(Paper presented at the Third Annual Work shop of the All-India Co-ordinated Coconut, Arecanut and Spices and Cashew nut Improvement Project held at Tamilnadu Agricultural University, Coimbatore 15-22 December, 1975).

GRAFTING TRIALS ON CASHEW

K. P. MUNISWAMI, I.F.S.

1. Introduction :

1.1. Cashew (*Anacardium occidentale L*), a tropical American species, is being grown in coastal belts of India, since last four centuries. Cashew planting activity has, however, increased considerably during the last few years, because of its foreign exchange earning capacity and the gradual stoppage of export of nuts by the East African countries to India for processing.

1.2. The species is being propagated through seed, which naturally results in the plant population showing great variation in yield and size of the nuts. To overcome these variations, which adversely effect the plantation economics and to maintain the purity of the parental stock, Vegetative propagation of the clones, selected for their proven desired characters is the only means. By making full use of this method, it should be possible to step up considerably the production of nuts from our orchards in record time to meet our country's requirements. The vegetative propagation methods are practiced in forestry and horticultrue to obtain plants of desired character for genetic improvement.

2. Early attempts :

2.1. In the early attempts to propagate cashew vegetatively, stress was mostly laid on airlayering. Though root development in the airlayering was fairly good there was heavy mortality, both at the nursery stage and more so in field plantings. There was also considerable damage to the layers, from the squirrels and birds, which tore away the plastic covering exposing the leyered portion. Large scale propagation of air layers for planting extensive areas is also not feasible, as the method itself is cumbersome and time consuming. From 1970, attempts were made on other methods of propagation like budding and veneer grafting at Venugarl centre which were found to be successful. During 1971 under the All-India Co-ordinated project, for improvement of cashew, the experimental work on budding and grafting was spread to other cashew research centres, with varying results. In Orissa, the side grafting was attempted during October 1973, with about 42 per cent success.

2.2. In Andhra Pradesh, under the centrally sponsored scheme during 1974, vegetative propagation on cashew was taken up near Bapatla (Guntur District) on one/two year old cashew seedlings during the first fortnights of August and September. The same type of work was carried out on one year old seedlings near Kavali (Prakasam district) during the first fortnights of October and November, As suggested by the Government of India, all the three types of grafting *Viz.* side, veneer and patch budding, were attempted. Patch budding was a complete failure. During August, veneer and side graftings gave nil per cent 'take,' while it was 5 per cent during September for both types. During October, side grafting gave 36 percent 'take' and veneer grafting gave only 11 per cent success, and this fell to 11 and 1 per cents respectively for the work done in November. During the grafting period in August, there were practically no showers and the humidity was low with hot sun, which resulted in the desiccation and dehydration of the scions. There was light drizzle during the grafting period in September and the same was satisfactory during the working period in October, which perhaps explains some success obtained. During part of the October grafting season the sky also was over cast. Though there were some showers in November grafting season the flushing out of the dormant buds had taken place and so the 'take' was low.

* Forest Geneticist, Government of Andhra Pradesh, Hyderabad.

2.3. With this back ground and experience gained during 1974-75, an experiment to determins the most suitable period and method of grafting *in-situ* wasunder taken at two places on the east coast of Andhra Pradesh at fortnightly intervals, starting from August. In Perali, near Bapatla the grafting was carried out on two year old seedlings and in Gollapalem, near Kavali, it was done on one year old seedlings. The experiment carried out and the results obtained at Kavali centre are presented in this paper.

2.4. Old Cashew plantations, raised in the late 1960 from local seed, contain many trees which are very poor yielders. Sanitary cleanings, inter cultivation and application of chemical fertilizers, carried out for the benefit of these low yielders, did not yield any tangible results, which reflected in the un-economic returns from these plantations. One method by which such trees can be made to yield better, is by way of top working them, replacing the old shoots with scions from known and proven high yielders. In an attempt to find out a method of top working cashew trees, an experiment was started during 1974-75, in 1956-Gollapalem, 1957-Perali and 1970-Thummalapenta West cashew plantations.

3. Kavali Research Centre:

3.1. This area is situated at the inter section of 15° North latitude and 80° East longitude, close to the Bay of Bengal. The soils are pure sand to a depth of about 4 m with no earth or humus. The climate is generally dry and hot and enervating during a major part of the year. Cold weather is not well pronounced and lasts for only two months in December and January. The mean annual rainfall of about 900 mm. mostly from N-E monsoon, is erratic and unevenly distributed, September, October and November being the main rainy months, though some precipitations also occur during S-W monsoon. The natural vegetation is sparse represented by the Southern Euphorbia Scrub type with fleshy Euphorbias predominating. Others are widely spaced, low and rounded bushes of *Zizyphus xyolpyrus*, *Capparis divaricata*, *Randia dumatorum*, *Acaica pinnata etc.*

3.2. The weather conditions prevailing on the days of grafting are given in Table 1.

4. Materials and Methods :

4.1 *Side grafting :*

4.1.1 *Preparing the root stock :*—A transverse cut, about 8 mm, to suit the thickness of the scion, selected for use in grafting, is made on the smooth portion of the stem of the root stock, at about 25 cms height from the ground level. Height of grafting is increased or the grafting point shifted to a side branch whenever it is found necessary. Two vertical cuts about 6 cms in length are then made running downwards from the ends of the transverse cut. The rectangular piece of bark, thus enclosed by the cuts, is then slowly lifted and peeled off from the stem startting from the top of the cut.

4.1.2 *Preparing the scion :*—The precured and selectee scion, which is about 15 to 20 cms in length, pencil thick and with a swollen terminal bud, is given one long slanting cut about 4 cms in length at its base, the cut being equal to the length of the opened up flap on the root stock. This cut is made on the side which faces away from the direction of the terminal bud. Another small slanting outer cut, measuring about 2 cms, is given on the opposite side of the inner cut meeting it, at the base. The edge where the two cuts meet is made as thin as posssible, with the cambium layers still intact on both sides of the central pith. The cuts made are smooth with even surfaces.

4.1.3 *Tying :*—The prepared scion is then inserted into the gap formed between the exposed wood and the opened up flap, taking care to see that the longer inner cut faces the stem and the shorter outer cut faces the flap. By this arrangement, the apical bud faces away from the stem, so that it grows up without any obstruction when it opens after the union is established. The grafting union is tied firmly with a 5 cms wide, 250 guage polythene strip. At the top of the graft union the polythene strip is wound twice in opposite directions between the scion and the stem, to prevent lekage of rain water into the union. No over - hanging tissues are left either on the scion or on the root stock, as they hinder the proper graft union.

4.1.4 *Topping :*—4 to 6 weeks after grafting, depending on the quickness of the 'take' and development of the dormant bud on the scion, the root stock is topped above the union and the cut end smeared with candle wax. The polythene tying is also cut and removed.

5.1 Vaneer grafting :

5.1.1 *Preparing the root stock :*—A long shallow, downward and inward cut, about 5 cms long, is made on the seedling on a smooth patch about 25 cms above the ground level. At the base of this cut, a second short, inward and downward cut, starting about 1 cm above the base of the first cut is made, meeting the first cut at it's base. By this process, a sliver of wood and

bark comes off leaving a small upward projecting flap at the bottom of the open cut surface.

5.1.2 *Preparing the scion* :—A precured scion, matching the cut made on the root stock is selected. A long cut, to match the length of the cut made on the root stock is made on the side of the scion facing away from the direction of the apical bud. A second short and slanting cut, to match the length of the small flap on the root stock, is made at the base and on the opposite side of the long cut, leaving a thin edge with the two cambium layers intact on both sides of the pith.

5.1.3 *Tying* :—The scion is inserted into the cut of the root stock, with the longer cut facing the wood inside. The scion is adjusted so that the cambium layers, on the root stock cut and the scion cut, match at least on one side, if not on both sides of the central pith.

5.1.4 Subsequent operations of tying and topping are as described earlier for side grafting.

6. Top-Working :

6.1 Selected poor yeilders from the old cashew plantations mentioned earlier, were felled at a height varying between 17 to 50 cms above the ground using a hand saw, in the first fortnight of April, 75. The girths of these trees varied from as low as 22 cms (1970 plantation) to 106 cms (1957 plantation) at the height of cutting. The exposed cut surfaces were smeared with Bordeaux paste.

6.2. All these cut stems put forth a large number of shoots developing from the dormant buds, the number of shoots going upto even 27 in one case within three months. These vigourously growing shoots were thinned in the last week of July retaining only 6-8 of them, well spaced on each stool.

6.3. Side and veneer graftings were carried out on these shoots at fortnightly intervals.

7. Curing of shoots :

7.1. The shoots required for use in grafting are prepared 10 days in advance and this operation is very important. Mature and healthy terminal shoots of the current season's growth, with dormant terminal buds are selected. They are pencil thick being about 8 mm in diameter, about 20 cms. long, and with brownish green bark.

7.2. The laminate of the leaves from such selected shoots are clipped off leaving only the petioles intact on the shoots. Within the next few days, these petioles dropoff,indicating that the shoots are getting cured. Due to storage of food material, the shoot also gets thickened and the terminal bud appears swollen. This swollen condition indicates that the shoots are ready for separation from the parent tree and use in grafting. After the separation from the tree, these scions are kept covered by moist cloth till they are used in grafting.

7.3. Throughout the experiment, the scions obtained from trees of "progeny 119," in 1970 Thummalapenta West cashew plantation were only used in the grafting work.

8. Results :

8.1. The results of the fortnightly graftings carried out are given in Table 2 and 3.

8.1.1. In *in-situ* side grafting, the success varies from 5 to 55 per cent, where as it is 1 to 44, 10 percent for veneer grafting. The highest percentage of 'take' for both the methods is obtained during August second fortnight grafting.

8.2. In top working experiment, 'take' under side grafting varies from 25 to 50 per cent and the same is 20 to 50 per cent in veneer grafting. Better results in top working are obtained through side graftings done during both the fortnights of September and second fortnight of August.

9. Discussions :

9.1. During the I grafting period (13-8-75 and 14-8-75) the day temperatures were high with bright sun and low humidity. The success obtained both in *in-situ* grafting and top working was nil. Due to hot and bright sum, low humidity and lack of rains (Vide Table 1 and graph)desiccation and dehydration of the scions had taken place, within the first two days of grafting leading to its death. The scions showed wrinkled surface on the bark, by the second day itself, indicating the start of dying process.

9.2. During the II fortnight (27-8-75 and 28-8-75) a high percentage of 'take' was obtained Viz 55 per cent for *in-situ* side grafting and 44 percent for *in-situ* veneer grafting . Top working also gave high 'take' during this period. The high per centage of union obtained, can be attributed to lower day temperatures, partly cloudy days, and high percentage of humidity in the evenings, because of the rain received during the period (two days period to and one day after the actual grafting days).

9.3. In the next grafting (10-9-75 and 11-9-75) fortnight, conditions were again not conducive to aid

graft union with bright sun and high day temperatures, leading to dehydration in the scions. The mid-day and after - noon humidity was, however, not as it was in I grafting period. Humidity in the morning was also high. Hence the 'take' was better but lower than II grafting period. In top working the percentage of success by the older trees was maintained where as on the younger trees it came down to 25 and nil percent for side and veneer grafting, respectively.

9.4. In the IV period, though the day temperatures were high, the high humidity during the day, reduced the high incidence of death of scions due to dehydration. The rain that fell the following day also helped in preventing the drying up of scions and maintaining high humidity. The precentage of success in *in-situ* side grafting went up to 24 percent while it was only marginal in veneer grafting. In top working, the older trees retained the the 50 percent 'take' in side grafting, while on the 5 years old trees, the grafting gave 50 success while the veneer grafting gave 20 percent 'take' only.

9.5. During the V and VI Working (8-10-75 and 15-10-75).....afternoon was also low. The 'take' was low for both methods of grafting. The top working also resulted in failure except for side grafting on older trees in the V fortnight.

9.6. For details of results please see Table 2 and3.

10. Tentative conclusions :

10.1. From the results obtained so far at Kavali it is seen that day temperatures, cloud cover, humidity during the mid-day and after - noon, seem to have a great influence on the establishment of a successful union. Precipitation during the period helps in the graft union.

0.2. Cloudy and Cool days are best for grafting. Hot and bright sun, causes dehydration in the scions and kills it subsequently. Protection from direc, hot sun by shading may reduce the death of scions as observed on sime grafted on some grafted plants that had the advantage of over-head shade during the mid-day and after - noon, resulting in higher percentage of success.

10.3 Humidity plays an important role in the 'take' of the union . High humidity, especially in the mid-day and after - noon apperas to help considerably the graft union. High humidity reduces the rate of dehydration by lowering the evaporation rate from the scions as is evident from the graph, where the 'take' curve for both side and veneer graftings almost follows the pattern of the humidity curve.

10.3.1 It is possible to increase the humidity around the grafting point with the help a strip of polythene sheet wound round the stem and tied at the upper end above the union. The lower end is left open for circulation of air.

10.4. Rainfall aids in graft union by moderating the day temperatures and increasing the humidity. It also keeps the scions green to certain extent without drying fast. But rainfall during the time of actual grafting slows down the progress of the work and also prevents proper union taking place, due to a thin film forming between the root stock and the scion. Further wet scions are not good for grafting.

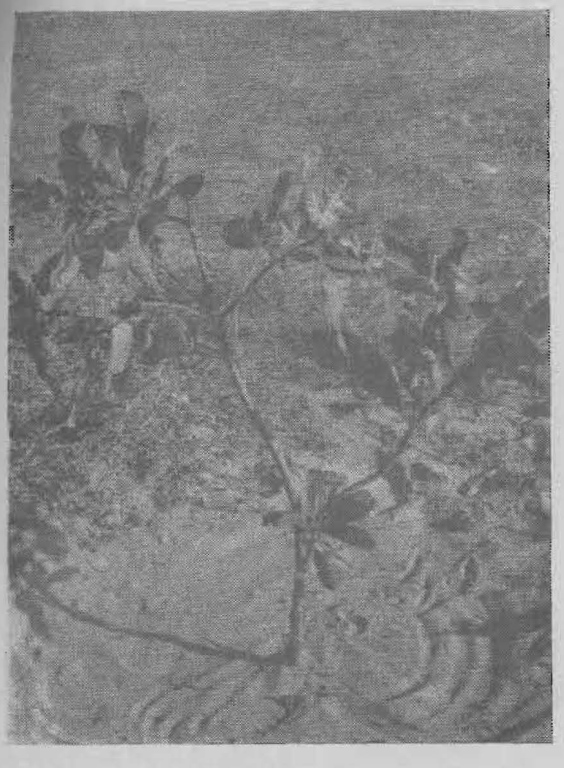
10.5. It is very difficult to get a number of days with all conditions favaourable for grafting and such days may be few and far between. Such days can not also be predicted and the shoots cured for the purpose in advance. To get proper scion material for use on such days, the shoots are to be cured every day, may be using only a part of the material that is ready for use on any particular day. This naturally results in wastage of large quantity of cured material, when they are not utilised in time because of prevailing unfavourable conditions for grafting on a particular day.

10.6. *In-situ* grafting is time consuming and laborious. Proper supervision is also difficult when large scale grafting is taken up, employing a large number of grafters. This can lead to lower rates of success.

10.7. It is possible to replace a few poor yielders in a plantation stocked with high yielders, by top working such trees , utilizing the mature root stock.

10.8. Between the side grafting and veneer grafting, the former method may be preferred, as it gives a higher 'take' and also easier to execute.

10.9. A lot more of work has to be carried out to evolve an easier and surer method, not very much dependent on the erratic climate, to propagate vegetatively a proven parent. With patience and perseverence in this field of research, it might of be possible before long to evolve and adopt the techinques for mass production of grafting cashew seedlings for large scale planting of high yielding strains. The Andhra Pradesh Forest Department is continuing its efforts in this direction and hopes to contribute substantially in the near future in our efforts to evolve and establish high yielding progenies on mass scale in the field.



Side Grafting

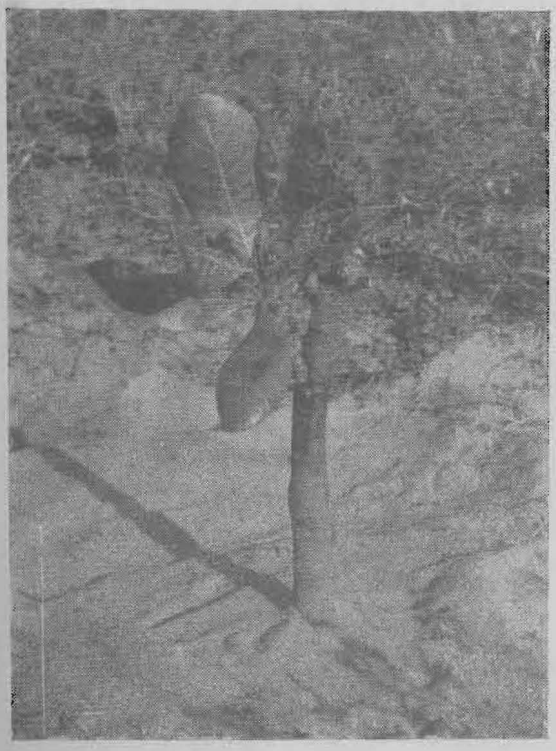
One year old cashew seedling showing the sprouted and growing scion at the base of the stem. The polythene tying is not removed and the root stock not topped.

Date of grafting :—23- 9-1975
Date of photo :—16-11-1975

Side Grafting

Grafted and topped one year old cashew seedling, with the well sprouted scion. The tying is still in tact.

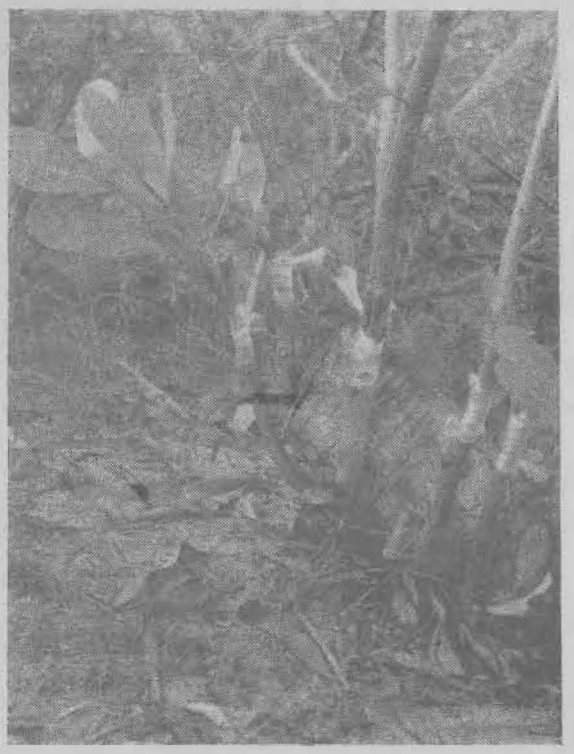
Date of grafting :—10-9-1975
Date of photo :—16-11-1975



Side Grafting

A topped root stock with the vigorous growing scion. The union is opened by cutting the polythene strip. The union is clearly seen.

Date of grafting :—27- 8-1975
Date of photo :—16-11-1975



Top working : Side Grafting.

Two topped shoots with the established and growing scions. Tying not yet removed.

Date of grafting :—10-9-1975
Date of photo :—16-11-1975

Side Grafting :

A topped shoot with the vigorous growing scion. The tying is removed by cutting it open.

Date of grafting :—27- 8-1975
Date of photo :—16-11-1975

TABLE 1

Climatic Data at Kavali on the dates of crafting.

Fort-night	Dates of grafting	Temperature		Humidity		Rainfall in the period		Remarks
		Min	Max.	Morn-ing.	Even-ing.	Date	mm.	
I.	13- 8-1975	77	97	63	41	..	..	Bright sun, partly coudy. Very windy.
	14- 8-1975	78	99	57	45	..	..	Very windy with bright sun.
II.	27- 8-1975	75	91	76	69	25- 8-1975	3.50	No bright sun. Partly coudy and windy.
						26- 8-1975	2.25	
	28- 8-1975	75	96	69	44	..	..	Do.
III.	10- 9-1975	73	92	83	53	..	..	Partly coudy and partly bright sun.
	11- 9-1975	74	96	80	54	..	..	Bright sun
IV	23- 9-1975	76	96	76	62	..	..	Bright hot sun.
	24- 9-1975	76	97	73	60	25- 9-1975	8.50	Bright hot sun.
V	8-10-1975	75	97	60	41	..	..	Partly cloudy, partly sunny, hot and sultry.
VI	15-10-1975	73	97	75	42	16-10-1975	90.50	Very bright sun, hot and sultry.

Note:—Rainfall that has fallen two days prior to and one day after the grafting dates, and that on the days of grafting, is taken into consideration, as only this moisture is likely to help in the take of the union.

TABLE 2

In-situ Grafting Results at Kavali.

Fortnight	Dates	Number of Side graftings			Number of Veneer graftings		
		Done	Successful	%	Done	Successful	%
I	13- 8-1975 14- 8-1975	97	0	0	99	0	0
II.	27- 8-1975 28- 8-1975	98	54	55	96	42	44
III.	10- 9-1975 11- 9-1975	99	5	5	98	6	6
IV.	23- 9-1975 24- 9-1975	98	24	25	98	7	7
V.	8-10-1975	98	15	15	107	11	10
VI.	15-10-1975	94	11	12	98	1	1

TABLE 3

Topping Results at Kavali.

Fortnight.	*Dates.*	*Number of Side Graftings*			*Number of Veneer Graftings.*		
		Done.	*Successful.*	%	*Done.*	*Succeful.*	%
I.	13- 8-1975/T	6	0	0	6	0	0
	14- 8-1975/S	4	0	0	4	0	0
II.	27- 8-1975/T	7	3	42	7	3	42
	28- 8-1975/G	4	2	50	4	2	50
III.	10- 9-1975/T	8	2	25	8	0	0
	11- 9-1975/G	4	2	50	4	2	50
IV.	23- 9-1975/T	6	3	50	5	1	20
	24- 9-1975/G	2	1	50	1	0	0
V.	11-10-1975/T	7	0	0	6	0	0
	G	3	1	23	3	0	0
VI.	15-10-1975/T	4	0	0	3	0	0
	G	4	0	0	4	0	0

T=Thummalapenta West 1970 Cashew plantation
G=Gollapalem 1956 Cashew plantation

KAVALI CENTRE