Improving the growth of cashew (*Anacardium occidentale*) seedlings interplanted into mature sheanut stands in northern Ghana

K. OPOKU-AMEYAW & M. R. APPIAH
Cocoa Research Institute of Ghana (CRIG), P. O. Box 8, New Tafo-Akim, Ghana

ABSTRACT

The effects of sulphate of ammonia and cowdung application on the growth of young cashew (*Anacardium occidentale*) seedlings within mature sheanut stands were studied in two field experiments in the savanna ecological zone of northern Ghana. A basal application of 22 and 21 g/plant of muriate of potash and triple superphosphate, and in addition to application of sulphate of ammonia at the rate of 0,70, and 140 g/plant significantly (P<0.05) increased plant height and girth and number of leaves per plant in one experiment. The effect of cowdung applied at 7 kg/plant was not significant (P<0.05) in any of the trials and was attributed to probably a slow rate of mineralization. Basal application of higher rates of muriate of potash and triple superphosphate at 40 and 100 g/plant, respectively, in addition to the sulphate of ammonia treatments in one experiment resulted in the development of leaf symptoms which were similar to those caused by boron deficiency. The need for further studies to validate the observation made is highlighted.

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RÉSUMÉ

OPOKU-AMEYAW, K. & APPIAH, M. R.: *Améliorant la croissance des semis d'anacardier* (Anacardium occidentale) *plantés entre les lignes des parcelles de karité mûr au nord du Ghana.* Les effets de sulfate d'ammonium et d'application de bouse de vache sur la croissance des semis jeunes d'anacardier (*Anacardium occidentale*) entre les parcelles de karité étaient étudiés dans deux expériences de champ dans la zone écologique de la savane au nord du Ghana. Une application basale de 22 et 21 g/plante de muriate de potasse et triple superphosphate et en plus d'application de sulfate d'ammonium à une proportion de 0, 70, et 140 g/plante augmentaient considérablement (P < 0.05) la taille et la circonférence de plante et nombre de feuille par plante dans une expérience. L'effet de bouse de vache appliqué à 7 kg/plante n'était pas considérable (P < 0.05) en aucun des essais et était attribué à une proportion lente probable de la minéralisation. L'application basale des proportions plus élevées de muriate de potasse triple superphosphate à 40 et 100 g/plante respectivement en plus de traitements de sulfate d'ammonium dans une expérience aboutissaient au développement des symptômes de feuille qui étaient semblables à ceux causé par carence en bore. La nécessité des recherches supplémentaires pour prouver la justesse de l'observation faite est mise en lumière.

Introduction

Cashew (*Anacardium occidentale*), a member of the family Anacardiaceae, is a crop of great commercial value. Some useful products obtained from cashew fruit include the edible kernel of the nut, cashew nut shell liquid, and the apple which can be eaten fresh or prepared into syrup, jams, jellies, beverages, and candied fruits (Ohler, 1979). Cashew originates from the northern part of South America and the Caribbean, and it is thought to have been introduced to Africa through the activities of the Portuguese traders (Ohler, 1979; Burkhill, 1985).

Cashew which was cropped on plantation basis in Ghana by the Workers' Brigade in the 1960s seemed to have been virtually neglected, even though it is a potential foreign exchange earner, based on the experiences of most countries where it is grown. In 1990, cashew came into the limelight once again and in line with the agricultural diversification programme, the Government of Ghana has recently started promoting cashew as a potential export crop.

The Cocoa Research Institute of Ghana, which has sheanut (*Vitellaria paradoxa*) research in the country as one of it's mandates, has been adopting cashew as an intercrop in sheanut stands in the wild to preserve and promote the economic use of sheanut which, despite its great socio-economic importance, is virtually undomesticated. The anticipated benefits of this practice include better suppression of weed growth due to an increased canopy development per unit area, and increased financial returns per unit area from the two crops. To derive the afore-mentioned benefits, a faster enhancement of the growth and development of the cashew is necessary. One approach might be the use of fertilizers, since it has generally been observed that cashew responds well to fertilizers, especially nitrogen during the vegetative growth stage (Rai, 1969; Falade, 1984; Ghosh & Bose, 1986). Ohler (1979) stated that application of fertilizers reduces the cost of weeding by inducing rapid canopy formation and also shortens the period to fruiting by one or more years.

The soils of northern Ghana on which the sheanut tree grows are inherently infertile, and although the cultivation of cashew is being promoted in that zone, no recommendation for fertilizer use had been established. Ekrement (1965) reported that cashew planting holes should be filled with dry grass or organic manure before planting. However, in spite of the role organic manures play as fertilizers and soil improvement agents (Hall, 1947; Finck, 1982), and the use of organic manures in compound farming in northern Ghana as confirmed by Nye & Stephens (1962), Ekrement's (1965) recommendation is hardly practised by farmers. Some of the reasons given by farmers interviewed by the authors in the study area for not adopting this practice included the large quantities of organic materials required, and their wrong perception that the soils are inherently highly fertile.

This paper, therefore, reports on a study of the effects of organic and inorganic fertilizer application on the growth of cashew seedlings, with the ultimate aim of developing a fertilizer recommendation for cashew seedlings which will boost their growth in an integrated system with sheanut in Ghana.

Materials and methods

Two experiments were carried out in the 1995/96 and 1996/97 seasons at the Cocoa Research Institute station at Bole in the Guinea Savanna zone of northern Ghana. The soils of the station are mainly Ferric Luvisols with smaller areas of Eutric Regosols and Lithosols (FAO-UNESCO, 1977). The long-term mean annual rainfall and daily temperature of the site are 1087 mm and 26.1 °C, respectively (Osei-Amaning, 1996). Table 1 shows the rainfall data for the experimental period seasons.

TABLE 1

Mean Monthly Rainfall Distribution (mm) in the Experimental Period

Month	*1995*	*1996*	*1997*
January	0.0	0.5	0.0
February	2.8	39.9	0.0
March	60.3	33.5	5.4
April	94.1	125.6	175.1
May	38.7	187.4	73.4
June	138.8	123.2	211.3
July	234.4	130.4	114.9
August	78.0	143.5	128.0
September	228.0	136.4	256.6
October	119.0	109.6	44.1
November	26.2	0.0	55.0
December	7.4	0.0	0.0

In 1995/96, the experiment was set up in a sheanut/cashew interplanted farm. Intra-plant spacing for the cashew was 9 m triangular in a plot of five plants. The experiment covered an area of 0.8 ha. For ease of management and also to minimize variability in soil characteristics, the cashew was spaced at 4 m × 4 m in the 1996/97 experiment. This reduced the experimental area to 0.5 ha and increased the sample size to 10 plants per plot. In both seasons, the treatments were replicated six times in a randomized complete block design. Three-month-old cashew seedlings raised in polyethylene bags were transplanted into 40 cm × 40 cm × 40 cm holes at the onset of the rainy season in June. The treatments investigated were as follows:

T1. Control (planting hole filled with top soil).
T2. Cowdung (7 kg) mixed with top soil (56 kg) and used to fill planting hole.
T3. Sulphate of ammonia at a rate of 70 g per plant.
T4. Sulphate of ammonia at a rate of 140 g per plant.

The sulphate of ammonia was applied 1 month after transplanting the seedlings. The sulphate of ammonia treatments received basal applications of muriate of potash and triple superphosphate at the rates of 22 and 21 g per plant, respectively, in the 1995/1996 experiment. In order to be within the ranges of the critical values of the elements required for cashew growth, the rates of muriate of potash and triple superphophate in the 1996/97 experiment were adjusted to 40 and 100 g per plant, respectively. Field maintenance in the 1995/96 experiment involved hoe-weeding of cashew lines and slashing of the inter-rows whilst in the 1996/97 experiment, all the plots were clean-weeded with a hoe.

Data collected from both trials included initial total nitrogen and available phosphorus contents of the soil and cowdung which were determined by the methods of Bremner (1960) and Troug (1930), respectively, plant height and girth, and number of leaves at 3-month intervals. Determination of the potassium content of the soil and cowdung, which was delayed due to lack of equipment at the beginning of the trial, was done later by flame photometry (Black *et al.*, 1965). In the 1995/96 season, the length and width of individual leaves of two plants per treatment in two replicates were measured 4 months after transplanting. These measurements were used to compute leaf area by using the equation developed by Murthy *et al.* (1985):

$$A = 0.21 + 0.69L*B$$

where A is leaf area, L is length, and B is width of leaf.

Results and discussion

Table 2 shows the initial contents of N, P and K of the soil and cowdung for the two experiments. The N and P contents of the soil were lower than the critical values of 0.1 per cent N and 3.7 ppm P at which fertilizer application is thought to be necessary for cashew growth in Nigeria (Egbe *et al.*, 1989). The initial K contents were, however, generally higher than the critical value of 0.12 me/100 g soil quoted by Egbe *et al.* (1989). Application of sulphate of ammonia generally improved the growth of cashew seedlings (Tables 3 and 4), and this is consistent with the findings of Falade (1984).

TABLE 2

Initial Nitrogen and Phosphorus Contents of the Soil and Cowdung (the Range for the Two Experiments)

Source	*Nutrient*			
	Depth (cm)	*N (%)*	*Available P (ppm)*	*K (me/100 g)*
Soil	0 - 15	0.050 - 0.079	2.66 - 3.32	0.130 - 0.262
	15 - 30	0.031 - 0.039	1.50 - 1.82	0.113 - 0.248
Cowdung		0.701 - 1.217	719 - 2250	2884 - 5384

In the 1995/96 experiment, only sulphate of ammonia at the rate of 140 g per plant increased the height and girth of cashew seedlings. Differences between treatments were, however, not significant, probably due to the high variability in the plants as evidenced by the high coefficients of variation, since the monthly rainfall distribution which could affect seedling survival, and, therefore, soil nutrient uptake did not vary between years (Table 1). The response of seedling height and girth to sulphate of ammonia

TABLE 3

Effects of Cowdung and Sulphate of Ammonia Application on the Growth of Cashew Seedlings: 1995/96 Experiment

*Treatment**	*Girth increments (cm) Period after transplanting (months)*					
	3	*6*	*9*	*12*	*15*	*18*
T1	4.4	9.1	12.7	17.5	25.8	29.7
T2	4.1	8.7	12.3	16.8	27.4	32.4
T3	4.4	9.3	12.9	19.1	26.7	32.0
T4	5.2	11.3	15.7	21.7	31.5	35.6
Sig. level	NS	NS	NS	NS	NS	NS
Sed (15 df)	0.85	1.60	2.00	2.40	4.89	4.8
CV (%)	36.4	28.8	26.8	21.9	30.5	25.6
	Height increments (cm)					
T1	19.5	32.9	39.8	55.7	93.6	117.4
T2	17.7	30.7	36.2	55.0	94.6	115.1
T3	20.4	37.2	44.7	56.9	103.8	122.5
T4	23.7	45.8	56.2	72.0	114.0	135.9
Sig. level	NS	NS	NS	NS	NS	NS
Sed (15 df)	4.31	8.35	8.76	14.81	24.14	26.25
CV (%)	36.8	39.6	34.3	42.8	41.2	37.1
	Leaf number increments					
T1	16.5	14.9	37.2	100.0	165.0	218.0
T2	14.7	18.2	37.1	103.0	200.0	220.0
T3	20.8	31.8	50.5	124.0	209.0	231.0
T4	26.9	52.8	98.9	159.0	235.0	251.0
Sig. level	NS	P<0.01	P<0.01	NS	NS	NS
Sed (15 df)	4.89	10.63	18.18	33.1	63.3	62.2
CV (%)	42.8	62.6	57.6	47.4	54.3	46.9

*T1 - Control, T2 - Cowdung, T3 - Sulphate of ammonia at 70 g per plant, and T4 - Sulphate of ammonia at 140 g per plant.

application in the 1996/97 experiment was positive and significant ($P<0.05$) irrespective of the rate, but there were no differences between the two levels applied. This suggests that the most economic dose for cashew seedlings in this area might be 70 g, thus confirming a similar recommendation in Nigeria by Falade (1984). In both years, the application of cowdung did not improve seedling height and girth. This was probably due to a slower rate of mineralization, since the N content of cowdung per planting hole was estimated at between 49 and 85 g.

Contrary to its effect on seedling height and girth, the application of sulphate of ammonia in the 1995/96 experiment increased the production of leaves, the effect being significant ($P<0.05$) at 6 and 9 months after transplanting. There was, however, a tendency for the number of leaves produced to be higher at the dose of 140 g per plant. A similar trend was observed in 1996/97, with the response being significant at all periods of recording except at 3 months after transplanting. Leaf size was not significantly affected by the treatments (Table 5). Although leaf areas were not measured in the 1996/97 experiment, some very peculiar observations were made in the plants receiving the sulphate of ammonia treatments. About 3 months after application, new leaves produced by plants of these treatments were small but very thick. These leaves hardly expanded beyond a mean leaf area of 17.5 cm^2. Other observations included profuse lateral shoot production and unusually early flowering (6 months after transplanting in two plants) in these treatments.

The observations made on leaves and lateral shoots were similar to those attributed to boron deficiency by Ohler (1979), and it is speculated that addition of the higher rates of either P or K might have produced an antagonistic effect on the availability of boron. Further work is, therefore, needed to ascertain the validity of this observation.

Increased leaf production without compromising leaf size as observed in the 1995/96 experiment is a highly encouraging effect of sulphate of ammonia application, since it can create canopies dense enough to inhibit weed growth (Ohler, 1979). It is generally acknowledged that the role of K becomes important during nut production. However, Falade (1984) added 21 g of P and 22 g of K in the planting hole and reported no adverse effect. The work in Madagascar cited by Ohler (1979) also reported the use of 65 g K in

TABLE 4

Effects of Cowdung and Sulphate of Ammonia Application on the Growth of Cashew Seedlings: 1996/97 Experiment

*Treatment**	*Girth increments (cm)* *Period after transplanting (months)*					
	3	*6*	*9*	*12*	*15*	*18*
T 1	4.3	8.8	10.9	14.2	17.7	22.6
T 2	4.1	8.9	11.6	16.3	20.3	24.0
T 3	8.4	14.9	18.2	23.4	27.4	32.0
T 4	8.5	14.1	17.2	23.0	27.6	31.1
Sig. level	P<0.001	P<0.001	P<0.001	P<0.01	P<0.01	P<0.01
Sed (15 df)	0.80	1.23	1.52	2.30	2.79	2.90
CV (%)	22.0	18.3	18.2	20.8	20.8	18.3
	Height increments (cm)					
T 1	11.6	27.1	33.6	45.7	68.9	87.0
T 2	12.4	29.1	38.8	52.1	72.7	94.8
T 3	33.3	47.1	56.7	65.7	84.4	110.6
T 4	27.3	43.6	56.7	64.2	81.8	97.0
Sig. level	P<0.001	P<0.01	P<0.01	NS	NS	NS
Sed (15 df)	2.94	6.00	6.99	8.20	9.10	10.52
CV (%)	24.1	28.3	26.0	25.0	20.3	18.8
	Leaf number increments					
T 1	14.3	19.3	31.0	42.0	76.7	99.3
T 2	14.0	25.2	43.0	58.0	86.6	127.9
T 3	59.6	91.8	122.0	140.0	144.8	168.4
T 4	61.2	133.7	181.0	187.0	173.3	187.6
Sig. level	P<0.001	P=0.01	P=0.01	P=0.01	P<0.05	NS
Sed (15 df)	7.11	25.31	35.0	37.3	32.7	33.54
CV (%)	33.0	64.9	64.5	60.4	46.9	39.9

*Treatment codes are as in Table 3.

TABLE 5

Effect of Cowdung and Sulphate of Ammonia Application on Mean Leaf Area (cm²) of Cashew Seedlings 4 Months after Transplanting: 1995/96 Experiment

*Treatment**	*Mean leaf area*
T 1	64.6
T 2	44.1
T 3	42.0
T 4	54.5
Sig. level	NS

*Treatment codes are as in Table 3.

the planting hole. This indicates that some amount of this element is needed for cashew seedling growth. The precocious flowering observed in some plants in the 1996/97 experiment suggests that the inherent K content of the soil is high enough to allow for the normal growth of cashew seedlings. There is, therefore, the need for a more detailed study of the effects of the macro-elements and also their rate of release from cowdung on cashew seedlings.

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