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SOME STUDIES ON ROOTING IN CASHEW (ANACARDIUM OCCIDENTALE LINN.) AIR LAYERS

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ABSTRACT

Cashew can be propagated by air layers but the extent of survival of the air layered plants in the field is limited (40 to 66 percent), probably because of the small number and brittle nature of the adventitious roots formed during propagation.

Studies at U.W.I., St. Augustine, have shown that root initation in cashew air layers occurs in the callus which is formed at the wound and increasing the amount of callus increases the total number and length of roots formed. Callus, and consequently root formation, were increased by using two consecutive rings in the marcot, joined by a bridge of bark. However, when three rings were used callus formation, as well as root initiation and elongation, were reduced.

Applying auxins, particularly IBA at 300 p.p.m. to the air layers increased root elongation but had no significant effect on root initiation.

INTRODUCTION

In several territories in the Region increasing attention is being paid to cashew as a possible commercial crop. However, one of the greatest difficulties experienced so far has been the unavailability of planting material, in particular, vegetatively propagated material.

Like other members of the Anacardiacae, cashew is a strongly outcrossing crop with the resultant variability in seedling population. There have been selection programmes in the region and a range of good quality material has been identified. Therefore it is essential that techniques of vegetative propagation be perfected in order to make improved clonal material available.

Among the different techniques, air layering is considered the most satisfactory method of cashew vegetative propagation so far (Argles, 1976; Nambiar, 1977; Nair et al., 1979).

Studies conducted at the Cashew Nut Research Station in Mangalore, India, and in Tanzania, have indicated that several physiological and

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ecological factors play roles in the rooting of air layers in cashew. Among these factors are the age of the parent trees (Rao and Hassan, 1957), the variation between cashew trees in root forming ability (Northwood, 1964), the age of the layered branches (Rao and Hassan, 1957; Rao, 1958), the stage of growth of the mother tree (Rao, 1958) and the rooting medium (Rao and Hassan, 1957; Northwood, 1964; Kromah, 1971).

The results of these studies have indicated that the survival of the rooted marcots after severing from the mother trees and transplanting to the field is relatively low and varies between 40 and 66 percent (Aiyadurai, 1968). The low percentage survival was suggested to be due to the brittle nature of the adventituous roots (Madhava Rao, 1969) and the limited number of roots formed (Rao and Hassan, 1957).

While the breakage of adventitious roots due to their brittle character could be overcome by proper nursery practices and care during the hardening stage before transplanting, attempts to increase the number of roots in cashew air layers, e.g. by using growth regulators, have given conflicting results (Rao and Hassan, 1957; Chonkar and Singh, 1967; Acharyya and Dash, 1972; Kromah, 1971).

In the West Indies it appears that the only work published on cashew air layering was that done by Kromah (1971), who studied the effect of different growth regulators. Measurements were mainly restricted to the percentage rooting of the cashew air layers. The effect of different treatments on parameters like number, length, diameter, dry weight or roots were not studied. Since these factors may affect the growth and development of the new plant, it was decided to measure them in experiments which involved growth regulators (mainly auxins) and variations in the ringing system. The purpose of this work was to obtain a basic understanding of the development of adventitious roots in cashew air layers.

Experiment 1

Among the different growth regulators, auxins were found to have a significant effect on the percentage rooting of cashew air layers (Chonkar and Singh, 1967; Acharyya and Dash, 1972; Kroma, 1971) and the concentration of the different types of auxins used ranged between 100 and 300 p.p.m.

MATERIALS AND METHODS

Vigorously growing shoots (0.8 - 1.2 cm in thickness) from the previous year's growth were selected for air layering. A ring of bark about 3 cm long was removed from each selected shoot and the cambium and phloem scraped off the wood to prevent healing across the ring. Aqueous solutions of IAA, NAA, or IBA at 200 p.p.m. or 300 p.p.m. were applied to the upper part of the cinctured ring with a paint brush. In the control treatment water alone was applied. Damp cacao moss, used as the rooting medium, was

wrapped around the cinctured stem and the entire mass was securely bound in a polyethylene wrap (10 x 25 cm) which was firmly tied at the upper and lower ends.

A completely randomized design was used and the treatments were replicated five times on young bearing cashew trees at the University Field Station. Layers were severed from the mother trees 45 days after ringing when root formation was observed through the transparent polyethylene sheets.

RESULTS AND DISCUSSION

The total number of roots was significantly increased by 300 p.p.m. IBA ($p < 0.01$) and 200 p.p.m. NAA ($p < 0.05$) treatments (Table 1). Two hundred p.p.m. IAA significantly increased the length of 1° roots ($p < 0.1$) and IBA at 300 p.p.m. increased the length of 2° roots ($p < 0.05$) as well as the total length of roots.

In this experiment there was no clear effect of the different treatments on percentage rooting of cashew air layers.

Table 1.--The effect of different auxin treatments on rooting of cashew air layers

Treatments	Mean no. of roots		Total Number of Roots	Mean Length (cm)		Total Length (cm)
	1°	2°		1°	2°	
IBA-200	26.0	22.8	48.8	73.6	26.2	99.8
IBA-300	42.8	33.8	76.6**	83.7	49.6*	133.3*
IAA-200	39.0	9.0	48.0	99.1*	13.2	112.3
IAA-300	23.8	4.2	28.0	32.9	4.4	37.3
NAA-200	33.4	23.0	56.4	71.3	29.9	101.2
NAA-300	20.4	10.2	30.4	35.4	6.7	72.1
Control	11.2	6.4	17.6	26.1	6.2	32.3

* $p < 0.05$
** $p < 0.01$

The percentage rooting in all treatments including the control was 100 except for IAA 300 p.p.m. (80%) which was mainly because of the healing of the wound and presumably the establishment of a vascular connection across the ring.

The unclear effect of the applied growth regulators on the percentage rooting seemed to confirm the results obtained by Rao and Hassan (1957) and disagreed with the findings of Kromah (1971).

In general, treatment of the marcots with auxins tended to increase the total length of roots as compared to the control, but this increase was not statistically significant except in the case of 300 p.p.m. IBA. Although the marcots were made at random on different branches of the mother trees, it was found that, without regard to the treatment applied, the location of the marcots on the mother trees was of significance. Marcots located in the shaded areas of the mother trees formed less roots than those located in the illuminated parts.

The results of this experiment suggested that there might be more than one factor responsible for the results obtained. It could be inferred that the method of application of the growth regulators (aqueous solutions), the slight variation in the concentrations used (200 and 300 p.p.m.) and the location of some marcots in the shade have attributed to the results obtained in this experiment.

Experiment 2

The effect of IBA concentrations and the location of marcots on the mother trees on the rooting of cashew air layers were investigated in an experiment on young bearing cashew trees at the University Field Station.

MATERIALS AND METHODS

A completely randomized design was used in this experiment. The treatments consisted of IBA 0, 300, 3,000 p.p.m. The effects of the different concentrations were tested on two locations on the mother trees namely: Exposed to the sun and shaded locations. IBA was applied to the upper part of the cinctured ring in the lanolin paste. In the control, lanolin alone was applied. The marcots were severed 45 days after ringing. There were three replicates in each treatment.

RESULTS AND DISCUSSION

In marcots exposed to the sun IBA at 300 p.p.m. gave the best results in the number of 2° roots ($p < 0.01$), total number of roots and the mean 1° root diameter in comparison to the control (Table 2). The effect of IBA at 300 p.p.m. appeared to be on the branching of 1° roots which resulted in the formation of a mass of fibrous roots spreading throughout the rooting medium. IBA at 3000 p.p.m. appeared to have some adverse effect on root development. In some cases 1° roots emerged, grew and then degenerated to a shrivelled mass.

Table 2.--The effect of different IBA concentrations on rooting of cashew air layers (exposed to sun)

Treatments	No. of roots			Total Number	Length of roots (cm)			Total Length	Root diameter (cm)	
	1°	2°	3°		1°	2°	3°		1°	2°
IBA 300 p.p.m.	55	55.3**	40	150.3	187.6**	143.6**	53.5	384.7**	0.30*	0.11
IBA 3000	35.6	6	2	43.6	82.3	11	0.50	93.8	0.24	0.04
Control	21.6	2.7	0	24.3	59.2	2.8	0	62	0.19	0.06

* $p < 0.05$
** $p < 0.01$

Within the different IBA treatments in the shade 3000 p.p.m. produced the best results with regard to the number of 1° ($p < 0.01$) and the total number of roots formed ($p \leq 0.05$) (Table 3). However, in the other parameters there were no significant differences between the hormone treatments.

It was observed that the number of leaves was relatively fewer in the marcots located in the shaded areas as compared to marcots located in the sun. This may have a direct effect on the root forming ability of the marcots located in the shade. The presence of leaves often has a stimulating influence on the rooting of air layers and cuttings (Hartmann and Kester, 1975). The limited number of leaves on marcots located in the shade as compared to the sun (Average leaf number was 13.7 and 65.9 respectively) was mainly due to the early leaf abscission in the shade.

In general, marcots located in the shaded areas of the mother trees formed less roots than those marcots exposed to the sun (Table 4).

Experiment 3

Root formation in cashew air layers was found to be restricted to the area of callus formation.

The histological studies (unpublished data) confirmed that the origin of adventitious roots in cashew air layers is in the callus. Root initials were found to be formed near or in the newly formed vascular system in the callus tissue.

It was noticed in the preliminary work that where a ring had accidentally been cut in a spiral rather than a single ring, callus formation was greatly increased. It was therefore decided to attempt to increase the number of roots initiated by increasing the area of callus formation and the quantity of callus formed.

MATERIALS AND METHODS

A completely randomized design was used in this experiment. The experiment consisted of three treatments namely:

a. 1 ring (control
b. 2 rings
c. 3 rings

There were three replicates in each treatment and each replicate of each treatment consisted of five marcots. The experiment was carried out on 13/2/81 and completed on 4/4/81 (48 days). Ringing in the control was done according to experiment (1). In the other two treatments additional rings were made 1 cm apart. A piece of bark (bridge) 1 cm wide was left connecting the rings of bark.

Table 3.--The effect of different IBA concentrations on rooting of cashew air layers (in the shaded areas)

Treatments	No. of roots		Total number of roots	Length of roots		Total length of roots	Root diameter	
	1°	2°		1°	2°		1°	2°
IBA 300	6	1	7	12.3	0.1	12.4	0.13	0.02
IBA 3000	15**	2	17*	27.0	0.8	27.8	0.17	0.02
Control	4	2	6	14.5	2.6	17.1	0.16	0.02

* $p < 0.05$
$p \leq 0.01$

Table 4.--The effect of different IBA concentrations on rooting of cashew air layers (sun and shade)

Treatments	Total number of roots		Total length of roots (cm)	
	Sun	Shade	Sun	Shade
IBA 300 p.p.m.	150.3	7	384.7	12.4
IBA 3000 p.p.m.	43.6	17	93.8	27.8
Control	24.3	6	62.0	17.1

Marcots were done at random on branches which were either vigorously growing or flowering or at the early stage of fruit setting.

RESULTS AND DISCUSSION

The two-ring treatment produced the greatest number of roots ($p < 0.001$), length of 1° roots ($p < 0.05$) and total length of roots ($p < 0.05$) (Table 5).

The mean diameter of 1° roots of the two ring treatment was appreciably greater than that of the other treatments even though the difference was not statistically significant. There was no significant difference between the three-ring treatment and the control (one-ring) in any of the parameters measured. In the two ring treatment roots were found arising more or less equally from both rings while in the three ring treatment roots were found arising mainly from the lowest ring.

The results of the ringing experiment showed that increasing the number of rings to two led to an increase in the total number of roots, length of 1° roots and the total length of roots. It was suggested that this might be due to the increase in the amount of callus formed in this treatment. However, in the three ring treatment the amount of roots formed was not significantly different from the control and less than the two ring treatment. This may be explained by the following:

1. The experiment was done when cashew trees were vigorously growing and flowering which resulted in the competition between sinks for assimilates. Young leaves, flowers and developing fruits are known to be strong sinks uor assimilates (Kadoya and Tanaka, 1972).

2. While the number of leaves was maintained more or less equally in all the treatments as a source for assimilates and other growth substances, the increase in the number of rings led to an increase in the sink capacity.

Table 5.--The effect of single and multiple ringing on rooting of cashew air layers

Treatments	No. of roots			Total number	Length of roots (cm)			Total number	Root diameter (cm)	
	1°	2°	3°		1°	2°	3°		1°	2°
2 Rings	35.4	34.2	24	93.6***	160.1	82.6	42	285.7*	0.33	0.10
3 Rings	25.3	8.1	0	33.4	57.6	15.1	0	72.7	0.19	0.08
Control (1 Ring)	22.1	3.2	0	25.3	59.3	2.8	0	62.1	0.19	0.06

* $p < 0.05$
*** $p < 0.05$

It could be argued that in the control the sink capacity was a limiting factor while in the three ring treatment the source was the limiting factor.

3. The duration of the experiment was similar in all treatments and it could be that the time was not enough for the three ring treatments to form roots.

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