions of Punjab, the months of June, July and August were best periods for veneer grafting during which 100 per cent take could be obtained in the case of mango.

In Guava, Bhandary and Mukherjee (1970) reported maximum success in veneer grafting during July compared to March, June or August. The take was 85 per cent during July, but with older scions, it was less successful. Rao and Kaul (1977) also observed July as the best month for veneer grafting in guava. The growth and leaf production was also highest during this season. Dipping the scion in Kinetin before grafting was detrimental to graft take and made little difference in subsequent growth.

2.1.3. Inarching

Rao and Rao (1957) carried out trials on inarching in cashew at the Central Cashewnut Research Station in Mangalore. Monthly grafting operation was done and the highest take (100 per cent) was obtained in November followed by March (80 per cent). The most successful period for approach grafting coincided with the active period of flowering and fruiting. Rao and Rao (1957) found that the period between January and June was congenial for satisfactory graft union in cashew.

Propagational trials conducted at Cashew Research Station, Kottarakkara revealed that the period from July to October was best for undertaking inarching under Kerala conditions (Anon, 1962). Under Andhra conditions inarching recorded 52 to 96 per cent success from July to December when done on seven month old cashew seedlings (Rao, 1979).

According to Naik (1941) the optimum time of inarching in mango seedlings was from February to July in South India. This was found true for Punjab also (Mukherjee, 1953). Singh (1960) pointed out that the success of inarching depended to a great extend on weather condition prevailing during the operation. Hot and dry periods and heavy rainfall conditions were injurious and hence in North India inarching was done

from July to August and February to March and in South India it was done in January to February.

Ahamed (1966) reported that in Pakistan inarching was successful to an extend of 80 per cent in the case of guava.

2.1.4. Side grafting

The first trial on side grafting in cashew in India appears to be that carried out by Rao et al. (1957c). He could not obtain good results in this method of propagation in cashew.

Anon (1978) reported that the highest success in vegetative propagation such as side grafting, veneer grafting and patch budding in cashew was obtained during the monsoon season commencing from June to September at Anakkayam, Kerala. At Vridachalam also maximum success of 81 per cent was obtained in July, while at Bubhaneswar the best month was found to be January when 88 per cent success was obtained.

Sahani and Patroe (1979) reported that side grafting in cashew could be successfully done in both the seasons viz., during spring (February to April) and during monsoon (July to October). The percentage of success obtained in the above two seasons was 46.50 and 44.75 respectively. Side grafting done on 1½ to three years old plants was found to be successful during June to September to an extent of 50 to 90 per cent under Vengurla conditions (Anon, 1983).

2.1.5. Soft wood grafting

Studies at the Regional Cashewnut Research Station, Vengurla had shown that soft wood grafting could be undertaken throughout the year with considerable degrees of success (65 to 96 per cent) except in December, when the success was found to be only 25 per cent (Anon, 1983). At Bubhaneswar soft wood grafting done at monthly intervals had shown that the period from May to July was congenial for undertaking soft wood grafting and the percentage of success was found to be over 50 per cent (Anon, 1983).

Patel and Amin (1981) studied the best period for soft wood grafting of mango *in situ* and they found that grafting between the third week of May and third week of August resulted in 95 to 100 per cent success.

2.1.6. Patch budding

The success of budding in cashew has been tried by various workers in different places. Naik (1949) observed that patch budding was successful in cashew. Phadnis *et al.* (1974) found that patch budding was superior to veneer grafting on one year old root stock plants during September to November in Maharashtra. Palaniswamy and Hameed (1976) in Tamil Nadu obtained 71 per cent success in patch budding when done in July. Bhatte (1977) claimed a success of five to fifty eight per cent for bud grafting if done on two year old seedlings in September-October under Goa conditions.

Singh and Singh (1954) recommended patch budding in mango as a better method of propagation when done during June under Uttarpradesh conditions. But Teotia and Maurya (1970) observed March as the best month for patch budding in mango under Basti conditions.

2.2. Effect of prior defoliation of scion shoots

Prior defoliation of scion shoots is one of the factors which determines the success of most of the budding and grafting operations.

Mukherjee and Majumder (1964) reported that in mango, the success of veneer grafting was very poor when done with scion sticks which were neither forced by defoliation nor enlarged. Kashyap et al. (1972) observed 20 to 30 per cent increase on the percentage of success for side grafting in mango when the scion shoots were defoliated 10 days before grafting. Gunjate and Limaye (1977) observed almost equal success in stone-grafting in mango with and without prior defoliation of scion shoots. According to Dhakal (1979), defoliation of scion shoots did not produce any beneficial effect on per cent of success in stone-grafting in mango. Singh and Srivastava (1981) observed that scions taken from February-March flush with ten days defoliation gave maximum success of 70 per cent where as the May-June flush with five days

defoliation recorded the least (23 per cent). Ram and Bist (1982) obtained better results with defoliated scions than with undefoliated scion for veneer grafting in mango.

Prior defoliation of scion shoots was found to be beneficial for budding also. Janhari and Singh (1970) studied the effect of bud activation on budding in mango. The best results were obtained in July by activating buds two weeks before budding.

2.3. Effect of method of grafting on percentage take

In mango, Bhan et al. (1969) did not notice any substantial difference between the two methods of grafting tried viz., whip and cleft for epicotyl grafting in mango. They obtained a success of 75 to 85 per cent in both these two methods. Patel and Amin (1976) tried bench grafting on one to two weeks old mango seedlings under Anand conditions. They found that all the techniques tried viz., whip, tongue, wedge and splice were equally good at the initial stages. The final success recorded was highest for whip followed by tongue, wedge and splice methods. In order to standardise the best method of epicotyl grafting in mango, Singh and Srivastava (1981) tried four methods viz., cleft, side, whip and tongue. Among these methods cleft grafting gave better results than others. Gunjate et al. (1982) did not find much

difference in the success in stone-grafting when done by splice, modified wedge and wedge methods of grafting. The success with splice and modified wedge method was slightly better than wedge method. But for ease and convenience wedge method was preferred for commercial use.

At Mozambique, Ascenso and Milheiro (1973) tried mini grafting in cashew by adopting two methods viz., cleft and splice. They used rootstocks and scions of three to five mm in diameter for the grafting operation. For both the methods they got 100 per cent success. Nagabhushanam and Mohan (1982) suggested that epicotyl grafting in cashew could be done either by the cleft method or splice method with little difference between these methods. A success of 20 to 30 per cent could be obtained by the above methods.

2.4. Effect of age of rootstock and scion

2.4.1. Epicotyl grafting

The age of the rootstock and scion also influences the success in grafting. Dhakal (1979) reported that scion shoots of more than two months old and stocks of less than two weeks old were more suitable for stone-grafting in mango. He obtained a success of 60 per cent for one week old seedlings

followed by 58 per cent success for two weeks old seedlings. Dengale (1980) found that one week old seedlings were the best for stone-grafting in mango. He obtained the maximum success (73.3 per cent) and maximum growth of stone-grafts with one week old mango seedlings. Singh and Srivastava (1981) tried stone-grafting using seedlings of two to ten days old and obtained the highest percentage of success (85 per cent) with five days old rootstock, followed by four days old rootstock (80 per cent). The result of a trial conducted at Konkan Krishi Vidyapeeth, Dapoli indicated that ten days old rootstocks were more suitable for stone-grafting in cashew compared to 20 days and 30 days old rootstocks (Anon, 1982). Maximum success of 69.2 per cent was obtained in May for ten days old rootstocks.

2.4.2. Inarching

According to Burns and Prayag (1920) 1½ to 2 years old seedlings were the best as stock seedlings for inarching in mango. But Pope and Storey (1933) was of the opinion that stocks of six to eight months old could also be successfully used. The use of still younger rootstocks was reported by Verma (1942) and Singh (1951). Verma got better results by using six to eight weeks old seedlings as stocks and equally tender shoots as scions.

But two to three weeks old seedling rootstocks were found to be best by Singh (1951). He found rapid healing of graft union and vigorous growth of scion after the detachment of grafts from the mother tree when two to three weeks old seedling rootstocks were used.

2.4.3. Veneer grafting

For veneer grafting in cashew seedling rootstocks of below six months old would be successfully employed. Phadnis (1974) found that seedling rootstocks of less than five months old with a girth of four to five cm and less than 50 cm height were the best. Nagabhushanam and Rao (1977) tried veneer grafting on rootstocks of various ages. Significantly higher take was obtained (96 per cent) on six months old stocks than with 15 to 20 months old stocks. The superiority of six months old rootstock over eight, five, four and three months old rootstock was also reported by Anon (1982). The results of the propagational trial conducted at Regional Cashew Research Station, Vengurla indicated that the percentage of success of the grafts prepared with four months old scion was significantly superior over three and five months. The highest success of 83 per cent was obtained when four months old scion was grafted on six months old rootstock (Anon, 1983).

Mukherjee and Majumder (1964) while studying the effect of different factors on the success in veneer grafting in mango found that the scion sticks of less than three months old were unsuitable. Scion sticks older than three months when used did not produce any good results. The increase in the percentage of take by the use of mature scion wood was also reported by Jagirdar and Bhatti (1968). They found that the age of the rootstock did not affect percentage success of grafting. But Rajput and Haribabu (1971) observed that the age of the scion must be more than three months for better success in veneer grafting in mango.

2.4.4. Splice grafting

For splice grafting in cashew two to four months old rootstocks were found to be good. Lefebvre (1971) obtained 95 per cent success when three months old seedlings of about five mm diameter were used. With ten weeks old seedlings having a diameter of three to five mm, Ascenso and Milheiro (1973) obtained a success of 100 per cent. Parente and Maciel (1973) obtained best results with six months old seedlings as root stocks. Ferraz et al. (1974) on the other hand, found four months old seedling stocks were the best compared to two, four, six and eight months old stocks.

2.4.5. Patch budding

Peixoto (1960) recommended root stocks of ten months old for better results in patch budding in cashew. Phadnis et al. (1974) used seedlings of 12 to 18 months old. They observed that when the age of the rootstock was increased the percentage of success also increased. They got a success of 67 per cent with 17 and 18 months old rootstocks. Parents and Maciel (1973) obtained good results with rootstocks of three, six and nine months. Ferraz et al. (1974) obtained 99.7 per cent success with eight months old rootstocks followed by 69 per cent with six months old rootstocks. The percentage of success on rootstocks of two and four months old were only four and 13 respectively.

Length and girth of the stock and scion also influence the success in grafting and budding. Giri (1966) reported that the percentage of success with seedlings of girth 1.3 to 1.6 cm was significantly higher than those of 1.0 to 1.29 cm and 0.77 to 0.99 cm for inarching in mango. For side grafting in mango, scions of 7.5 cm long were more suitable than 15.0 and 22.5 cm long (Kanwar and Bajwa, 1974). Ram and Bist (1952) used scion shoots of five to 15 cm long for veneer grafting in mango and obtained maximum success of 80 per cent with 10 cm long scions.

2.5. Other factors that affect success in grafting

2.5.1. Response of different promising types of cashew to epicotyl grafting

The response of different promising types of cashew to epicotyl grafting was reported by Anon (1983). Six types were selected for the grafting operation and the percentage of success recorded one month after grafting had shown that among the six types tried, BLA 39-4, BLA 139-1 and K-22-1 recorded the maximum percentage of success of 81.17, 77.16 and 71.61 per cent respectively. The other three types viz., H-3-13, NDR 2-1 and H-3-17 recorded 65.13, 62.12 and 58.05 per cent take respectively.

Stock scion compatibility in epicotyl grafting was also studied at the Regional Cashew Research Station, Madakkathra, Kerala (Anon, 1983). In the trial, four promising types of cashew were used as rootstocks and scions in all possible combinations. They found that there was no incompatibility problem among the types in any of the combinations tried. The type BLA 39-4 recorded better percentage of take on its own rootstock. Among the different types used as rootstocks, BLA 39-4 and BLA 139-1 appeared to be the best.

2.5.2. Effect of various methods of protection of grafts and graft union in epicotyl grafting

Nagabhushanam (1982) obtained a success of 30 per cent for stone-grafting in cashew by adopting simple whip and cleft method. He could increase the percentage of success to 60 by capping the scion with a narrow polythene bag and securing at the base with a rubber band. The idea was to prevent the descication of the scion by providing high humidity. At Regional Cashewnut Research Station, Vridachalam, the epicotyl grafts immediately after the operation were kept in open sun, under partial shade and inside the mist chamber. Under open sun none had sprouted, under partial shade percentage of take was only 15.1 while under mist it was 85 per cent. Eventhough the graft take was more inside the mist chamber, after the formation of four to five leaves the rootstock started rotting from the point just below the graft union. Trials are in progress at the station to find out the cause for the rotting of rootstock (Anon, 1983).

Materials and Methods

MATERIALS AND METHODS

The present investigations were carried out in the College of Horticulture, Vellanikkara to standardise the technique of epicotyl grafting in cashew. The main objectives of the study were to standardise the most suitable season for grafting operation under Kerala conditions, to find out the effect as well as the duration of precuring of scions on the graft uptake, to determine the proper size, thickness and age of the rootstock and scion material, to standardise the best method of grafting and to assess the success of graft take under mist.

3.1. Standardisation of the season, method of grafting, nature of precuring and effect of mist on percentage of success of graft union

The experiment to standardise the season, the method of grafting and the nature of precuring consisted of the following six treatments.

T1 - 10 day precuring cleft method

T2 - 10 day precuring splice method

T3 - 5 day precuring cleft method

T4 - 5 day precuring splice method

T5 - Without precuring cleft method

T6 - Without precuring splice method

A sample of 50 plants was used to study the effect of each treatment. The experiment with the above six treatments was conducted at monthly intervals from June, 1982 to May, 1983.

Root stocks required for the various treatments were raised by monthly sowing of the seeds collected during March, 1982. The seeds were dried uniformly and stored in sealed polythene bags under room temperature. About 600-850 seeds were sown every month to get enough seedling rootstocks. The seeds were sown in polythene bags of size 15 x 20 cm in a medium consisting of sand, soil and cowdung in equal proportions. The first sowing was done during May, 1982 and was continued till May, 1983. The viability of the seeds progressively declined and in order to compensate the loss, sufficient number of seeds were sown.

From the germinated seedlings, 300 vigorous seedlings of uniform girth and height were selected (Plate I). The grafting operation was done at monthly intervals during the second week of every month on five to seven days old rootstocks using scion sticks collected from the type NDR 2-1 maintained at the Cashew Research Station, Madakkathra. The type NDR 2-1 is a selection obtained from Naduvathur of Kerala State. Three to four months old dormant terminal shoots about six to eight cm long and 2 to 2.5 cm thick, brown in colour and with swollen buds were used as scion material for the grafting (Plate III). The grafted plants were kept under shade till the successful establishment of the grafts. The successful grafts after three months of the operation

were transplanted in polybags of size 30 x 45 cm in a media consisting of sand, cowdung and soil in equal proportions. Drenching the soil with a mercuric fungicides like Aretan' was also done at fortnightly intervals as a prophylatic measure against the soil borne fungal diseases.

Observations on the percentage of success of all the six treatments were recorded twice viz., one month and two months after the grafting operation. The graft take was more or less stable after two months and hence observations on the percentage of success was restricted to two months after grafting. The data taken two months after the operation were analysed statistically to standardise the most suitable period of grafting, the method of grafting and nature of precuring.

3.1.1. Standardisation of the season

To standardise the season of grafting observations on graft take for different treatments were pooled in each month and the effects of the seasons were tested for significance using chi-square test as suggested by Snedecor and Cochran (1967). The relevant formula used is as given below:

$$\chi^2 = \frac{\sum (f - F)^2}{F}$$

where χ^2 = chi-square

f = Observed frequency of success

F = Expected frequency of success

$$= \frac{Ri \times Cj}{N}$$

where Ri = Row total

Cj = Column total

N = Grand total

with degrees of freedom (r - 1) (C - 1)

where r = Number of rows and

C = Number of columns

3.1.2. Standardisation of the method of grafting

To standardise the best method of grafting, data were pooled over different seasons and periods of precuring and the pooled data were subjected to chi-square analysis as described earlier.

The methods of grafting tried in the experiment were cleft and splice. In cleft method of grafting the root-stocks were decapitated four cm above the cotyledons and perpendicular cuts about three cm long were made in the centre of the stocks. The precured scion shoots were given slanting sharp cuts on either side to give an exact fit matching the cambial layers of both the stock and the scion. The scion sticks so prepared were then inserted into the clefts of the stocks. After insertion of the scion into the cleft of the stock, the graft union was fastened with a polythene ribbon of 150 gauge for the graft joint to heal in due course (Plate IV - VIII).

In splice method the scion was given a slanting cut of four to six cm on one side and a similar cut on the top of the stock seedling. The cut surfaces of both the stock

and scion were matched together and tightly wrapped with polythene film (Plate IX - XII).

3.1.3. Effect of precuring (prior defoliation) of scion shoot on percentage success of graft union

To study the effect of precuring of scion shoots on the success in stone-grafting, data were pooled over season and method of grafting and the pooled data were subjected to chi-square analysis. The scion sticks were given two different duration of precuring viz., five days and ten days ahead of the grafting operation. The precuring was done by clipping ½th of the lamina with a pair of scissors and leaving ½th of the lamina intact.

3.1.4. Effect of mist on the percentage success of graft union

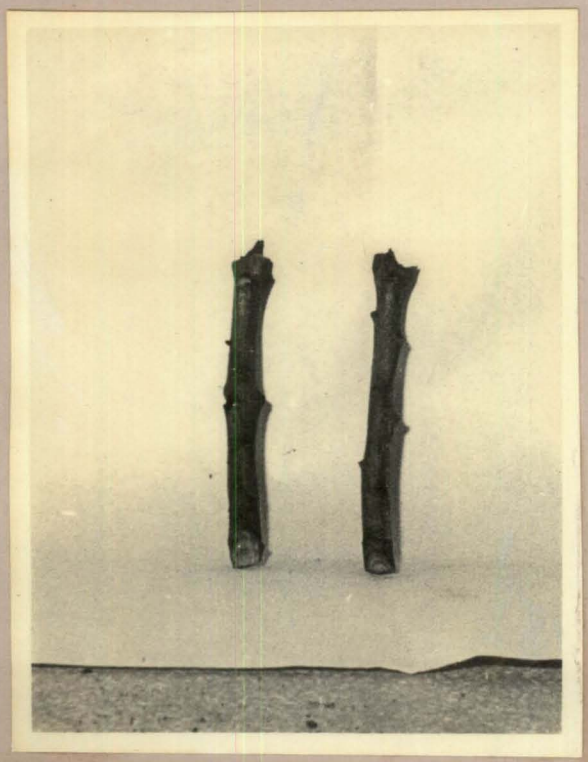
The influence of high percentage of humidity on graft take was also studied. For this 25 grafts under each treatment were kept in open and in mist condition. This study was done from August, 1982 to December, 1982. Mist condition was created by spraying water to the mist chamber made of thick polythene sheets thrice daily with a sprayer. The meterological observations like maximum and minimum temperature and relative humidity inside and outside the mist chamber were recorded during the course of study. In order to find out the influence of

Plate 1. The rootstock ready for grafting

Plate 2. Selected scion shoot

Plate 3. Scion sticks after precuring with apical dormant buds

Plate 4. The rootstock with transverse cut given about 4 cm above the cotyledons



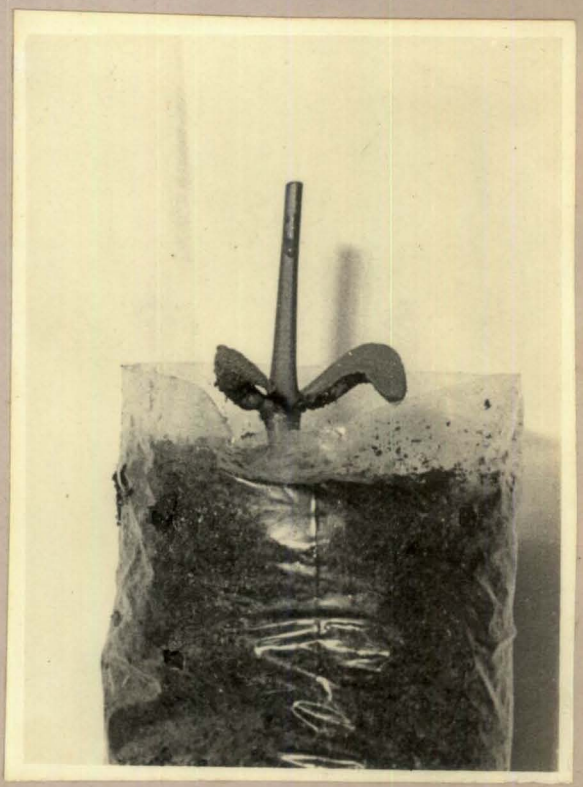
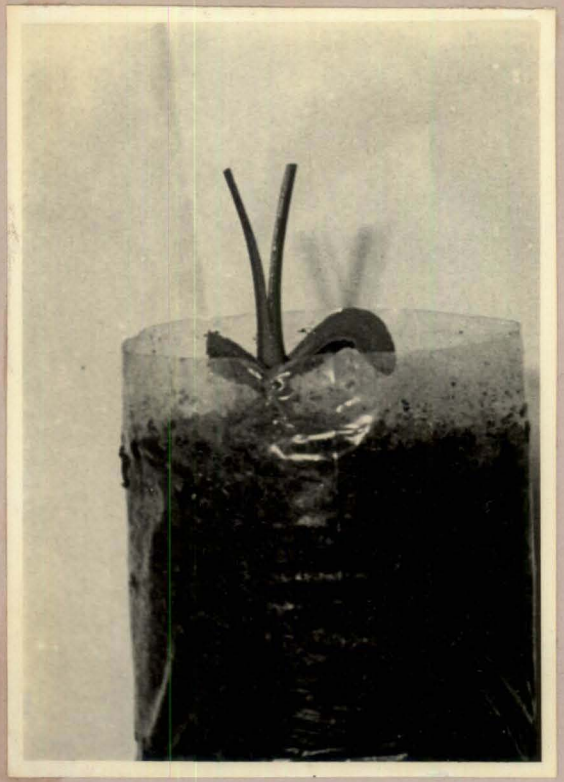


Plate 5. The rootstock with the cleft made in the middle

Plate 6. Scion stick with slanting cuts on either side

Plate 7. The prepared scion material after insertion into the cleft of the stock

Plate 8. The graft joint after securing with a plastic ribbon



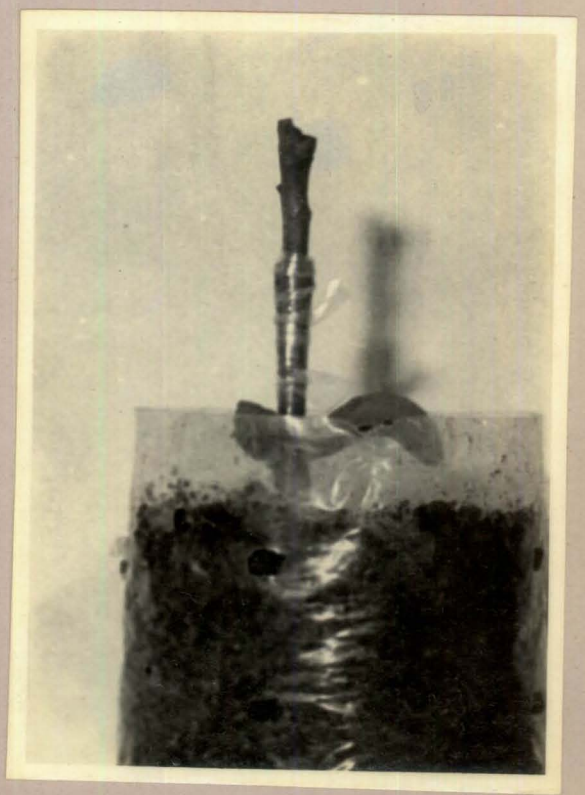
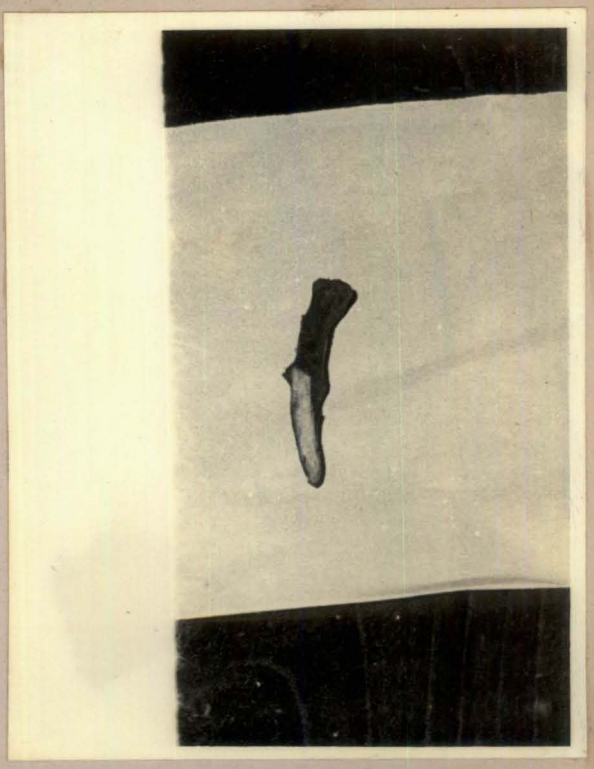


Plate 9. The rootstock with a slanting cut on top

Plate 10. Scion stick with slanting cut on one side

Plate 11. The cut surfaces of both the stock and scion joined together

Plate 12. An epicotyl graft



mist over open condition the number of successful grafts in open and mist condition was compared using chi-square test. The weather factors such as relative humidity maximum and minimum temperature of both open and mist condition were compared by applying the paired 't' test as given by:

$$t = \frac{\overline{ldl}}{sd}\sqrt{n-1}$$

where n = Number of samples

d = difference in paired values of the weather factors in open and mist condition

The relationship between the effect of weather factors on the ultimate take of the grafts was studied by calculating simple linear correlation coefficients.

Growth behaviour of grafts

For the purpose of observations, representative samples of size of ten were taken from each treatment.

The following different vegetative growth parameters were taken at fortnightly intervals from June, 1983 to September, 1983.

a. Height - The height of both stock and scion was taken separately. The height of the stock was measured from the ground level to the middle of the graft joint and that of the scion from the middle of the graft joint to the tip.

b. Girth - Girth of both the stock and scion was also taken separately. Girth of the stock was measured 2.5 cm from the soil surface and that of the scion 0.5 cm above the graft joint.

Growth rate of stock and scion during different periods for various treatment was estimated by fitting a simple linear regression equation of the form $Y = a + bt$.

where Y = Expected value of the variable at time 't'

b = Linear growth rate

a = Y intercept

With a single independent variable the tests of significance of linear regression coefficient is equivalent to that of simple correlation coefficient. Hence the correlation coefficients were transformed using the Z transformation and the significance of the differences between growth rates of stock and scion were tested by using the Z test given by:

$$\frac{Z_1 - Z_2}{\sqrt{\frac{1}{n1 - 3} + \frac{1}{n2 - 3}}}$$

where $Z_i = \frac{1}{2} \log_e \frac{1 + ri}{1 - ri}$

i = 1 or 2

ri = Simple correlation coefficient

The data on the ratio of the girth of the stock to girth of the scion was analysed by analysis of variance and

significant results were compared after finding out the critical difference.

3.2. Effect of the age of the rootstock on success in stone-grafting

To study the effect of the age of the rootstock on the success in stone-grafting a trial was initiated during April, 1983 and was repeated in May, 1983. The following three treatments were included to standardise the age of the rootstock.

A1 = Fifteen days old rootstock

A2 = Ten days old rootstock

A3 = Five days old rootstock

A sample of 50 plants were used to study the effect of different treatments. Grafting was done by the cleft method using scion sticks defoliated ten days prior to the date of grafting. The effect of age of the rootstock on graft take was analysed by applying the chi-square test.

In order to find out a suitable length and girth of the stock and scion the data taken on these parameters immediately after grafting were analysed statistically using chi-square test.

Results

RESULTS

Results on the standardisation of the different aspects of stone-grafting in cashew are presented below:

4.1. Standardisation of the season, method of grafting and nature of precuring on percentage of success in stone-grafting

Results of the experiment to standardise the season, method of grafting and nature of precuring are presented in Tables 1 and 2. The percentage of success of grafting was recorded one month and two months after the operation. The data taken two months after the grafting operation were analysed statistically by chi-square test to standardise the most suitable season for grafting, the method of grafting and nature of precuring.

4.1.1. Standardisation of the optimum season for grafting

Data on the effect of season on success in stone-grafting are tabulated in Table 3 and the chi-square values for comparisons between pairs of months with regard to the number of successful grafts are presented in Appendix 1.

There were significant differences among the seasons with regard to the percentage of success. Maximum success was recorded during the month of August (30.66 per cent) followed by September (22 per cent), May (21 per cent)

Table 1. Effect of season, method of grafting and nature of precuring on the success in stone-grafting (Percentage success one month after grafting)

Treatments			June	July	August	September	October	November	December	January	February	March	April	May
	Method of grafting	Period of precuring												
T1	cleft	10 day	62	62	80	44	28	48	8	74	65	53.33	32	78
T2	splice	5 day	54	68	84	44	28	68	0	48	20	40.00	22	48
T3	cleft	10 day	40	50	84	52	76	32	8	24	32	48.51	52	62
T4	splice	5 day	28	42	60	12	56	12	8	16	6	22.85	14	70
T5	cleft	Nil	24	42	60	60	8	12	12	22	22	40.00	20	30
T6	splice	Nil	12	38	52	20	4	12	8	18	6	15.50	16	40

Table 2. Effect of season, method of grafting and nature of precuring on the success in stone-grafting (Percentage success two months after grafting)

Treatments			June	July	August	September	October	November	December	January	February	March	April	May
	Method of grafting	Period of precuring												
T1	cleft	10 day	10	20	44	24	4	8	4	34	34	23.30	10	48
T2	splice	10 day	10	18	40	32	8	24	0	14	10	26.67	4	28
T3	cleft	5 day	8	20	24	28	24	12	0	6	14	22.85	20	20
T4	splice	5 day	6	10	28	4	36	4	4	8	2	20.57	8	20
T5	cleft	Nil	6	10	20	36	4	4	4	8	6	12.00	6	4
T6	splice	Nil	2	14	28	8	0	4	4	10	6	6.67	6	6

Table 3. Effect of seasons on the success in stone-grafting

Sl. No.	Month	Total number grafted	No. of successful grafts	Percentage success
1	June	300	21	7.0
2	July	300	46	15.3
3	August	150	46	30.6
4	September	150	33	22.0
5 *	October			
6	November	450	36	8.0
7	December			
8	January	300	40	13.3
9	February	300	36	12.0
10	March	225	42	18.6
11	April	300	27	9.0
12	May	300	63	21.0

Value of χ^2 = 120.0787**

(*) Observations during the months of October, November and December were pooled together for chi-square analysis to make the cell frequency sufficiently large.

** Significant at 1% level of probability

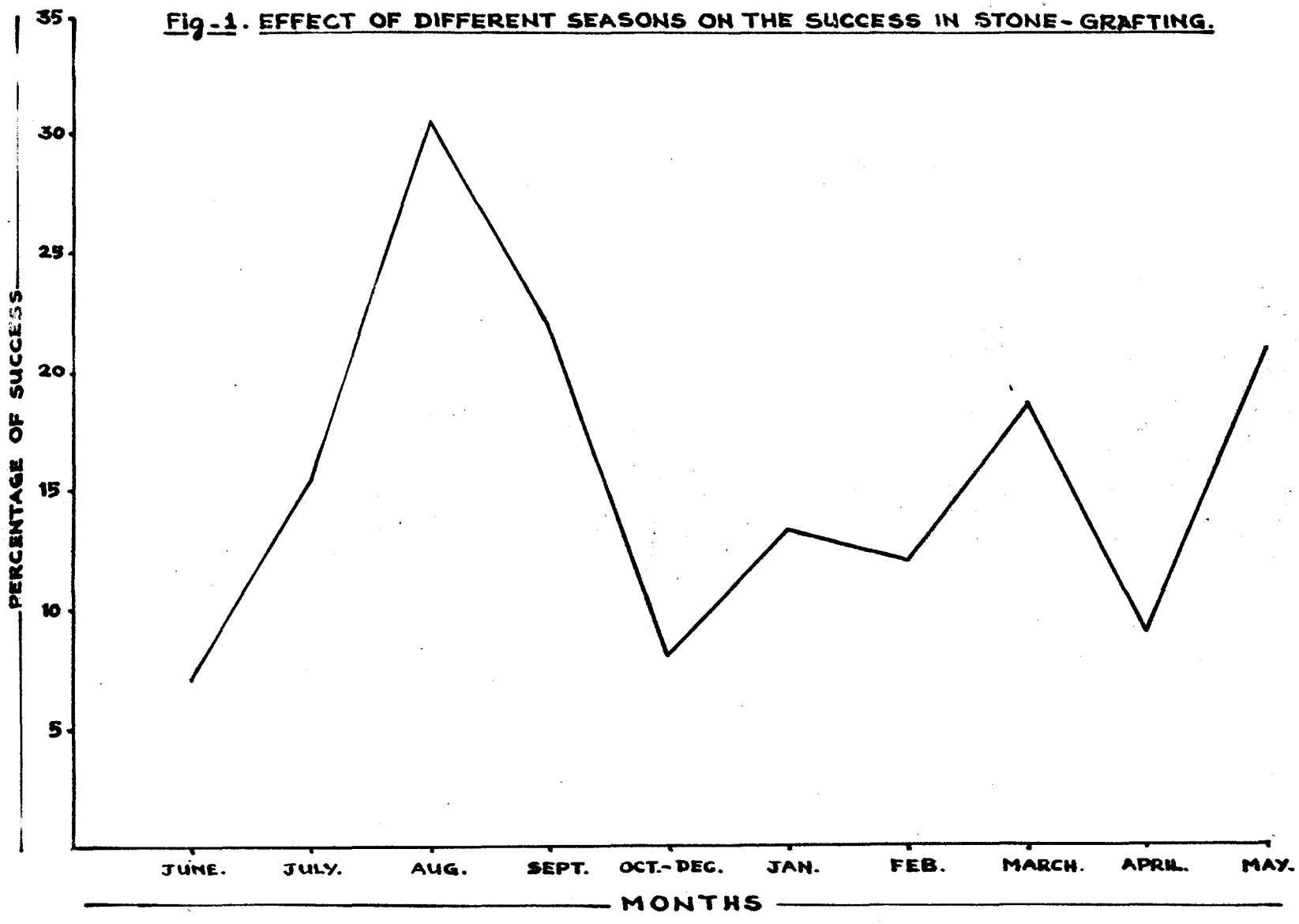
and March (18.66 per cent). The period from October to December was found to be comparatively less suitable for grafting as the success obtained was very low (Fig. 1). There was no significant difference among the success percentages during the months of September, March and May (Appendix 1).

Monthly weather data recorded during the period of grafting are presented in Appendix II. When the percentage of success was correlated with weather parameters such as rainfall, number of rainy days, temperature and relative humidity, it was found that there were no significant correlations between the various weather parameters and the percentage of success. The correlation coefficients between the percentage success and weather parameters during different months are given in Appendix III.

4.1.2. Effect of method of grafting and precuring on the percentage of success

Data on the percentage of success for the different methods of grafting and for the different durations of precuring are presented in Table 4. There was significant difference among the treatments with regard to the percentage success in stone-grafting. The highest percentage of success was recorded for T1 (23.29) where grafting was done by the cleft method using

Fig-1. EFFECT OF DIFFERENT SEASONS ON THE SUCCESS IN STONE-GRAFTING.



scions precured ten days ahead of the grafting operation, followed by T2 (16.70 per cent) where grafting was done by the splice method using 10 day precured scions. Among the various treatments tried, grafting by the splice method using non-cured scions (T6) responded least (7.65 per cent) as compared to the rest. Significant differences among pairs of treatments were tested by chi-square test and the results are presented in Appendix IV. From this it could be noted that T1 was significantly superior to all others. T2 was better than T5 and T6. T6 was found to be significantly inferior to all other treatments. Thus the result indicated that the treatment T1 where grafting was done by the cleft method using 10 day precured scions was better than all other treatments.

4.1.3. Standardisation of the method of grafting

To determine the over all effect of the method of grafting on the percentage of success, the data on Table 4 were subjected to chi-square analysis by pooling the frequencies of success over different precuring treatments and the results are presented in Table 5. Of the two methods of grafting viz., cleft and splice, cleft method recorded significantly higher success (15.97 per cent) compared to splice (12.12%)(Fig. 2).

Table 4. Effect of method of grafting and precuring on the success in stone-grafting

Treatments			Total number grafted	Success	Percentage success
	Method of grafting	Period of precuring			
T1	cleft	10 day	455	106	23.29
T2	splice	10 day	455	76	16.70
T3	cleft	5 day	460	74	16.08
T4	splice	5 day	460	56	12.17
T5	cleft	Nil	475	42	8.84
T6	splice	Nil	470	36	7.65

Value of χ^2 = 64.3259**

** Significant at 1% level of probability

Table 5. Effect of method of grafting on the success in stone-grafting

Sl. no.	Treatment	Total number grafted	Success	Percentage success
1	cleft	1390	222	15.97
2	splice	1385	168	12.12

Value of χ^2 = 8.48**

** Significant at 1% level of probability

4.1.4. Effect of precuring (prior defoliation) of scion shoot on the percentage of success in stone-grafting

In order to determine the overall effect of the duration of precuring on the percentage of success in grafting, the data presented in Table 4 were subjected to chi-square analysis by pooling the frequencies of success over the different grafting methods tried. Results of the studies are presented in Table 6. Chi-square values for comparisons of different periods of precuring with regard to the number of successful grafts are given in Appendix V. There was significant difference in the success obtained with regard to the duration of precuring. Precuring the scions ten days ahead of the grafting operation was significantly superior (20 per cent) to precuring five days before the grafting operation (14.25 per cent) or precuring immediately before grafting (control - 8.25 per cent) (Fig. 3). However both types of precuring were better than the control where no curing was done.

4.1.5. Effect of mist on the ultimate take of the grafts

To study the effect of mist on the ultimate take of the grafts, 25 grafts from each treatment were kept in open and 25 grafts under mist. The data on the

percentage of success recorded one month and two months after the grafting operation are furnished in Table 7a and 7b. The data taken two months after grafting were used to find out the effect of treatments and the effect of season under mist condition. The treatment effects were not significant as will be seen from Table 7c. The percentage of success during different months under mist condition when tested by chi-square test showed significant variation. Grafting done during August gave maximum success of 14 per cent followed by that done during September. The percentage success in the above cases were 7.33 and 2.88 per cent respectively (Table 7d).

The data on graft intake under open and mist conditions were pooled and the percentage of success under the two conditions were compared by chi-square test. It was found that there was significant difference between the percentage success under open (15.33 per cent) and mist (6 per cent) conditions (Table 7e).

Meterological observations such as maximum and minimum temperatures and relative humidity in open and mist conditions were compared using paired 't' test and the data are presented in Table 7f. Student's 't' values for comparing the effect of meterological factors in open and mist conditions are given in Appendix VI. Significant differences were observed with regard to relative humidity and maximum temperature between open and

Table 6. Effect of precuring of scions on the success in stone-grafting

Sl. no.	Treatments	Total number grafted	Success	Percentage success
1	10 day precuring	910	182	20.00
2	5 day precuring	920	130	14.13
3	Without precuring	945	78	8.25

Value of χ^2 = 52.954**

** Significant at 1% level of probability

Table 7a. Effect of season, method of grafting and nature of precuring on the success in stone-grafting under open and mist conditions (Percentage of success one month after grafting)

	Months									
Treatments	August		September		October		November		December	
	Open	Mist	Open	Mist	Open	Mist	Open	Mist	Open	Mist
T1	80	64	44	32	28	32	48	80	8	8
T2	84	72	44	20	28	44	68	48	0	0
T3	84	48	52	36	76	52	32	28	8	12
T4	60	56	12	28	56	48	12	44	8	4
T5	60	28	60	28	8	20	12	28	12	4
T6	52	68	20	44	4	16	12	48	8	4

Table 7b. Effect of season, method of grafting and nature of precuring on the success in stone-grafting under open and mist conditions (Percentage of success two months after grafting)

Treatments	Months									
	August		September		October		November		December	
	Open	Mist	Open	Mist	Open	Mist	Open	Mist	Open	Mist
T1	44	16	24	8	4	0	8	8	4	0
T2	40	24	32	4	8	0	24	8	0	0
T3	24	4	28	12	24	0	12	4	0	0
T4	28	8	4	8	36	0	4	12	4	4
T5	20	8	36	0	4	0	4	8	4	4
T6	28	24	8	8	0	0	4	4	4	4

Table 7c. Effect of different treatments on the success in stone-grafting under mist condition

Sl. no.	Treatments	Total number grafted	Success	Percentage success
1	T1	125	8	6.4
2	T2	125	9	7.2
3	T3	125	5	4.0
4	T4	125	7	5.6
5	T5	125	6	4.8
6	T6	125	10	8.0

Value of χ^2 = 2.482

Table 7d. Effect of different seasons on the success in stone-grafting under mist condition

Sl. no.	Treatments	Total number grafted	Number of successful grafts	Percentage success
1	August	150	21	14.00
2	September	150	11	7.33
3	October-December	450	13	2.88

Value of χ^2 = 25.2165**

** Significant at 1% level of probability

Table 7e. Effect of mist over open condition on the success in stone-grafting

Sl. no.	Treatments	Total number grafted	Number of successful grafts	Percentage success
1	Mist	750	45	6.00
2	Open	750	115	15.33

Value of χ^2 = 34.2818**

** Significant at 1% level of probability

Table 7f. Distribution of maximum temperature, minimum temperature and relative humidity under open and mist conditions during different dates of observations

Date	Maximum temperature (°C)		Relative humidity (%)		Minimum temperature (°C)	
	Open	Mist	Open	Mist	Open	Mist
20/11	32.50	27.87	79.00	86.25	22.50	24.25
21	31.50	28.25	90.25	78.75	19.50	24.12
22	31.50	28.25	64.75	86.50	24.50	24.87
23	32.20	28.50	61.25	85.00	24.50	23.81
24	32.20	27.87	58.50	79.25	24.50	24.75
25	31.00	27.50	73.75	93.25	23.20	23.37
26	30.00	26.37	59.75	82.25	23.50	23.37
27	32.00	28.55	56.00	76.25	23.20	23.00
28	32.20	29.67	67.25	84.23	23.50	22.25
29	32.50	29.25	60.75	86.50	21.50	22.37
30	32.40	28.00	56.25	90.50	21.00	24.37
1/12	32.40	28.75	55.00	89.00	22.60	22.75
2	37.50	28.00	51.25	93.00	23.50	22.87
3	29.50	25.00	52.25	71.00	22.50	23.37
4	29.60	24.75	73.50	95.50	23.50	24.00
15	31.50	27.00	52.25	67.25	24.00	22.50
16	33.00	28.00	63.00	79.75	23.00	23.75
17	32.00	28.25	64.00	69.00	23.00	23.50
18	31.60	25.92	53.50	83.50	22.00	23.75
19	32.00	28.25	62.50	62.00	21.50	22.00
20	31.60	28.87	64.00	67.50	22.20	24.00
21	31.20	27.87	61.75	58.75	22.00	23.15
22	31.20	28.62	62.25	58.50	21.50	22.50
23	31.50	27.62	49.25	58.75	22.60	21.50
24	30.50	26.62	59.25	64.50	23.50	23.00
25	31.50	30.12	61.50	70.50	22.50	23.50
26	31.00	30.00	59.75	55.00	23.00	22.50
27	31.50	30.12	56.50	65.75	23.00	22.00
28	31.00	30.12	57.25	70.50	22.50	23.00
29	32.50	29.05	54.00	65.00	23.50	23.00
30	31.00	27.75	53.50	73.00	22.00	22.50
31	32.50	28.00	64.50	52.25	22.50	22.75
1/1	31.60	28.50	45.50	67.25	24.00	23.50
2	33.00	25.75	51.00	75.00	21.50	23.00
3	33.00	24.50	49.50	82.00	23.00	22.50
4	33.00	27.75	42.75	71.00	23.50	23.00
5	32.40	28.75	52.25	73.00	22.50	23.00
Value of 't'	14**		8.11**		1.41	

** Significant at 1% level of probability

mist conditions. There was no significant difference between open and mist condition with regard to the minimum temperature. Maximum temperature of open condition was found to be higher and relative humidity was found to be lower.

Growth behaviour of grafts

The data on the different growth parameters recorded at fortnightly intervals of the grafts produced during the months of June, July, August and September are presented in Tables 8, 9, 10 and 11. On statistical analysis it was found that there was significant difference in the growth rate for the different parameters tested. Linear growth rate at fortnightly intervals regression equations for describing the growth behaviour of the stock and scion with respect to different parameters for different treatments are presented in Appendix VII, VIII, IX and X.

In the case of grafts produced in July maximum growth rate for the length of the scion was noted for T3 and the minimum for T6. For the girth of the stock the maximum rate was exhibited by T2 and the least by T3. The girth of the scion was maximum for T1 and the least for T3.

For the grafts produced in August T5 recorded the highest rate for the girth of the stock. The lowest growth rate for the girth of the stock was recorded by T6.

With respect to the length of the scion the maximum rate was recorded by T3 and the least by T6. For the girth of the scion the maximum rate was exhibited by T1 and the least by T4.

The highest rate for the girth of the stock and scion was recorded by T6 and the lowest by T3 for the grafts produced in September. The maximum rate for the length of the scion was given by T1 and the minimum by T3.

When the growth rates of the girth of the stock and scion were compared no significant difference was observed that is girth of the stock and scion exhibited the same pattern with regard to growth. The data on the ratio of girth of the stock to girth of the scion were analysed using the analysis of variance technique and the significant results were compared after finding out the critical differences. The results of the analysis are presented in Appendix XI and from the results it is evident that the treatment T1 significantly different from other treatments in the month of June. The treatments T2 to T5 are on par. So it can be stated that the girth of the stocks and scions of the grafts under the treatments T2 to T5 are exhibiting the same growth rate giving a ratio of about one. In all the other months no significant differences were observed in the growth rate of the girth of the stock and scion for the different treatments tested (Appendix XII).

4.2. Effect of age of the rootstock on the success in stone-grafting

The data on the effect of the age of the rootstocks on the ultimate success of stone-grafting are presented in Table 12. Of the three age groups of rootstocks tested, viz., five, ten and fifteen days old maximum success of 33.33 per cent was obtained for five days old rootstocks followed by 10 days old rootstocks (24 per cent). However, there was no significant difference between these two. Fifteen days old rootstocks were least suitable for grafting (Fig. 4).

4.3. Standardisation of the girth and length of the stock and scion

To find out the optimum girth and length of the stock and scion on the success in stone-grafting the data on the girth and length of the stock and scion taken at the time of grafting were grouped into different classes and analysed by chi-square test. The results of the analysis are presented in Tables 13, 14 and 15 and the chi-square values for comparisons between pairs of classes of different parameters are presented in Appendix XIII and XIV.

From the Tables it could be seen that stocks and scions of girth 2.1 to 2.4 cm were found to be the best for getting the maximum success. Similarly scions of

Fig-2. EFFECT OF METHOD OF GRAFTING ON THE SUCCESS IN STONE-GRAFTING.

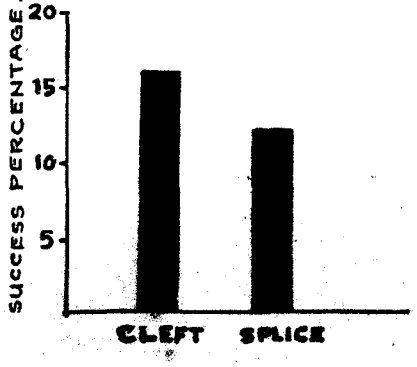


Fig-3 EFFECT OF PRECURING OF SCIONS ON THE SUCCESS IN STONE-GRAFTING.

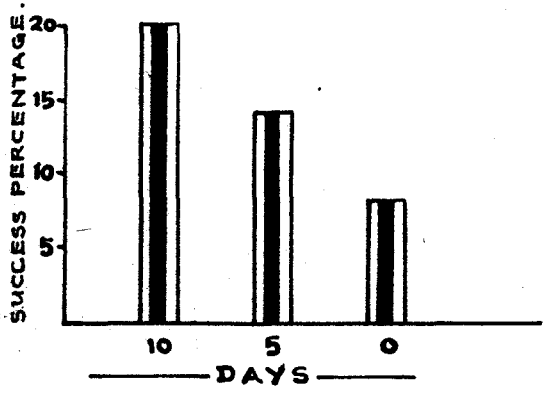


Fig-4. EFFECT OF AGE OF THE ROOT STOCK ON THE SUCCESS IN STONE-GRAFTING.

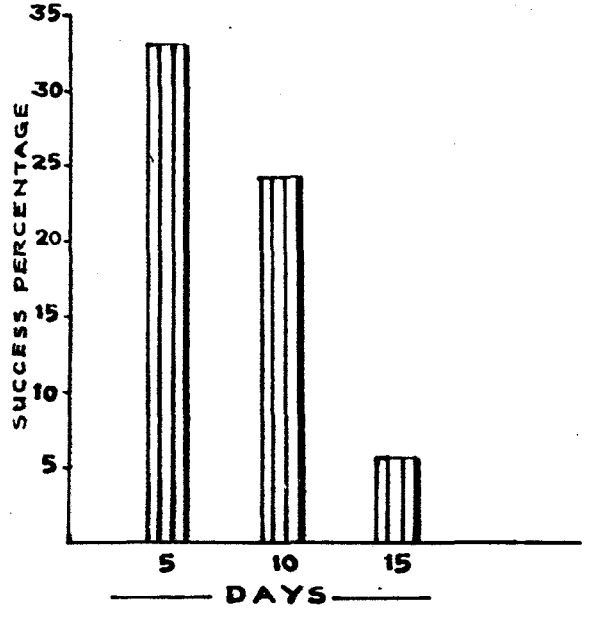


Table 12. Effect of age of the rootstock on the success in stone-grafting

Age groups	April			May			Total (April + May)		
	Total number grafted	No. of successful grafts	Percentage success	Total number grafted	No. of successful grafts	Percentage success	Total number grafted	No. of successful grafts	Percentage success
15 days	60	5	8.33	50	1	2	110	6	5.45
10 days	50	10	20.00	46	14	28	100	24	24.00
5 days	40	15	37.50	50	15	30	90	30	33.33

Value of chi-square

15 day vs 10 day vs 5 day	11.42**	15.24**	25.24**
15 day vs 10 day			21.04**
15 day vs 5 day			26.0655**
10 day vs 5 day			0.7112

** Significant at 1% level of probability

Table 13. Effect of girths of stock and scion on the success in stone-grafting

Class	Girth of the stock			Girth of the scion		
	Success	Failure	Percentage success	Success	Failure	Percentage success
Below 2.1 cm	5	5	50.00	7	5	58.33
2.1 to 2.4 cm	46	31	59.74	44	25	63.76
Above 2.4 cm	10	23	30.30	14	25	35.89

Value of χ^2 = 8.0045**

** Significant at 1% level of probability

Table 14. Effect of length of stock on the success in stone-grafting

Class	Success	Failure	Percentage success
3.0 - 3.5 cm	36	24	60.00
3.6 - 4.1 cm	21	18	53.84
4.2 - 5.0 cm	9	12	42.86

Value of χ^2 = 1.8789

Table 15. Effect of length of scion on the success in stone-grafting

Class	Success	Failure	Percentage success
4.5 - 6.5 cm	30	32	48.38
6.6 - 8.5 cm	12	13	48.00
8.6 - 10.5 cm	19	4	82.60
Above 10.5 cm	5	5	50.00

Value of χ^2 = 7.5902*

* Significant at 5% level of probability

length 8.6 to 10.5 cm was found to be better than all the other classes tested. With respect to the length of the stock there was no significant difference between the different classes.

Discussion

DISCUSSION

Standardisation of an effective method of vegetative propagation in cashew has drawn the attention of a number of scientists from the earliest days of cashew research in our country. Among the different methods of vegetative propagation tried, air-layering has been found to be the simplest and effective method of vegetative propagation under Kerala conditions. However, this method has not found favour with many growers due to high degree of mortality when the air-layers are planted in the main field (Damodaran et al. 1979; Ohler, 1979). Hence the need for a suitable method of vegetative propagation of selected types is keenly felt in cashew especially in the absence of a method highly suitable for different situations.

Several asexual propagation methods have been tried in various Cashew Research Stations in India and abroad with varying degrees of success. Among the different methods tried, epicotyl grafting has given promising results in other states of India (Maiti and Biswas, 1980; Singh and Srivastava, 1981 and Nagabhushanam and Mohan, 1982). The encouraging results obtained in the State of Maharashtra on the large scale multiplication of cashew and mango through epicotyl grafting prompted to try, this method on systematic lines at the College of Horticulture, Vellanikkara, Kerala.

In any types of vegetative propagation, the success or failure varies with environmental conditions and many a time become location specific (Hartman and Kester, 1978). Evolution of a successful method largely depends upon factors like season, the method of grafting, age of the root-stock or scion and the scion variety used.

Detailed studies are therefore necessary on the various aspects of epicotyl grafting so as to arrive at definite conclusions for recommendation of this method under Kerala conditions. The present studies were conducted at the College of Horticulture, Vellanikkara, Kerala Agricultural University during the period from June, 1982 to May, 1983.

5.1. Standardisation of season

The seasonal influence on the success of vegetative propagation is well established (Hartman and Kester, 1978). The results of the present studies indicated that the best period for stone-grafting in cashew was August-September under Kerala condition. These results generally conformed to the findings of Nagabhushanam and Mohan (1982) who suggested that July to September was the best season for stone-grafting under Vittal conditions of Karnataka State. They suggested that fairly distributed rainfall with high humidity and heavy precipitations

occurred during those months might have contributed for better success. A high positive correlation between the percentage of success and relative humidity was also reported by Patel and Amin (1978) and Gunjate et al. (1982). However, during the course of the present studies no statistical correlation was obtained between the percentage of success and the different weather parameters like rainfall, temperature and relative humidity. Hence the high percentage of success obtained during August - September in the present studies presumably cannot be attributed to weather factors alone. The possibility of the physiological conditions of the stocks and scions influencing success in epicotyl grafting cannot be ruled out. However, a detailed study in this respect is necessary to establish a correlation if any, between percentage of success and various weather parameters on one hand, and physiological conditions of the stock and scion on the other hand.

The effect of relative humidity on the percentage of success of grafting was further amplified in the studies by keeping the plants in a mist chamber. Though the percentage of success one month after the operation was high, there was a high incidence of infection of sprouted grafts which ultimately reduced the percentage of final success. Detailed studies are necessary to isolate and identify these organisms causing rotting of the new sprouts. Similar observations were also made at

Regional Cashewnut Research Station, Vridachalam (Anon, 1983).

It was also observed that the percentage of final success was maximum under open condition compared to mist condition. Harnekar (1980) also obtained maximum success for epicotyl grafting in cashew at Dapoli conditions during the period when the humidity was less. It can be stated from the present studies also, that the humidity has an adverse effect on epicotyl grafting.

5.2. Standardisation of method of grafting

The present study revealed that the cleft method of grafting was better than splice method in view of getting high percentage of success. Because of the tight fitting of stock and scion in cleft method, there could be a better and easy healing of the graft union. More over cleft method is more easy and convenient also. Singh and Srivastava (1981) from their studies conducted at Lucknow also emphasised the superiority of cleft method over other methods of grafting in mango. Because of the ease and convenience cleft method has been recommended for commercial adoption by Gunjate *et al.* (1982) even though they did not find much difference in the success when done by splice, modified wedge and wedge method.

5.3. Effect of precuring on percentage take

The data revealed that precuring ten days before the grafting operation was better (20 per cent success) than five days precuring (14.25 per cent success) and non-curing (8.25 per cent success). The defoliation might have caused an immediate rise in sucrose content of the phloem sap of the shoot which would have increased the osmotic value and thereby caused a rapid movement of solutes towards the apex of the shoot. This would have resulted in a high meristematic activity at the bud level that helped in better sap flow and good callus formation giving a better graft union (Munch, 1930 and Zimmerman, 1958b). Fahmy (1952) also observed a positive correlation between the amount of carbohydrates in the tissues and percentage of success of graft union. The beneficial effect of defoliation of scion shoots over undefoliated ones have been also observed by Teotia and Maurya, 1970; Kashyap, 1972; Pathak and Srivastava, 1974; Dhakal, 1979; Ram and Bist, 1982. Thus, from the present study, it could be concluded that precuring of scion shoots prior to the grafting operation is advantageous for getting higher percentage of success in cashew.

5.4. Standardisation of age of rootstocks

Among the three age groups of stocks tried during the course of the present investigation, five days and

ten days old root stocks were found to be equally good compared to 15 days old stocks. The high percentage of 'take' might be due to more reserve food material available in the cotyledons and higher meristematic activity compared to relatively older stocks as reported by Singh and Srivastava (1981). The results of a trial conducted at Konkan Krishi Vidyapeeth, Dapoli also showed the superiority of 10 days old rootstocks over 20 and 30 days for epicotyl grafting in cashew.

It is obvious from the above discussion that there is ample scope for adopting epicotyl grafting as a promising method of vegetative propagation of cashew in Kerala. At the same time it has been amply demonstrated that this method is delicate unlike in the case of air-layering and several factors decide the ultimate success of this method. The influence of season, age, physiological condition of stock and scion and weather conditions seemed to exert considerable influence on the success or otherwise of this method. It might also be possible that the biochemical make up of the stock and scion, and the physiological conditions of the mother tree also influence the healing of the graft union. The necessity for detailed studies on all the above aspects cannot be over emphasised.

Summary

SUMMARY

A study on the propagation of cashew was carried out at the College of Horticulture, Vellanikkara from June, 1982 to May, 1983 with an objective of standardising the technique of stone-grafting. The results of the studies are summarised below:

1. The highest percentage of success was recorded during the month of August (30.66 per cent) followed by September (22 per cent), May (21 per cent) and March (18.66 per cent). The period October to December was most unsuitable for stone-grafting as the percentage of success is comparatively very poor.

2. The percentage of success of graft union was correlated with weather parameters such as quantity of rainfall, number of rainy days, maximum and minimum temperatures and relative humidity. It was found that there was no correlation between the various weather parameters tested and the percentage of success.

3. Among the two grafting methods tried cleft method recorded significantly higher percentage of success (15.97 per cent) compared to splice method (12.12 per cent).

4. Defoliation of scion shoots ten days before the grafting operation recorded significantly higher percentage of success of 20 per cent than five days precuring and control, where the percentages of success were only 14.13 and 8.25 respectively.

5. The percentage success of grafting under mist and open conditions was compared using chi-square test and it was observed that percentage success under open condition was significantly higher than that under mist.

6. Statistical analysis of the data on growth characters such as girth of the stock and scion and height of scion taken at fortnightly intervals showed that there was significant linear growth rate for the different parameters studied. The data on the ratio of the girth of the stock to girth of the scion was analysed using analysis of variance technique and it was found that all the treatments except T1 (grafting by the cleft method using 10 day precured scions) of the grafts produced in the month of June exhibited the same growth rate for girth of the stock and scion giving a ratio of about one.

7. The age of the rootstock was standardised and it was found that ten days and five days old rootstocks were equally good and 15 days old rootstocks were least suitable.

8. In order to find out the suitable length and girth of the stock and scion the results were analysed and it was observed that stocks and scions of girth 2.1 cm to 2.4 cm was better than those of above 2.4 cm. Similarly scions of length 8.6 cm to 10.5 cm was better than those with a length of 4.5 cm to 6.5 cm, 6.6 cm to 8.5 cm and above 10.5 cm.

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Appendices

APPENDIX I

Chi-square values for comparisons between pairs of months with regard to the number of successful grafts

Months	July	August	September	October to December	January	February	March	April	May
June	10.501**	52.023**	21.306**	0.256	6.587*	4.361*	16.571**	0.815	24.418**
July		17.66**	3.070	9.940**	0.488	14.335**	1.0238	5.630*	3.239
August			3.87*	57.15**	23.75**	28.57**	9.14**	42.22**	6.22*
September				21.665**	5.526*	7.702**	0.625	14.625**	0.059
October to December					5.622*	3.318	16.698**	0.233	26.550**
January						0.241	2.774	2.839	6.200**
February							4.517*	1.436	8.818**
March								10.524**	0.437
April									16.941**

** Significant at 1% level of probability

* Significant at 5% level of probability

APPENDIX II

Monthly weather data recorded during the period of grafting

Month	Rainfall		Temperature °C		Relative humidity (%) AV	Percentage success
	Quantity mm	Number of rainy days	Mean maximum	Mean minimum		
June, '82	657.6	26	30.60	23.10	79.80	7.00
July	600.9	26	29.10	22.92	87.50	15.33
August	575.4	27	28.90	24.30	85.00	30.66
September	67.4	10	30.98	24.00	78.88	22.00
October	277.8	18	32.04	23.13	77.00	12.66
November	98.4	7	31.40	23.93	71.88	9.33
December	5.2	1	31.93	23.19	58.40	2.00
January, 83	0.0	0	33.25	21.64	51.31	13.33
February	0.0	0	34.46	22.70	64.00	12.00
March	0.0	0	36.15	23.76	65.00	18.66
April	0.0	0	36.20	25.80	66.00	9.00
May	37.4	3	35.10	25.50	69.00	21.00

APPENDIX III

Correlation coefficients between percentage of success and weather parameters during different months

Weather parameters	Correlation coefficients
Rainfall	-0.2283
No. of rainy days	-0.2972
Maximum temperature	+0.1790
Minimum temperature	-0.2754
Relative humidity	-0.4372

APPENDIX IV

Chi-square values for comparisons of different treatments with regard to the number of successful grafts

	Treatments				
	T2	T3	T4	T5	T6
T1	6.187*	7.524**	19.422**	36.285**	435.025**
T2		0.063	3.801	12.963**	17.767**
T3			2.902	11.287**	15.831**
T4				2.764	5.314*
T5					0.436

** Significant at 1% level of probability

* Significant at 5% level of probability

APPENDIX V

Chi-square values for comparisons of different period of precuring with regard to the number of successful grafts

Comparisons	Value of χ^2
10 day vs 5 day	11.14**
5 day vs control	16.25**
10 day vs control	53.10**

** Significant at 1% level of probability

APPENDIX VI

Student's 't' values for comparing the effect of meterological factors in open and mist condition

Character	't' value
Relative humidity	8.11**
Maximum temperature	14.00**
Minimum temperature	1.41

** Significant at 1% level of probability

APPENDIX VII

Linear growth rate at fortnightly intervals regression equation, for describing the growth behaviour of the stock and scion with regard to different characters for different treatments (June)

Treatments	Linear growth rate	Regression equation
T1 Girth of the stock	0.2058**	Y = 1.0920 + 0.2058 x
Girth of the scion	0.0990**	Y = 1.5764 + 0.0990 x
Length of the scion	0.3166**	Y =20.7110 + 0.3166 x
T2 Girth of the stock	0.1531**	Y = 1.5458 + 0.1531 x
Girth of the scion	0.1104**	Y = 1.5625 + 0.1104 x
Length of the scion	1.4027**	Y = 9.1993 + 1.4027 x
T3 Girth of the stock	1.1614**	Y = 1.4039 + 0.1614 x
Girth of the scion	0.1047**	Y = 1.5318 + 0.1047 x
Length of the scion	1.0533**	Y =12.2663 + 1.0533 x
T4 Girth of the stock	0.1969**	Y = 1.0698 + 0.1969 x
Girth of the scion	0.1515**	Y = 1.0315 + 0.1515 x
Length of the scion	2.8708**	Y = 2.8695 + 2.8708 x
T5 Girth of the stock	0.1939**	Y = 8.6165 + 0.1939 x
Girth of the scion	0.1453**	Y = 9.5684 + 0.1453 x
Length of the scion	1.6896**	Y = 6.9169 + 1.6896 x
T6 (••)		

** Significant at 1% level of probability

(••) Growth measurements could not be taken since sufficient number of plants were not available.

APPENDIX VIII

Linear growth rate of fortnightly intervals regression equation for describing the growth behaviour of the stock and scion with regard to different characters for different treatments (July)

Treatments		Linear growth rate	Regression equation
T1	Girth of the stock	0.1624**	Y = 1.5493 + 0.1624 x
	Girth of the scion	0.1077**	Y = 1.6655 + 0.1077 x
	Length of the scion	1.7097**	Y = 8.2569 + 1.7097 x
T2	Girth of the stock	0.1704**	Y = 1.4163 + 0.1704 x
	Girth of the scion	0.1019**	Y = 1.7576 + 0.1019 x
	Length of the scion	1.7441**	Y = 5.7392 + 1.7441 x
T3	Girth of the stock	0.1385**	Y = 1.6683 + 0.1385 x
	Girth of the scion	0.0799**	Y = 1.8652 + 0.0799 x
	Length of the scion	1.8055**	Y = 4.7189 + 1.8055 x
T4	Girth of the stock	0.1509**	Y = 1.5822 + 0.1509 x
	Girth of the scion	0.0809**	Y = 1.8882 + 0.0809 x
	Length of the scion	1.6869**	Y = 5.8598 + 1.6868 x
T5	Girth of the stock	0.1694**	Y = 1.5881 + 0.1694 x
	Girth of the scion	0.0827**	Y = 1.9903 + 0.0827 x
	Length of the scion	1.3770**	Y = 11.0828 + 1.3370 x
T6	Girth of the stock	0.1498**	Y = 11.0828 + 0.1498 x
	Girth of the scion	0.0938**	Y = 1.6692 + 0.0938 x
	Length of the scion	1.2136**	Y = 8.7413 + 1.2136 x

** Significant at 1% level of probability

APPENDIX IX

Linear growth rate at fortnightly intervals regression equation for describing the growth behaviour of the stock and scion with regard to different characters for different treatments (August)

Treatments	Linear growth rate	Regression equation
T1 Girth of the stock	0.1391**	Y = 1.2362 + 0.1391 x
Girth of the scion	0.0891**	Y = 1.4964 + 0.0891 x
Length of the scion	2.5115**	Y = 4.6943 + 2.5115 x
T2 Girth of the stock	0.1158**	Y = 1.4190 + 0.1158 x
Girth of the scion	0.0660**	Y = 1.8038 + 0.0660 x
Length of the scion	2.1766**	Y = 3.2286 + 2.1766 x
T3 Girth of the stock	0.1238**	Y = 1.1701 + 0.1238 x
Girth of the scion	0.0786**	Y = 1.5472 + 0.0786 x
Length of the scion	2.9447**	Y = 12.5115 + 2.9447 x
T4 Girth of the stock	0.1108**	Y = 1.4985 + 0.1108 x
Girth of the scion	0.0543**	Y = 2.0741 + 0.0543 x
Length of the scion	1.3086**	Y = 7.5937 + 1.3086 x
T5 Girth of the stock	0.1595**	Y = 1.0707 + 0.1595 x
Girth of the scion	0.0837**	Y = 1.7158 + 0.0837 x
Length of the scion	2.5437**	Y = 5.4191 + 2.5437 x
T6 Girth of the stock	0.0983**	Y = 1.6846 + 0.0983 x
Girth of the scion	0.0687**	Y = 1.7632 + 0.0687 x
Length of the scion	0.8823**	Y = 10.4919 + 0.8823 x

** Significant at 1% level of probability

APPENDIX X

Linear growth rate at fortnightly intervals regression equation for describing the growth behaviour of the stock and scion with regard to different characters for different treatments (September)

Treatments	Linear growth rate	Regression equation
T1 Girth of the stock	0.1411**	Y = 1.4620 + 0.1411 x
Girth of the scion	0.0811**	Y = 1.8028 + 0.0811 x
Length of the scion	2.1085**	Y = 4.0682 + 2.1085 x
T2 Girth of the stock	0.1100**	Y = 1.6889 + 0.1100 x
Girth of the scion	0.0538**	Y = 2.1294 + 0.0538 x
Length of the scion	1.9671**	Y = 3.9991 + 1.9671 x
T3 Girth of the stock	0.1037**	Y = 1.6760 + 0.1037 x
Girth of the scion	0.0470**	Y = 1.9955 + 0.0470 x
Length of the scion	0.6338**	Y = 6.1940 + 0.6338 x
T4 Girth of the stock	0.1177**	Y = 1.4942 + 0.1177 x
Girth of the scion	0.0693**	Y = 1.7769 + 0.0693 x
Length of the scion	1.1175**	Y = 7.5690 + 1.1175 x
T5 Girth of the stock	0.1190**	Y = 1.7701 + 0.1190 x
Girth of the scion	0.0796**	Y = 1.9790 + 0.0796 x
Length of the scion	2.0561**	Y = 4.8591 + 2.0561 x
T6 Girth of the stock	0.1700**	Y = 1.3094 + 0.1700 x
Girth of the scion	0.1131**	Y = 1.5343 + 0.1131 x
Length of the scion	1.7525**	Y = 6.1322 + 1.7525 x

** Significant at 1% level of probability

APPENDIX XI

Analysis of variance for the ratio of the girth of the stock to girth of the scion for different treatments of the grafts produced during different months

Source of variation	Months of observation							
	June		July		August		September	
	df	M.S.	df	M.S.	df	M.S.	df	M.S.
Total	104		119		101		101	
Treatment	4	0.806**	5	0.0110	5	0.0142	5	0.0106
Error	100	0.0111	114	0.0016	96	0.0070	96	0.0083

** Significant at 1% level of probability

APPENDIX XII

Mean of the ratios of the girth of the stock to girth of the scion for different treatments of the grafts produced during different months

Treatments	June	July	August	September
T1	1.3048	1.1745	1.1582	1.1012
T2	1.1709	1.1635	1.1171	1.0512
T3	1.2024	1.1845	1.0976	1.1076
T4	1.2043	1.2100	1.0818	1.0865
T5	1.1790	1.2240	1.1471	1.0982
T6	- *	1.1745	1.1241	1.1253
CD	0.06489	NS	NS	NS

* Growth measurements could not be taken since sufficient number of plants were not available

APPENDIX XIII

Chi-square values for comparisons between pairs of classes for different girths of stock and scion with regard to the number of successful grafts

Class	Girth of the stock- value of χ^2	Girth of the scion- value of χ^2
Below 2.1 vs above 2.4	1.3108	1.9011
Below 2.1 vs 2.1 - 2.4	0.3462	0.1295
2.1 - 2.4 vs above 2.4	8.0096**	7.7846*

** Significant at 1% level of probability

* Significant at 5% level of probability

APPENDIX XIV

chi-square values for comparisons between pairs of classes for different length of the scion with regard to the number of successful grafts

Length of the scion

Class	Value of χ^2
1. 4.5 - 6.5 vs 6.6 - 8.5	0.0011
2. 4.5 - 6.5 vs 8.6 - 10.5	8.0471**
3. 4.5 - 6.5 vs above 10.5	0.00897
4. 6.6 - 8.5 vs above 10.5	0.01144
5. 6.6 - 8.5 vs 8.6 - 10.5	6.2730*
6. 8.6 - 10.5 vs above 10.5	3.7364

** Significant at 1% level of probability

* Significant at 5% level of probability

STANDARDISATION OF THE TECHNIQUE OF STONE-GRAFTING IN CASHEW (*Anacardium occidentale* L) AND MANAGEMENT PRACTICES FOR FIELD ESTABLISHMENT

By

SHYLAJA. M. R.

ABSTRACT OF A THESIS

Submitted in partial fulfilment of
the requirements for the degree of

Master of Science in Horticulture

Faculty of Agriculture
Kerala Agricultural University

Department of Horticulture
(Pomology & Floriculture and Landscaping)
COLLEGE OF HORTICULTURE
Vellanikkara - Trichur

1984

ABSTRACT

The studies on the propagation of cashew by stone-grafting was carried out at the College of Horticulture, Vellanikkara during June, 1982 to May, 1983 to find out the season for stone-grafting, to study the effect of precuring of scions, to standardise the best method of grafting and to find out the proper size, thickness and age of the rootstock on percentage of success of grafting.

The studies revealed that the months of August, and September were most suitable for stone-grafting under Kerala conditions. The period from October to December was most unsuitable. Of the different treatments tried the treatment T1, where grafting was done by the cleft method using scion sticks defoliated 10 days ahead of the grafting operation was found to be significantly superior to all the other treatments. Defoliation 10 days prior to the grafting operation was definitely superior to five days precuring and non-curing. Similarly the cleft method was found to be better than splice method. There was no significant correlation between the percentage of success and the various weather parameters like quantity of rainfall, number of rainy days, maximum and minimum temperatures and relative humidity. The mist condition did not improve the ultimate take of the grafts. There

was linear growth rate for the different growth parameters tested such as the girth of the stock and scion and height of the scion. Also the girth of the stock and scion exhibited the same growth rate giving a ratio of about one for all the treatments except for the treatment T1 (grafting by the cleft method using 10 day precured scions) of the grafts produced in the month of June. There was apparently no difference in the percentage success in stone-grafting prepared from 10 days old and five days old stocks. Stocks and scions of girth 2.1 to 2.4 cm was found to give better success than those of above 2.4 cm. Scions of length 8.6 to 10.5 cm was found to be better than those with a length of 4.5 to 6.5 cm, 6.6 to 8.5 cm and above 10.5 cm.