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Research note: Dry matter yields of *Panicum* and *Brachiaria* with nitrogen fertilisation or *Pueraria* in an oil palm plantation

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Abstract

Pure stands of guinea grass (*Panicum maximum* cv. Ntchisi) and ruzi grass (*Brachiaria ruziziensis*), with or without N fertiliser at 200 kg/ha, and tropical kudzu (*Pueraria phaseoloides*), plus mixtures of each grass with the legume were established in a mature oil palm plantation and in the open to ascertain their productivity at Ibadan, south-west Nigeria.

Dry matter (DM) yields during the growing season (16 weeks in plantation; 24 weeks in the open) were higher in the open than in the plantation. Nitrogen-fertilised guinea grass and guinea grass-tropical kudzu mixture produced the highest DM yields both in the open (7.1 and 5.9 t/ha, respectively) and under oil palms (3.1 and 2.1 t/ha). The DM yields of ruzi grass-tropical kudzu in the open and under oil palms were 5.9 and 2.7 t/ha, respectively, while that of N-fertilised ruzi grass in the open was 4.2 t/ha. In the oil palm plantation, ruzi grass without N fertiliser produced more DM (1.8 t/ha) than when given N (0.2 t/ha). More biomass was produced in plots planted to pastures than in unplanted plots with natural vegetation, both in and outside the plantation. Strategic use may be made of the plantation to produce forage (reserves) for dry season use.

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Introduction

Land under a mature oil palm plantation offers some opportunities for pasture and animal production in the face of increasing competition for available land for other uses. Except for early attempts at the formerly West African Institute for Oil Palm Research (WAIFOR), now Nigerian Institute for Oil Palm Research (NIFOR), the possibility of integrating livestock into oil palm plantations in Nigeria has not been considered (Mack 1989). Guinea grass (*Panicum maximum* cv. Ntchisi), ruzi grass (*Brachiaria ruziziensis*) and tropical kudzu (*Pueraria phaseoloides*) are among the pasture species with potential for use in oil palm plantations (Oshitoye 1990). The objectives of this study were to: (i) determine the DM yields of the species in simple grass-legume mixtures in comparison with their pure stands with or without N fertiliser; and (ii) compare biomass yields of the pastures with that of volunteer vegetation or natural plant cover. The information obtained would serve as an impetus for pasture development in, or integration with, tree crop plantations.

Materials and methods

The study was conducted in a 35-year-old oil palm plantation and an adjoining open area on the Teaching and Research Farm of the University of Ibadan, Ibadan, Nigeria. Ibadan (7° 20'N, 3° 50'E; 200 m above sea level) lies at the northern fringe of the rainforest zone. Annual rainfall ranges between 1150–1500 mm with peaks in June and September. The mean maximum and minimum temperatures are 34°C and 24°C, respectively.

The soil of the experimental site is an Alfisol with the following characteristics in and outside the plantation, respectively (Oshitoye 1990): 17.2 and 16.8 g/kg, organic C; 1.2 and 1.1 g/kg, total N; 9.26 and 9.02 mg/kg, available P; and 0.09

and 0.18 cmol/kg, exchangeable K. Soil textural classes were sandy loam in the plantation and loamy sand in the open. Light transmission measured at various points under the oil palm canopies averaged 59% with coefficient of variation (CV) of 13%.

A randomised complete block design was adopted in and outside the plantation with the following 8 treatments:

1. Guinea grass
2. Guinea grass with tropical kudzu
3. Guinea grass + 200 kg/ha N
4. Ruzi grass
5. Ruzi grass with tropical kudzu
6. Ruzi grass + 200 kg/ha N
7. Tropical kudzu
8. No planting (natural plant cover)

Avenues in the plantation with the full complement of palm trees were utilised to establish the forages. However, such avenues were few and only 2 replications could be established. Three replications were established outside the plantation.

The pastures were established in June 1992. The land in the open was ploughed, but in order to avoid disturbing the roots of the palms, the land in the plantation was not ploughed. Instead, the experimental area was clean-weeded prior to establishing the pastures in the plantation. The plot size was 4 × 4 m with a yield plot of 3 × 3 m, the rest being border discards. The pastures under the palms were established away from the tree trunks. Both grasses were planted vegetatively from crown splits. Guinea grass was planted every 0.5 m in rows spaced 1 m apart in the sole and mixed plots, while ruzi grass was planted at 0.5 × 0.5 m in sole plots and at the same plant spacing of 1 × 0.5 m as guinea grass in the mixtures. Seed of tropical kudzu, scarified by soaking in boiled water for 1 min, was drilled between rows of the respective grasses in the mixtures, and every 0.5 m in sole plots at 6 kg/ha. Compound fertiliser (NPK 15:15:15) was broadcast on the experimental area before planting at 300 kg/ha. All pastures were hand weeded as needed during the establishment phase, i.e. till May 1993.

In May 1993, plants were cut at 15 cm above ground level with matchets and the cut herbage discarded. Thereafter, 2 harvests were taken at 8-weekly intervals and 4 at 6-weekly intervals in the pastures under oil palm and in the open, respectively. The cutting intervals reflected the amount of regrowth estimated visually. Urea was applied at 200 kg/ha N in equal doses after each cut, giving 3 applications in the pastures under oil palm and 5 applications in the open.

At each harvest, weight of cut herbage in each plot was recorded. Samples were taken, separated into component species and each subsample weighed. Samples from the cut natural plant cover were not separated into component species, but the dominant species were noted. The various samples and subsamples were dried at 105°C to constant weight for determination of DM content. The Land Equivalent Ratios (LERs) of the mixtures were calculated using the formula given by Willey (1985).

Data were analysed by the General Linear Model (GLM) procedure of SAS (SAS 1987). The treatment means were compared by Duncan's multiple range test at 5% level of significance.

Results

Dry matter yields

The annual DM yields of the pastures are presented in Table 1. Generally, high CVs characterised data in the plantation and significant differences were not detected. Among the grasses, the highest DM yields in the plantation (3.1 t/ha) and in the open (7.1 t/ha) were produced by N-fertilised guinea grass, while N-fertilised ruzi grass, in the plantation, produced the least (0.2 t/ha). The lack of significant differences may reflect large interplant variations as indicated by a high CV of about 91%. In the open, N-fertilised guinea grass significantly outyielded all other grass treatments.

Tropical kudzu with ruzi grass in the plantation produced about 29% and 175% higher DM yield than kudzu alone and kudzu with guinea grass, respectively. However, the yields were not significantly different, probably due to high interplant variations as noted above. In the open, DM yields of tropical kudzu alone (3.5 t/ha) and the legume in mixture with ruzi grass (3.4 t/ha) did not differ significantly, but were both significantly higher than the yield (2.4 t/ha) of the legume in mixture with guinea grass.

Nitrogen-fertilised guinea grass and ruzi grass-tropical kudzu plots produced the highest total forage (grass + legume) DM yields of 3.1 t/ha and 2.8 t/ha, respectively, in the plantation, but

Table 1. Dry matter yields of pastures in an oil palm plantation and in the open.

	Grass		Legume		Weeds		Total Grass-legume		Total Biomass	
	Under	Open	Under	Open	Under	Open	Under	Open	Under	Open
					(t/ha)					
GG[1]	1.5	3.3b[2]	—	—	0.4	0.4b	1.5	3.3b	1.9ab	3.7b
GG/TK	1.3	3.5b	0.8	2.4b	0.2	0.1b	2.1	5.9ab	2.3ab	6.0a
GG/N	3.1	7.1a	—	—	0.7	0.1b	3.1	7.1a	3.8ab	7.2a
RZ	1.8	2.7b	—	—	0.3	1.1b	1.8	2.7b	2.1ab	3.8b
RZ/TK	0.6	2.5b	2.2	3.4a	1.3	0.0b	2.8	5.9ab	4.1a	5.9a
RZ/N	0.2	4.2b	—	—	1.4	2.6ab	0.2	4.2b	1.6ab	6.8a
TK	—	—	1.7	3.5a	0.1	0.0b	1.7	3.5b	1.8ab	3.5b
Nat	—	—	—	—	0.7	3.0a	—	—	0.7b	3.0b
	ns		ns		ns		ns			
CV(%)	90.6	24.9	79.8	9.0	139.2	91.0	63.7	22.9	54.1	15.4

[1]GG = Guinea grass; GG/TK = Guinea grass + tropical kudzu; GG/N = Guinea grass + N fertiliser; RZ = Ruzi grass; RZ/TK = Ruzi grass + tropical kudzu; RZ/N = Ruzi grass + N fertiliser; TK = Tropical kudzu; Nat = Natural plant cover.
[2]Means in a column followed by different letters are significantly different according to Duncan's multiple range test ($P < 0.05$).

differences were not significantly different. In the open, the total forage DM yields on N-fertilised guinea grass, guinea grass-tropical kudzu and ruzi grass-tropical kudzu mixtures were higher ($P<0.05$) than on other pastures.

On average, grass, legume and weed DM yields in the plantation were 36%, 52% and 67% of their respective yields in the open.

The natural plant cover in the plantation consisted mainly of carpet grass (*Axonopus compressus*), and broadleaf species such as goat weed (*Synedralla nodiflora*) and siam weed (*Chromolaena odorata*). In the open, on the other hand, grasses such as *Cynodon dactylon*, *C. nlemfuensis*, *Digitaria decumbens*, indigenous guinea grass and some broadleaves such as siam weed were predominant.

Competition and yield advantage

Land Equivalent Ratios (LERs) as an index of the relative competitive abilities of the components and the yield advantage of the combined yields of the mixtures are presented in Table 2. In both locations, guinea grass had higher partial LER values than tropical kudzu. The legume had a higher partial LER than ruzi grass in the plantation, but both had similar LER values in the open. The combined LERs of guinea grass-tropical kudzu in both locations and ruzi grass-tropical kudzu in the open were greater than unity, with values of 1.34, 1.72 and 1.91, respectively. The combined LERs of both mixtures were higher in the open than in the plantation.

Table 2. Land Equivalent Ratio (LER)[1] of individual components and mixtures in an oil palm plantation and in the open.

Pastures[2]	Grass	Legume	Total
Under			
GG/TK	0.86	0.48	1.34
RZ/TK	0.32	0.68	1.00
Open			
GG/TK	1.05	0.67	1.72
RZ/TK	0.94	0.97	1.91

[1]Dry matter yield of each component of the mixture as a ratio of their respective yields in pure stands.
[2]GG/TK = Guinea grass + tropical kudzu; RZ/TK = Ruzi grass + tropical kudzu.

Discussion

This study has shown clearly that the species tested can be grown quite successfully under an oil palm stand but yields are quite depressed, relative to those obtained in the open. In both situations, herbage DM yields can be increased by replacing natural plant cover with improved pasture species. The reason for the negative influence of N on ruzi grass yield in the plantation is not clear.

The generally lower yields of the grasses in the plantation than in the open are consistent with the general consensus that growth and yield of tropical grasses are depressed under shade (Whiteman *et al.* 1974; Ludlow 1978). The lower yields in the plantation are reflected in the need for only 2 × 8-week cuts (16 weeks growth) compared with 4 × 6-week cuts (24 weeks growth) in the open. Under the shade of the plantation, ruzi grass could not maintain its relative competitiveness with tropical kudzu leading to an increase in weed growth compared with the open. Shading influences the competitive relationships between species as different species or even varieties within a species have different adaptability to shade (Wong *et al.* 1985). Grasses are usually the more aggressive and dominant component of mixtures (Singh *et al.* 1983), as was the case in the guinea grass-tropical kudzu mixture in the present study.

The yield superiority of N-fertilised guinea grass and grass-legume swards over the unfertilised grass stands has also been reported in south-west Nigeria by Akinyemi and Onayinka (1982) and elsewhere by Singh *et al.* (1983). In the open, guinea grass-tropical kudzu, ruzi grass-tropical kudzu and tropical kudzu treatments exhibited good weed-suppressing abilities, which may be attributed to shading by the tall grass and the vigorous and twining growth habit of the legume, which normally results in the formation of a thick mat on the soil surface (Bogdan 1977). The pure stand of tropical kudzu was also effective in suppressing weeds in the plantation. Tropical kudzu is, in fact, popular in plantation agriculture for weed control (Thomas 1978).

Some of the treatments, namely unfertilised sole guinea grass and N-fertilised ruzi grass did not persist in the plantation, even with the 8-week cutting interval adopted. The treatments supported only natural vegetation by the end of the trial. The poor persistence of some of the pastures in the plantation indicates a need for more strategic utilisation of pastures in the plantation. The potential exists to use these pastures as dry season fodder reserves, in which case utilisation would be delayed till the critical periods of the dry season. The pastures would then have ample time to accumulate DM during the rainy season. There is also a need to evaluate more forage species for shade tolerance and persistence when cut or grazed in the plantation.

Based on their higher DM yields, guinea grass and ruzi grass mixtures with tropical kudzu and N-fertilised sole guinea grass may be appropriate for establishing in oil palm plantations for forage production.

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