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Full Length Research Paper

Determination of optimum age for transplanting cashew (*Anacardium occidentale*) seedlings in Northern Ghana

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The effect of age on the survival and growth of transplanted cashew seedlings was studied in the savanna ecological zone of northern Ghana in three field experiments. The seedling ages studied varied between 1.5 and 4.5 months after sowing. Seedling age significantly affected the survival of cashew seedlings one year after transplanting in two experiments with seedlings of between 1.5 and 2 months old establishing better than the older seedlings ages. Neither the growth of seedlings nor the proportion of plants that flowered two years after transplanting was significantly affected by seedling age at transplanting. A recommendation on the optimum period for raising cashew seedlings for transplanting in northern Ghana is given.

Key words: Cashew, seedling age, transplanting.

INTRODUCTION

Cashew (*Anacardium occidentale*) farms can be established either by planting seeds at stake or as nursed seedlings. Planting seeds at stake has been the more preferred method since cashew seedlings have been reported not to transplant too well due to their delicate root system (Duke, 1983; Davis, 1999; Jorker, 2000; Judge, 2001) Planting at stake has also been reported to be quicker, cheaper and allows the plant to develop its root system naturally especially the taproot (Ohler, 1988). However, the disadvantages associated with this method of establishment in terms of lower germination rates, higher seed rates required, less opportunity for selecting good seedlings to ensure uniform establishment and risk of serious damage by animals (Judge, 2001), provide a strong case for investigating the establishment method whereby nursery raised seedlings are used.

Cashew was introduced into Ghana in the early 1960's but was neglected despite its enormous export potential. As one of its strategies to alleviate poverty in the rural areas and widen the base of the agricultural exports, the Government of Ghana is presently actively promoting the cultivation of cashew to increase the income of rural dwellers. The Ghanaian Ministry of Food and Agriculture is recommending the use of nursed seedlings for establishment of cashew farms. However, locally there is a dearth of empirical information on the age at which cashew seedlings should be transplanted into the field to ensure high survival rates and optimum growth. Recommendations generated elsewhere on the optimum age for transplanting cashew vary, being 1 to 1.5 months and 2 to 2.5 months for Tanzania and Nigeria, respectively (Has-san and Rao, 1957; Adenikinju et al., 1989).

This paper reports on the findings of a study, aimed at determining, under Ghanaian conditions, especially in the north where the timing of the rain season could be erratic, the optimum seedling age at which field transplanting is most feasible.

MATERIALS AND METHODS

Three experiments were carried out in 1995/96, 1996/97and 2002/03 seasons at the Cocoa Research Institute of Ghana substation at Bole (9º 01' N, 2 º 29' W, 309 m asl) in the Guinea Savannah zone of northern Ghana. The long-term mean annual rainfall and daily temperature of the site are 1087 mm and 26.1^{o}C, respectively (Osei-Amaning, 1996). The soils of the station are mainly Ferric Luvisol with smaller areas of Eutric Regosols and Lithosols (FAO-UNESCO, 1977). Tables 1 and 2 show the rainfall and temperature data of the site for the experimental seasons. Cashew seeds were sown in 25 cm x 17.5 cm polythene bags at different times in the the nursery to obtain seedlings of ages 1.5, 2, 2.5, 3, 3.5, 4 and 4.5 months at the time

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Table 1. Mean monthly rainfall distribution (mm) at the experimental site.

Month	1995	1996	1997	2002	2003
January	0.0	0.5	0.0	0.0	0.0
February	2.8	39.9	0.0	0.0	30.8
March	60.3	33.5	5.4	31.9	28.8
April	94.1	125.6	175.1	96.0	124.3
May	38.7	187.4	73.4	145.7	190.4
June	138.8	123.2	211.3	-	235.1
July	234.4	130.4	114.9	244.4	49.6
August	78.0	143.5	128.0	252.7	128.9
September	228.0	136.4	256.6	157.7	304.1
October	119.0	109.6	44.1	68.8	102.3
November	26.2	0.0	55.0	17.6	56.0
December	7.4	0.0	0.0	0.0	1.0

Table 2. Mean monthly temperatures (^{O}C) at the experimental site during the period of the trials.

Month	1995	1996	1997	2002	2003
January	-	27.2	27.3		26.6
February	-	29.1	28.2		29.1
March	-	30.3	30.0		29.9
April	-	28.5	28.8		28.9
May	-	28.2	27.6		27.8
June	26.8	26.1	26.3	26.4	25.7
July	25.5	25.2	25.1	25.7	25.5
August	25.4	25.2		24.8	
September	26.1	25.4		25.5	
October	26.8	26.2		26.4	
November	26.2	25.1		26.9	
December	26.3	26.4		25.6	

of transplanting in the rainy period in mid- June of each year. The seven treatments of different seedling ages were laid out in a randomised block design and replicated four times with twenty five plants per plot. The plants were spaced at 4 x 4 m in plots measuring 20 x 20 m which were maintained by clean -weeding with a hoe. Due to scarcity of seeds, it was not possible to raise 4.5 months old seedlings in the 1995/96 and 1996/7 seasons and 1.5 months old ones in the 1996/97 season. Data, collected in all the experiments, included seedling survival and growth (girth and height increments) at one year after transplanting. The girth of the seedling was mea-sured with a veneer calliper at 5 cm from the ground whilst seedling height was recorded with a metre rule. Measurements started at transplanting and were Repeated at 3-monthly intervals until the seedlings attained the age of one year. In the 1996 / 97 season, the proportion of plants in each treatment that flowered two years after transplanting was also recorded. The data were analysed using analysis of variation (ANOVA) and the means separated by standard error of difference. The data on percentage seedling survival was arcsine-transformed before analysis.

RESULTS

Seedling survival

Table 3 shows the effect of seedling age on seedling sur-ival one year after transplanting. Although in the 1995/96 season the effect was not significant, seedling age signi-ficantly affected seedling survival in the 1996/97 and 2002 / 03 seasons. In the 1996/97 season, 2 months and 2.5 months old seedlings ($P<0.05$) survived significantly better than the 3.5 and 4 months old ones. How-ever in the 2002/03 season, it was only the 1.5 month seedlings which gave significantly ($P<0.01$) better survival than those that were 4 and 4.5 months old. In all seasons, 4 month old seedlings gave survival rates of above 85%.

Seedling growth

Neither seedling girth nor height was significantly affected by seedling age one year after transplanting in all seasons (Tables 4 and 5). When averaged over the three experi-ments, the 3 month old seedlings produced the least growth one year after transplanting.

Effect of seedling age on flowering

The age of the seedlings did not significantly affect the proportion of plants that flowered two years after transplanting in the 1996/97 experiment (Table 6) probably due to the high variability observed within treatments. It was, however, observed that a higher proportion of the 2 month old seedlings flowered earlier than the others.

DISCUSSION

Damage occurring to the tap roots of cashew plants during transplanting has been the main cause of transplanting failure especially in older seedlings (Ohler, 1988; Decker et al., 2001). Hassan and Rao (1957) reported that trans-planting one-month old seedlings sown in 25 x 19 cm bags was a more practical method of planting than keeping them for two months since the older seedlings suffered larger transplanting shock. In Nigeria, Adenikinju et al. (1989) recommended that cashew should be transplanted within 2 to 3.5 months after germination. The results of the present study indicate that, in northern Ghana, gene-rally cashew seedlings between the ages of 1.5 to 3.5 months could be transplanted to give an establishment success of over 90%. Younger seedlings (1.5 and 2 months), however, tended to give slightly higher establish-ment success than older ones depicting a trend similar to the results of Barros et al. (1974) cited by Ohler (1988). This could be partly attributed to the fact, being smaller in size, they might have had higher root:shoot ratio (Watson, 1985) which is important for providing adequate water via the roots to replenish water lost through transpiration.

Table 3. Effect of seedling age at transplanting on percentage seedling survival at one year after transplanting (values in brackets are arcsine transformed data).

Seedling age (months)	Seedling survival (%)			
	1995/96	1996/97	2002/03	Mean
4.5	-	-	81.1 (66.2)	-
4	86 (68.1)	88 (70.6)	89.2 (73.5)	87.7
3.5	95 (79.2)	92 (74.1)	94.5 (78.2)	93.8
3	71 (57.9)	97 (83.0)	97.9 (84.4)	88.6
2.5	85 (67.6)	99 (87.1)	97.8 (84.4)	93.9
2	90 (71.6)	100 (88.2)	97.7 (84.3)	95.9
1.5	83 (68.6)	-	100 (88.2)	91.5
Sig. level	(NS)	(*)	(**)	
Sed (12 df) :1996/97		(4.19)		
Sed (18df) :2002/2003			(5.56)	

NS – not significant at 5% probability level. *- significant at 5% probability level
**- significant at 1% probability leve

Table 4. Effect of seedling age at transplanting on seedling girth increment one year after transplanting.

Seedling age (months)	Seedling girth (mm)			
	1995/96	1996/97	2002/03	Mean
4.5	-	-	25.5	-
4	28.0	22.3	23.3	24.5
3.5	22.4	22.7	25.3	23.5
3	19.9	22.3	22.9	21.7
2.5	23.4	22.7	27.4	24.5
2	28.2	27.6	24.8	26.9
1.5	23.5	-	23.0	23.2
Sig. level	NS	NS	NS	

NS – not significant at 5% probability level

Table 5. Effect of seedling age at transplanting on seedling height increment, one year after transplanting.

Seedling age (months)	Seedling height (cm)			
	1995/96	1996/97	2002/03	Mean
4.5	-	-	93.9	-
4	93.0	69.3	85.6	82.6
3.5	72.0	76.5	96.4	81.6
3	57.0	66.8	79.9	67.9
2.5	73.6	67.8	97.7	79.7
2	93.6	87.3	87.3	89.4
1.5	79.7	-	84.0	81.9
Sig. level	NS	NS	NS	

NS – not significant at 5% probability level

Maintaining such a balance might have resulted in very little transplanting shock among them (Kozlowski and Dav-ies, 1975). The slightly better establishment of the younger seedlings is an advantage since it reduces the time need-ed for nursery activities. The survival rates of above 85% but less than 90% achieved by the 4-month old seedlings indicate that in situations where rainfall is delayed or erratic, resulting in seedlings exceeding the

ideal age of 2 months, transplanting such seedlings may offer a reasonable option than discarding them.

Judge (2001) reported that in Jamaica, seedlings can be raised in the ground and transplanted with 90 percent success, provided the plants are taken up with a good ball of soil and the top cut back by one third, when they are transplanted into the field. Cutting back a plant may cause some setback in shoot growth. The equally high establish-ment success achieved in the present study, especially, in the 1996/97 seasons, without application of any pre-plant-ing treatment to the shoot or roots indicates that cashew seedlings can transplant very well contrary to the generally held view that it is difficult to transplant.

Seedling age in the present study did not affect the growth of the seedlings and the proportion of trees that flo-wered one and two years after transplanting, respectively. This supports the findings of Barros et al. (1974) cited by Ohler (1988), which showed equal girth development in transplanted one month old seedlings and those from seeds sown in situ after some months.

Most existing cashew farms in Ghana were established from seeds planted at stake. The establishment rate of seedlings planted at stake in this study (data not presen-ted) ranged between 62 and 64%. This indicates that a lot more effort will have to be put into filling of vacancies than when transplanted seedlings are used. The results of the present study have shown that cashew seed-lings can be successfully raised and transplanted into the field with a high degree of success especially when very young seedlings are used. To benefit from the use of nur-sed seedlings it is, therefore, recommended that for northern Ghana, nursing of cashew seedlings should start in April so that the seedlings would be about 2 months old in June when there is likely to be enough soil moisture for transplanting to take place.

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