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The Rooting Performance of Shea (*Vitellaria paradoxa* C.F. Gaertn) Cuttings Leached in Water and Application of Rooting Hormone in Different Media

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Abstract: In order to improve the rooting performance of shea stem cuttings to enhance the establishment of shea plantation, an investigation was carried out in 2003/2004 at the Cocoa Research Institute of Ghana Substation, Bole in a polythene propagator. The propagating structures for the experiment were kept under a shade net (50% shade) to create a microclimate for the cuttings. The treatments employed were leaching, different growth media and hormone application. Rejuvenated (coppiced cuttings) shoots that were not leached (not dipped in water) gave significantly higher rooting than the leached cuttings while Seradix 3 powder applied cuttings produced significantly higher ($p<0.05$) rooting than the control. Significantly high in number, more developed and longer roots per cutting were recorded for the rice husk medium than the sand and sand+top soil (1:1) media. The biochemical analysis significantly recorded high levels of sugar and phenol for cuttings that were not leached in water. The results of this study demonstrated that rice husk medium was the best for rooting shea cuttings.

Key words: Rice husk medium, phenol, sugar, sand , sand+top soil

INTRODUCTION

The sheanut tree, *Vitellaria paradoxa* Gaertn is found in dry savanna and parklands of the Sudan zone. In this zone, the annual rainfall ranges from 500-1200 mm (Sallé *et al*., 1991). It is regarded as an important crop because of its local and national economic importance (Desmarest, 1958). In Northern Ghana, the pulp of the shea fruit is eaten as food by the populace during the dry season. The seed of *V. paradoxa* with a fat content of about 50% is used locally by many as a cleanary fat or oil, for soap manufacture and as an ointment. The 9.5 million estimated trees found in Northern Ghana could give a possible yield of 10,000 tonnes of sheanut but the annual collection ranges from 4000-8000 tonnes (Abbiw, 1990) and contributed about $100,000 per annual to the country in 1996 (Hall *et al*., 1996). Currently, no commercial shea tree plantation has been established in the country. Except for research plantations, all existing trees are in the wild and are constantly being destroyed by bush fires.

A number of propagation studies have been initiated since 1975 at the Cocoa Research Institute of Ghana (CRIG) Substation at Bole (Yidana, 1994), but the propagation successes have been low and inconsistent (Opoku-Ameyaw, 1996). Opoku-Ameyaw *et al*. (2000) also reported that re-juvenated shoots rooted better than the soft and semi-hardwood types. They further explained that slightly wounding the cuttings by squeezing 1cm from the tip of the base improved the rooting performance. Leaching of cuttings as reported by Hess (1962) and Hartmann *et al*. (1997) adversely affected rooting of stem cuttings by reducing the levels of soluble endogenous plant substances which are responsible for cell division and metabolic activities. Ofori-Gyamfi (1998) also working on coffee (*Coffee conaephera* var. Robusta, Pierve) observed that rooting performance depended on the type of medium used in the propagating structure. The purpose of this study was to determine the best rooting medium and influence of leaching and hormone application for optimal rooting of shea cuttings for vegetative propagation towards plantation establishment.

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MATERIALS AND METHODS

The experiment was carried out in June, 2004 at the Cocoa Research Institute of Ghana sub-station, Bole, 9° 01'N, 2°.29'W, 309 m above sea level. Cuttings made of rejuvenated shoots of lengths between 12 and 15 cm were harvested and set up in a 2×2×3 factorial design. The first factor involved leaching (leaching and no leaching) of cuttings, the sub-factor was dipping of the cuttings in hormone (Seradix 3 powder and no Seradix) whilst the sub-factor was settings cuttings in the different media (top soil, Top soil+sand and rice husk). All the cuttings were prepared by retaining 6 matured leaves as recommended by Opoku- Ameyaw *et al*. (2000). Twenty cuttings were set per treatment and replicated three times.

A set of 120 cuttings (A) was harvested the first day and dipped in water to a depth of 2 cm for 24 h while the second set (B) of 120 cuttings was also harvested the next day. The two sets A and B were sub divided into two: A1 and A2 (60 cuttings each) and B1 and B2 (60 cuttings each). The lower base of A1 and B1 were dipped in Seradix powder hormone (8000 ppm) to a depth of 0.5 cm for 2 min before setting. While A2 and B2 were set without hormone (control). Three polythene propagators were constructed under a shed to provide 50% shade. Each of them was either filled with top soil (sandy loam) or sand+top soil (1:1) or rice husk medium to a depth of 15 cm above the gravel layer in the propagating structure. Each of the groups A1, B1, A2 and B2 was divided into three groups of 20 cuttings and set the same day in any of the propagating structures containing any of the three media.

Dithane M45 at 2000 ppm was sprayed on all the cuttings to control fungal infection. Monitoring was done every three days to remove dead and infected leaves and cuttings. Watering was done as and when necessary. The parameters studied were number of cuttings alive (dormant, callused and rooted), number of roots developed per cuttings and average root length of cuttings. Samples of the harvested cuttings which were leached/not leached before setting were analyzed for total sugars and total free phenols according to the methods of Dubois *et al*. (1956) and Swain and Hillis (1959), respectively.

Statistical Analysis

The experiment had a randomized complete block design with 2×2×3 with three replications. All obtained data were subjected to analysis of variance using Genstat 5 release (3.2) statistical software. Fisher's Least Significant Difference (LSD) method was used to determine differences among means for each parameter. Significance was defined at $p<0.05$.

RESULTS AND DISCUSSION

The results indicated that, among the leaching treatments, rejuvenated cuttings that were not leached (dipped in water) significantly ($p<0.05$) induced more and longer roots. Leached cuttings did not record any rooting. Callus formation was not significant for leaching (Table 1).

The results demonstrate that cuttings, which recorded high rooting without the leaching treatment, might be due to the retention of free auxin, water soluble sugars, free phenols and other nutrients. The

Table 1: Effects of leaching on the rooting performance of coppiced cuttings

	Cuttings alive after 120 days (%)				
Treatments	Dormant cuttings	Callused cuttings	Rooted cuttings	No. of roots per cuttings	Average root length (cm)
Leached	20 (24.3)	20 (26.1)	0 (0.0)	0.0	0.0
Not leached	40 (35.8)	30 (24.7)	40 (45.5)	4.0	9.7
LSD (p = 0.05)	9.8	ns	10.7	2.5	1.7

ns: Not significant. Values in parenthesis are angular transformed

Table 2: Effects of hormone treatment on the rooting performance of coppiced cuttings

	Cuttings alive after 120 days (%)				
Hormone application	Dormant cuttings	Callused cuttings	Rooted cuttings	No. of roots per cuttings	Average root length (cm)
Control	40 (43.4)	20 (26.1)	0 (0.0)	0.0	0.0
Seradix powder	20 (21.8)	30 (29.0)	30 (36.4)	5.0	6.7
LSD (p = 0.05)	12.3	ns	11.7	0.8	1.2

ns: Not significant. Values in parenthesis are angular transformed

Table 3: Effects of rooting media on the rooting performance of coppiced cuttings

	Cuttings alive after 120 days (%)				
Media	Dormant cuttings	Callused cuttings	Rooted cuttings	No. of roots per cuttings	Average root length (cm)
Top soil and sand	40 (42.7)	30 (31.4)	10 (15.0)	2.0	6.1
Sand	50 (53.3)	30 (28.9)	10 (16.7)	4.0	7.8
Rice husk	30 (36.5)	60 (68.1)	40 (36.7)	5.0	10.3
LSD (p = 0.05)	11.3	12.7	11.5	1.8	2.3

Values in parenthesis are angular transformed

results confirm earlier observation made by Hess (1962) that these unleached soluble plant substances are responsible for root initiation and deactivation of indolaceticacid oxidase (IAAoxidase), preventing the destruction of the auxin IAA (Hartmann *et al*., 1997; Fadl *et al*., 1979).

Hormone application significantly affected the number of dormant and rooted cuttings, the number of roots developed per cutting and root length. Cuttings treated with Seradix 3 powder gave higher rooting, more developed roots and longer roots than the control (Table 2).

Middleton *et al*. (1980) observed that auxins enhance rooting through the translocation of carbohydrate and other nutrients to the rooting zone. Application of the Seradix 3 powder may have increased the level of auxin to enhance the rooting performance of the cuttings. The production of adventitious roots in plants through cell division, multiplication and specialization is also controlled by plant growth substances, especially auxins (Davis and Hassig, 1990).

Significant ($p<0.05$) number of rooted cuttings, more developed and longer roots were also recorded for cuttings which were set in the rice husk medium while sand and top soil+sand media showed poor rooting performance (Table 3).

The rooting potential of cuttings with regard to media was studied by Ofori-Gyamfi (1998) in coffee propagation. He stated that rice husk plays a very important role in temperature regulation, which enhanced metabolic activities, especially auxin biosynthesis (Leopold, 1960) thus promoting root initiation. Rice husk with high aeration as reported an promote metabolic activities and enhance root initiation. This probably explains why rice husk recorded high rooting than the other media.

Significant interaction existed among the treatment except the number of dormant and callus cuttings (Table 4).

Treatment interaction between cuttings that were not leached, dipped in Seradix 3 powder and set in rice husk medium significantly ($p<0.05$) recorded higher rooting and longer roots while the leached cuttings (in water) without hormone application and set in top soil+sand and sand media did not record any rooting. The leaching treatments significantly affected the sugar and phenol levels (Table 5).

Cuttings that were not leached recorded high levels of sugars and phenols (Table 5), which may be responsible for high rooting performance. The presence of sugar in the cuttings promotes rapid translocation of other essential substances like the endogenous auxins, vitamins and micronutrients as well as growth and development of the rooted cuttings (Wiegel *et al*., 1984). Girouard (1969) observed that plants with high levels of phenol help in the deactivation of IAAoxidase and improved rooting. Modification of IAAoxidase activity, liberation of endogenous auxins and formation of covalently

Table 4: Interaction effects of leaching, hormone application and media on the rooting performance of coppiced cuttings

Interaction treatment (leaching × hormone × media)	Cuttings alive after 120 days (%) Dormant cuttings	Callused cuttings	Rooted cuttings	No. of roots per cuttings	Average root length (cm)
Lch×Ctrl×TpSd	20 (24.8)	10 (12.3)	0 (0.0)	0.0	0.0
Lch×Ctrl×Sd	20 (26.9)	10 (15.8)	0 (0.0)	0.0	0.0
Lch×Ctrl×RH	10 (14.7)	10 (16.3)	10 (13.6)	3.0	9.1
Lch×S3P×TpSd	10 (12.7)	20 (25.7)	10 (16.5)	2.0	3.2
Lch×S3P×Sd	20 (25.8)	0 (0.0)	10 (12.8)	4.0	8.5
Lch×S3P×RH	0 (0.0)	10 (13.4)	30 (33.0)	2.0	6.4
N Lch×Ctrl×TpSd	10 (11.1)	10 (18.4)	10 (16.5)	3.0	10.5
N Lch×Ctrl×Sd	0 (0.0)	20 (21.7)	10 (12.8)	5.0	6.8
N Lch×Ctrl×RH	10 (16.7)	30 (28.9)	10 (11.1)	5.0	10.9
N Lch×S3P×TpSd	10 (15.0)	0 (0.0)	10 (15.3)	2.0	5.7
N Lch×S3P×Sd	0 (0.0)	0 (0.0)	20 (26.1)	3.0	8.4
N Lch×S3P×RH	20 (25.7)	10 (12.9)	70 (67.6)	5.0	15.1
Interaction LSD (p = 0.05)	ns	ns	10.3	1.8	2.3

ns: Not significant. Values in parenthesis are angular transformed. Ctrl: Control; Lch: Leached; NLch: Not leached; TpSd: Top soil and sand; Sd: Sand; RH: Rice Husk; S3P: Seradi×3 Powder

Table 5: Levels of sugars (mg g^{-1}) and total free phenols (μg g^{-1}) in cuttings leached with water

Treatments	Carbohydrate concentration (mg g^{-1}) Soluble	Insoluble	Total	Total free phenols (μg g^{-1})
Leached	5.1	21.0	26.1	88.5
Not leached	8.6	26.4	35.0	132.8
LSD (p = 0.05)	2.5	4.5	4.6	25.7

bonded auxin-phenolic conjugates occur due to the presence of phenols (Hackett, 1970; Fadl *et al*., 1979) and contribute to the rooting performance of cuttings.

CONCLUSION

Overall, the results of this study demonstrated that rice husk medium was the best for rooting shea cuttings. Leaching cuttings in water for 24 h before setting reduces the rooting performance. Seradix '3' hormone treated cuttings recorded good rooting than the non-hormone treated cuttings. All the cuttings, which were not leached, recorded high levels of sugar and total free phenols that contributed to the high rooting performance and well developed roots of the cuttings.

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