Evaluation of Dual-purpose Cowpea (*Vigna unguiculata* (L.) Walp.) Varieties for Grain and Fodder Production at Shika, Nigeria

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Summary

A three-year field study of eight new and one check dual-purpose cowpea varieties was carried out to evaluate their grain and fodder production potential. Germination and seedling establishment were both high and greater than 80%. Mean dry fodder and seed yields varied from 1,262 to 3,598 kg/ha and 528 to 1,149 kg/ha respectively, with varieties IAR 4/48/15-1, IAR 72 and TVU 12349 retaining larger amounts (> 50%) of fresh green leaves at pod harvest during the dry season. Crude protein (CP) content of fodder averaged between 15.2 and 21.6%. There were more pods/plant for varieties IAR 4/48/15-1, IAR 7/180-4-5 and TVU 12349. 100-seed weight was highest with IT89KD-288 and Kananado (check). Fodder yield, pods/plant and leaf content were moderately correlated with seed yield. Results showed that varieties TVU 12349, IT89KD-288, IAR 2/180/4-12 and IAR 4/48/15-1 appeared suitable for both fodder and grain production. The use of appropriate cowpea varieties to enhance farmer income in an integrated production system is suggested.

Résumé

Evaluation de la performance des variétés de niébé (*Vigna unguiculata* (L.) Walp.) à produire à la fois des graines et du fourrage à Shika au Nigeria

Huit variétés de niébé améliorées et une locale (témoin) ont été testées en champ pendant trois ans en vue d'évaluer leur performance à produire à la fois des graines et du fourrage. Les résultats obtenus montrent que les taux de germination et de croissance étaient élevés (80%) pour toutes les variétés étudiées. Les moyennes de rendement étaient respectivement de 1262 à 3598 kg/ha pour la production de fourrage sec et de 528 à 1149 kg/ha pour la production de graines. Les variétés IAR 4/48/15-1, IAR 72 et TVU 12349 ont produit la plus grande quantité de feuilles vertes (> 50%) au stade de la récolte de graines durant la saison sèche tandis que les variétés IAR 4/48/15-1, IAR 7/180-4-5 et TVU 12349 ont produit le plus grand nombre de gousses par plant. Le poids de 100 graines le plus élevé a été produit par la variété IT89KD-288 et la variété témoin (Kananado). Le pourcentage moyen de la matière protéique variait de 15,2 à 21,6%. Une faible corrélation a été observée entre les rendements en graines, les rendements en fourrage et le rapport gousses/plant. Pour l'augmentation du revenu des fermiers, les variétés TVU 12349, IT89KD-288, IAR 7/180-4-12 et IAR 4/48/15-1 s'avèrent les plus performantes pour ces paramètres étudiés et sont à recommander dans un système de production intégré.

Introduction

In the subhumid zone of Nigeria as described by Ker (1), poor ruminant performance, particularly of cattle, is largely attributed to the inadequate supply of quality feed resources on natural rangelands during the 5-7 months dry season. Quality in this regard refers to crude protein and digestible crude protein contents of the feed as these vary sharply throughout the year. Inevitably, animals depending on these resources go through cycles of weight gains during the wet season and weight losses during the dry season. The problem is being compounded by rising human and livestock populations which put pressure on land for food. Among the effects of the increasing pressure on land are the spread of cropping to marginal areas such as those previously used for grazing, thus forcing closer integration of crop and livestock activities, with a greater dependence on crop residues as fodder resources (2). Herd owners are therefore highly dependent on crop residues to supplement grazing during the dry season. For most of these, supplementation grain legume residues are most important.

Cowpea is one of the grain legumes (plant protein food sources) in Nigeria where much attention has been devoted to growing it for seed. Over 80% of this crop is grown in the savanna zone, in the northern half of the country. It is usually sown during the wet season either as sole crop or as an intercrop (mostly with maize). A large number of small to medium - scale

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farmers in the northern part of the country preserve the forage obtained after grain harvest for use as livestock feed during the dry season. Cowpea forage is high in nutritive value, palatable and has high market value (3, 4). Cowpeas are also important in the nutrient economy of low-input cropping systems since they can fix N_2 through symbiotic association with bacteria, thereby improving soil fertility and reducing the need for N fertilizer. Eaglesham *et al.* (5) reported that intercropping cowpea with maize improved N nutrition of maize. Presently, one of the most commonly grown dual-purpose cowpea varieties among agropastoral farmers in northern Nigeria is Kananado, an unimproved local variety. Even though this variety is drought tolerant and pest resistant both in the field and in storage, it has low seed and forage yields. The low forage yield thereby reduces its value as livestock feed. Attention is therefore being paid to find and introduce varieties which have the ability to produce good grain for human consumption and quality fodder for livestock at no extra cost.

The study present compared the forage dry matter and seed yields of 8 dual-purpose (late maturing) cowpea varieties. The study is part of a series of all Nigeria Cowpea Varietal Trials, which evaluates recently developed varieties from Institute of Agricultural Research of Ahmadu Bello University, Zaria in northern and International Institute for Tropical Agriculture, Ibadan in western Nigeria.

Materials and methods

Site characteristics

The experimental site was at National Animal Production Research Institute (NAPRI), Shika (11^o 15'N, 7^o 32'E, 610 m) in the subhumid zone of Nigeria. The zone has one (unimodial) wet season which begins in April/May and finishes by mid-October. Mean maximum temperature varies between 27-35 ^{0}C, depending on the season. Kowal (6) described the physical properties of the soil as well-drained sandy loam soil with a clay fraction consisting mainly of kaolinite and small quantities of illite deficient in N and P. Based on World Reference Base for Soil Resources (WRB) and the FAO/UNESCO Soil Map of the World (7), Shika soil could be classified as Arenosol. Soil characteristics (0–15 cm) of the experimental site before the commencement of the experiment are given in table 1.

Experimental design and procedures

Seven new and one traditional (Kananado, as check) varieties of dual purpose cowpea (*Vigna unguiculata* L. Walp) were examined for various production parameters in a randomized block design. Plot sizes were 3 m x 6 m and these consisted of 5 rows which were 6 m long. Plots were replicated four times. Generally, two seeds per planting hole were sown at a spacing of 50 cm within rows, in rows 75 cm apart. Seeds were

Table 1
Soil characteristics (0-15 cm) of the experimental site before planting of cowpea in 1995

pH	total N (%)	total P (ppm)	Ca^{2+}	K^+	Mg^{2+}	Clay	Silt	Sand
			meq/100 g			(%)		
5.6	0.041	35.1	2.02	0.098	0.108	8.10	10.71	81.19

The values are mean values taken by the author.

These are means of randomly taken soil samples from the site. Total rainfall average (1985-1994) and rainfall records during the trial seasons are shown in table 2.

Table 2
Rainfall received during the trial years (1995, 1996 & 1997) and long-term (1985-1994) means for Shika

	Long-term (1985-1994)	1995	1996	1997
Months:		(mm)		
April	35.06 (6)[1]	102.8 (5)	11.0 (6)	56.1 (10)
May	120.44 (9)	56.3 (7)	131.1 (12)	76.1 (14)
June	175.14 (12)	125.5 (14)	126.3 (14)	177.3 (12)
July	250.28 (12)	161.1 (11)	210.0 (15)	248.0 (14)
August	278.92 (24)	313.9 (19)	207.6 (20)	273.7 (20)
September	172.36 (13)	167.6 (15)	179.4 (17)	202.5 (17)
October	42.00 (4)	45.7 (4)	65.6 (6)	56.9 (12)
Total	1074.22 (77)	927.4 (75)	930.9 (90)	1090.7 (99)
Total received by Cowpea	N.A.	432.3 (32)	379.4 (35)	429.7 (38)

[1] Values in parenthesis indicate numbers of rainy days.
N.A. – Not applicable.
The values are mean values taken by the author.

dressed with Super-homai(R), a fungicide before planting. Sowings were done on 10, 15 and 20 August in 1995, 1996 and 1997 respectively. All plots were weeded twice using a traditional hoe and kept insect-free by application of Dimethoate + Cypermethrin at a rate of 100 ml/20 l of water twice at flower bud initiation and mid- podding (50% of plants with pods). In the second year (1996), a third spraying at the same rate was necessitated by heavy infestation of aphids (*Aphids* spp.) during pod formation.

Stand count at establishment was taken 28 days post planting (DPP) using 1 m x 1 m quadrats. Three counts were taken and averaged per plot. Percent ground cover was estimated using 1 m x 1 m quadrats marked with stripes 20 cm apart. Notes of days to first flower appearance and maturity were also taken. At pod maturation, dried pods were harvested from 3-centred rows of 4 m length. Dry pods were picked twice for most varieties. After pods had been harvested all plants within 3-centred rows of 4 m length were cut at ground level, weighed, and sun-dried (for about 7 days) to hay stage (cowpea haulm) and reweighed using a 10 kg balance for dry weight estimation. Thereafter, subsamples of the haulm were taken, milled and analysed for N. Nitrogen content (on DM basis) was determined only in the second season using standard Kjeldhal methods (8), and expressed as crude protein content (CP= % N x 6.25). Leaf content defined as percentage of leaf component yield from whole plant cowpea haulm. The remainder of the plots were observed for the ability of varieties to remain green further into the dry season after pod harvest.

Data analysis

The experimental design was a randomised block design with four replications. Data analysis for significant overall treatment effect was conducted by Analysis of Variance (ANOVA) using the SAS software and GLM procedure (9). Year and replicate were treated as random variables, while cultivar effects were considered fixed. Simple correlation coefficients between agronomic traits were calculated.

Results and discussion

Establishment and growth

Table 3 shows averages of stand count at establishment (SCE), days to first flower appearance (DFFA) and maturity (DPM).

Average stand count taken 28 days post planting (DPP) when pooled across years, varied between 9.7 plants/m^2 for IT89KD-288 and 11.5 plants/m^2 for TVU 12349. The results show that SCE (> 80% of the expected SCE) was high. Varieties IT89KD-288, IAR 72, TVU 12349 and control (Kananado) on the average took longer than 60 days to DFFA, while IAR 2/180/4-12 flowered much earlier (at about 44 DPP) than other varieties. Days to maturity differed significantly (P< 0.05) between varieties. The growing period was longest in TVU 12349, followed by IAR 72 and Kananado, and shortest in IAR 2/180/4-12 and IAR 7/180-4-5. Apart from IAR 72 and Kananado which recorded death of 1 stand each at mid flowering in 1995, further observations showed that plant mortality was nil for other varieties. Ground cover was higher for TVU 12349 and Kananado (with about 100 and 90% ground covered respectively) than other varieties at early flowering stage.

Table 3
Mean stand count at establishment (SCE), days to first flower (DFF) and days to pod maturity (DPM) of multipurpose cowpea varieties

Cowpea varieties	SCE (Plants/m^2)	DFF	DPM
		days	
IT89 KD-288	2.7	66.0	92.6
IAR 2/180/4-9	3.0	55.6	95.6
IAR 2/180/4-12	3.2	44.1	86.7
IAR 7/180-4-5	3.1	50.1	86.5
IAR 4/48/15-1	3.2	50.8	93.9
IAR 72	2.9	60.9	108.1
TVU 12349	3.5	73.8	114.1
Kananado (check)	3.2	64.8	107.1
Mean	3.1	58.3	98.1
LSD (P< 0.05)	0.9	8.3	6.8

Fodder yield and CP content

Mean fodder dry matter (FDM) yields varied significantly (P< 0.008) between years. FDM yields were 2229, 3106 and 2387 kg/ha for 1995, 1996 and 1997, respectively. FDM yields varied widely (C.V. of 33%) and highly significantly (P< 0.0001) between varieties (Table 4).

Table 4
Mean crude protein content and residual fodder yield and yield components

Cowpea varieties	Fodder yield (kg/ha)	CP	Leaf content
		%	
IT89 KD-288	2150	19.9	42
IAR 2/180/4-9	2488	19.5	27
IAR 2/180/4-12	3025	17.8	41
IAR 7/180-4-5	2813	15.2	45
IAR 4/48/15-1	2113	15.8	57
IAR 72	3475	21.6	56
TVU 12349	4238	19.8	57
Kananado (Check)	1638	18.2	15
Mean	2743	18.5	43
LSD (P< 0.05)	487	3.1	5.4

FDM was best for TVU 12349 (3598 kg/ha), followed by IAR 72 (3203 kg/ha) and IAR 2/180/4-12 (3010 kg/ha). Other varieties yielded < 3000 kg/ha. The yields obtained in the present study compare favourably to earlier reports on some dual purpose cowpea varieties for parts of Northern Nigeria such as in Shika (10, 11), and Samaru and Kano (12). Except for IAR 2/180/4-9 and Kananado, all varieties had > 40% leaf content at pod maturity (Table 4).

Apart from Kananado, most varieties maintained some degree of green leaves till about 3 weeks post pod harvest. Low fodder yields in varieties IT89KD-288, IAR 4/48/15-1 and Kananado when compared

with other varieties could be attributed to less leaf retention at pod maturity. CP was highest (21.56%) for variety IAR 72 and lowest (11.90%) for Kananado. Based on the National Research Council report giving the critical level of 10.88% (1.74% N) for ruminants (14), all cowpea varieties examined met the requirements for cattle production in the dry season of sub-humid Nigeria where CP contents of available grasses are lower than 7%.

Seed yield and yield components

Results form ANOVA indicate that variety (P< 0.0001) had significant effects on number of pods/plant and seeds/pod, while differences between years (P> 0.081) and year*variety interaction (P> 0.103) were insignificant. Mean number of pods/plant ranged from 32.2 pods/plant for IAR 4/48/15-1 to 14.4 pods/plant, while mean number of seeds/pod was highest (14.0) for TVU 12349 and lowest (9.8) for Kananado (Table 5).

Table 5
Seed yield and yield components

Cowpea varieties	Pod number (plant^{-1})	Seed number (pod^{-1})	100 seed wt (g)	Seed yield (kg/ha)
IT89 KD-288	26.8	11.50	21.69	963
IAR 2/180/479	20.0	12.44	12.15	738
IAR 2/180/4-12	28.3	11.36	14.15	850
IAR 7/180-4-5	31.6	12.16	13.78	686
IAR 4/48/15-1	32.2	11.33	13.29	1000
IAR 72	23.2	12.50	19.04	763
TVU 12349	30.3	13.88	9.43	888
Kananado (Check)	11.3	9.80	19.39	563
Mean	25.5	11.87	15.36	806
LSD (P< 0.05)	3.6	2.40	4.39	238

The order of mean seed weight for years was: 1995> 1996> 1997. Generally, mean 100-seed weight was significantly affected between varieties (P< 0.0001) and varied from 10.27 g/100 seeds for TVU 12349 to 21.69 g/100 seeds for IT89KD-288.

Generally, seed yields of all the new varieties were better when compared to check. When pooled across years, mean seed yields were significantly higher (P< 0.002) for IAR 4/48/15-1 (1099 kg/ha) and TVU 12349 (1027 kg/ha) and lowest for the check (Kananado) which only yielded 563 kg/ha (Table 5). Incidentally, observations showed that the pods of varieties IAR 4/48/15-1 and TVU 12349 shattered and lost most of their seeds when pods were dry. This indicates the need for successive pod picking if seed yield losses are to be avoided. Seed yields from the present study were within the ranges reported by Shoyinka (12) under good experimental conditions in northern Nigeria.

Relationship among varieties

Percent leaf content (r= 0.544, P< 0.001), fodder yield (r= 0.511, P< 0.001) and pod/plant (r= 0.496, P< 0.005) were to some extent correlated with seed yield, thus suggesting the importance of initial plant size in predicting reproductive yield if growing conditions remain favorable (11). The relationship between seeds/pod and seed yield was fairly weak (r= 0.379; P< 0.025). The lack of significant relationship between DFFA and 100-seed weight with seed yield, could infer that these characters might not be so important in breeding and selection for yields in cowpeas (11). A reverse association was recorded between seed yield and days to maturity (r= - 0.080, P< 0.021), an indication that with delayed maturity, seed yield could probably be affected by environmental conditions particularly day and night temperatures and low moisture levels which according to Smartt (15) could affect normal pod development. Associations between pods/plant and seeds/plant (r= 0.593), leaf content and pods/plant (r= 0.577), leaf content and fodder yield (r= 0.544) were also significant (P< 0.05).

Conclusions

Data from this study indicate that variety TVU 12349 appeared most suitable for combined use. Other varieties that showed promise are IT89KD-288, IAR 2/180/4-12 and IAR 4/48/15-1. This therefore suggests that crop-livestock farmers would be able to harvest grains for food and substantial amounts of cowpea haulm for feed after pod harvest for their livestock at no extra cost for forage production. Our data indicate that the local variety (Kananado) in particular, seemed unsuitable for crop-livestock farmers, as it recorded the lowest fodder yield and seed yields, though it is the most popular variety among farmers, because of its disease and pest resistance.

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