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Interannual variation in fodder production in cowpea varieties in Niger

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ABSTRACT

In the south areas of Niamey, the capital of Niger, where there is a higher density of livestock because of the Niger River, cowpea is grown mainly for fodder. Unfortunately, there is a lack of dual-purpose cowpea varieties with high potential for fodder production. Therefore, an experiment was carried out in two sites (Ticko and Bogodjotou) located in the Southwest of Niamey during the rainy season of 2001 and 2002, in order to compare the production of nine cowpea varieties. The results indicated that in 2001, the fodder yield of all varieties were significantly ($p<0.01$) higher than those of 2002. But not significant difference was recorded between the two sites during the two years. In 2001, at Ticko, "Baban waké", Kanannado and IT93K-398-2 had higher fodder yields than the remaining varieties with 1032 kg/ha, 879 kg/ha and 866 kg/ha respectively. The lowest fodder yields were recorded for Locale variety which is grown by farmers, IT89KD-349 and TVu 1234-9 with 715 kg/ha, 499 kg/ha and 677 kg/ha, respectively. In 2002, the highest fodder yields were also recorded for introduced varieties such as "Baban waké", IN92E-3, IT89KD-288, IT89KD-349, Kanannado, IT93K-398-2 and TN256-87 compared to Locale variety. The results indicated the possibility to increase fodder production through the introduction of dual-purpose cowpeas and thus increasing farmers' income.

Keys words: Cowpea, varieties, fodder, Niger.

INTRODUCTION

Cowpea (*Vigna unguiculata* (L.) Walp) is one of the most important food legumes and a valuable component of the traditional cropping systems in the semi-arid tropics covering Asia, Africa, Central and South America (Singh et al., 2003). In Niger, the third largest producer of cowpeas in the world, cowpea is traditionally the main fodder crop. In this country, FAO (2008) estimates cultivation of cowpea on 5,294,700 ha and a production of 1,569,300 tons in 2008.

Cowpea offers a valuable contribution towards human food as well as livestock fodder and due to this dual-purpose character, it is a very attractive crop (Singh et al., 2003). The grains are consumed as a major source of cheap protein by humans, and the haulms are fed to livestock as a nutritious fodder. Dry cowpea haulms have higher crude protein, digestibility, and mineral contents, but less

fiber compared with other forage legumes (Tarawali et al., 2002). Unfortunately, in Niger, both the grain and haulm yields are minimal in farmers' conditions. The FAO (2008) estimates an average cowpea grain production in West Africa of 465 kg/ha whereas an average of 200 kg/ha was recorded in farmer's field in Niger (JAICAF, 2009).

In the south areas of Niamey, the capital of Niger, where there is a higher density of livestock because of the River Niger, cowpea is grown mainly for fodder (Elbasha et al., 1999). At the end of the growing season, fodder (*harawa* in Hausa local language) is cut, rolled and stored in tree-forks or on rooftops for use or sale during the harsh dry season (Tarawali et al., 2002). In Nigeria, some farmers who sell cowpea fodder during the dry season when feed shortage is critical, may gain up to 25% of their annual cash income from the sale of fodder (Dugje et al., 2009). In addition, cowpea fodder is particularly valued as an animal supplement in the period leading up to Muslim festivals when sheep are traditionally slaughtered.

In view of the importance of cowpea grain as well as fodder, particularly in West Africa, the International Institute of Tropical Agriculture (IITA) who has a global mandate for cowpea improvement, initiated a systematic breeding programme in 1989 to develop dual-purpose cowpea varieties (Singh et al., 2003).

The objective of this investigation was to compare, during two years (2001 and 2002), the fodder production of nine varieties of cowpea, including IITA varieties, in farmer's conditions in two sites (Ticko and Bogodjotou) located in the south west of Niger.

MATERIALS AND METHODS

Plant material and growing conditions

Description of experimental sites

A field experiment was conducted during the rainy season in 2001 and 2002 at two sites, Ticko (13°05' N -1°47' E) and Bogodjotou (13°05' N -1°49 E). These two sites are located in the district of Torodi at approximately 50 km and 60 km Southwest of Niamey, the capital of Niger.

The soil of the two sites is sandy and deep (> 2 m). At Ticko, the chemical characteristics of the soil at the beginning of the study was: pH 5.9; Organic C concentration 0.18; total N concentration 0.165 g kg^{-1}; phosphorus Bray concentration 0.003 g kg^{-1}. At the Bogodjotou site, the soil was slightly high in clay and alluvium.

The climate of the sites is Soudano-sahelian with a short rainy season of about four months (from June to September). The mean rainfall of the thirty years (1971-2000), calculated at the rainfall station of Torodi (located at about 15 km of each site) is 571 mm ± 52 mm (Atta et al., 2010). In Ticko and Bogodjotou, the total rainfall was 412 mm and 426 mm in 2001, and 560 mm and 595 mm in 2002 respectively (Figure 1).

Description of varieties

Nine cowpea varieties originating from Niger and Nigeria were tested in the field during the rainy season (Table 1).

- *Varieties from Nigeria*

Five dual-purpose varieties provided to us by Dr B.B. Singh from IITA of Kano (Nigeria) were used: IT89KD-349, IT93K-398-2, IT89KD-288, TVu 1234-9 (IITA improved varieties) and Kanannado (local variety cultivated widely in northern Nigeria).

- *Varieties from Niger*

Four varieties of cowpea were tested including 2 improved and 2 local varieties cultivated by farmers:

- IN92E-3 and TN256-87 are improved varieties selected for their dual purpose for grain and fodder production by Institut National de la Recherche Agronomique du Niger (INRAN). They were provided to us by Dr M. Adamou (I.N.R.A.N. Kollo-Niger).

- the two local varieties were "Baban waké", originated from the area of Gaya, located in the Soudano sahelian zone (about 300 km in the South East of Niamey, rainfall of about 800 mm/year) and the Locale variety of cowpea cultivated in the area of Ticko.

Table 1: Origin and characteristics of nine varieties of cowpea.

Name of variety	Origin	Group of maturity	Utilization
"Baban Waké"	Gaya (Niger)	Late maturity	Dual-purpose
IN92E-3	INRAN† (Niger)	Medium maturity	Dual-purpose
IT89KD-288	IITA‡ Kano (Nigeria)	Late maturity	Dual-purpose
IT89KD-349	IITA Kano	Medium maturity	Dual-purpose
IT93K-398-2	IITA Kano	Medium maturity	Dual-purpose
Kanannado¶	Kano	Late maturity	Dual-purpose
Locale*	Ticko (Niger)	Early maturity	Grain
TN256-87	INRAN	Medium maturity	Dual-purpose
TVU1234-9	IITA Kano	Medium maturity	Dual-purpose

†: Institut National de la Recherche Agronomique du Niger ; ‡: International Institute for Tropical Agriculture
¶: local variety grown by farmers in north Nigeria; *: local variety grown by farmers in the area of Ticko including Bogodjotou.

Growing conditions

The cowpea varieties were grown in association with a local variety of millet cultivated by farmers at Ticko.

Sowing

Cowpea and millet were intercropped in farmer's fields at Ticko and Bogoudjoto that had been fallowed two years. Millet was hand sown at a density of 2.25 m between two rows and 1 m between plants within rows. Two rows of cowpea were intercropped within two rows of millet in the two sites (Figure 2). The density of cowpea was about 0.75 m between rows (of millet or of cowpea) and 1 m between plants within rows. In 2001, millet was planted on June 18th and June 27th, at Ticko and Bogodjotou respectively. The planting date for cowpea was July 17th and July 23rd respectively. In 2002, millet was planted on June 11th in Ticko and June 26th in Bogodjotou while cowpea was planted on July 30th and July 22nd respectively. The number of seeds sown per pocket was approximately 5 for millet and for cowpea.

Plant weeding and thinning

In order to promote good growth conditions, plants of the two sites were weeded twice using hoes. They were also thinned to 3 plants per pocket during the first weeding at approximately 30 days after planting the millet.

Cowpea fertilization

Cowpea fertilization for the two sites consisted of Di-Ammonium Phosphate (DAP) at about 2 g per pocket which corresponds to 26 kg per ha. The fertilizer was applied in a pocket roughly 5 cm from seed location.

Experimental design

The experimental design of each site was a complete randomised block with three replications. Each replication consisted of ten plots of 12 m length and 11.25 m width organized as following:

- For nine plots, millet was intercropped with the nine cowpea varieties at densities previously indicated. Therefore, each plot contained five rows of millet and eight rows of cowpea (Figure 2). The four central rows of cowpea were used to measure haulms yield at harvest.

- One plot used as a control contained only pure millet.

The ten plots of each repetition were arranged in two rows of five plots. The distance was about 4.5 m between the two rows, and 2 m between two consecutives plots within the row. The distance between two replications was about 6.75 m.

Measurements

2001

The precocity of flowering, expressed in days after planting, was noted for each variety of cowpea at Ticko. Flowering was

considered to be 50% of plants had opened flowers. In Ticko, the following measurements were also done at harvest on ten plants per replication for each cowpea variety: number of branches per plants, length of the first and second branch counted from the base to the tip of the plant.

2001 and 2002

After harvest, the haulms' yield of cowpea varieties was determined in the two sites. For this measurement, the four central rows were harvested and separated into different organs: grains, pod wall, and stem + leaves. These parts were dried for 48 hours at 85 °C and weighted.

Statistical analysis

Statistical analysis was performed using the software SAS STAT (SAS Institute Inc Cary, NC, 27513 USA). ANOVA was also performed on the data. For each year, data from the two sites was analysed separately and then grouped. A final analysis was carried out using the GLM procedure of SAS for the data of the two years. Differences between means for fodder yield were compared using the Student Newman Keuls test at 0.01 probability level.

RESULTS

Flowering

The precocity of flowering differed significantly ($P<0.01$) among varieties (Table 2). The INRAN variety, TN256-87 was the earliest flowering variety, flowering at 60 days after planting (DAP). Kanannado and "Baban waké" were the latest, flowering respectively at 101 and 110 DAP. The remaining varieties were in between the two.

Plant morphology

In order to study the plant morphological development of each variety, the total number of branches/plant, and the length of the two upper branches were measured. The results indicated a significant difference ($p<0.01$) among varieties given these parameters (Table 2). The highest number of branches/plant was recorded for "Baban waké", and the lowest one for Kanannado, TVu 1234-9, IT89K-398-2 and Locale. "Baban waké" had the longest branches, with 90 cm and 113 cm, respectively for the first and the second branch (Table 2). The shortest branches were recorded for IT93K-398-2, at 52 cm and 40 cm respectively.

Fodder yield

The F values of Snedecor and the significance of the fodder yield is shown in Table 3. The results indicated a highly significant ($p<0.01$) effect of year for this parameter. In 2001, the varieties produced higher fodder than in 2002 (Table 4). But the difference among sites was not significant. Therefore, in both sites, fodder yield was around 800 kg/ha and 450 kg/ha, respectively in 2001 and 2002. The interaction between site and year was not significant, while the interaction between variety and site was significant (Table 3).

The results indicated a major difference in fodder yield between the 9 varieties. In 2001, at Ticko site, the variety "Baban waké" and the IITA varieties, Kanannado and IT93K-398-2, had the highest fodder yield, 1032 kg/ha, 879 kg/ha and 866 kg/ha respectively (Table 4). The lowest fodder yields where recorded for Locale variety grown by farmers, IT89KD-349 and TVu 1234-9 with respectively 715 kg/ha, 499 kg/ha and 677 kg/ha. The remainings varieties were intermediates. In Bogodjotou, Baban waké, Kanannado and IT89KD-288 had the highest fodder yield (Table 4).

In 2002, Baban waké and IN92E-3 yielded more than the other varieties at Ticko, with 467 kg/ha and 609 kg/ha, respectively (Table 4). The Locale variety and TVu 1234-9 had the lowest yields, with 354 kg/ha and 223

Table 2: Flowering, total number of branches and length of the two first branches of nine varieties of cowpea planted at Ticko in 2001.

Varieties	Flowering (DAP‡)	Plant branches		
		Total number	Length of the 1st branch (cm)	Length of the 2nd branch (cm)
"Baban waké"	109.67a	4.50a†	139.13a	134.63a
IN92E-3	65.67bc	4.03ab	83.03bc	84.93b
IT89KD-288	67.00b	3.57ab	72.17bc	73.93bc
IT89KD-349	67.00b	4.20ab	90.13b	93.17b
IT93K-398-2	68.33b	3.20b	51.67c	40.37c
Kanannado	101.00a	3.03b	73.80bc	80.53bc
Locale	63.67c	3.23b	72.47bc	72.87bc
TN256-87	60.00d	3.67ab	63.90bc	72.70bc
TVu 1234-9	64.00c	3.27b	92.17b	91.03b
Mean	**70.04**	**3.63**	**82.05**	**82.69**
Significance	**	**	**	**

‡: days after planting
†: Values in the same column with the same letter (s) are not significantly different
**: Indicate significant differences at 0.01 probability level.

Table 3: Table of F Snedecor for variation between years, sites and varieties.

Factor of variation	Fodder yield
Year 2001 and 2002	
Year	145.14**
Site	2.99NS
Variety	7.49*
Site x year	0.94NS
Variety x year	3.24**
Variety x site	3.10**
Variety x year x site	1.59NS
Year 2001	
Variety	6.56**
Site	2.61NS
Variety x site	2.27*
Year 2002	
Variety	2.60*
Site	0.48NS
Variety x site	2.52*

*: Indicate significant differences at 0.05 probability level;
**: Indicate significant differences at 0.01 probability level.
NS = non significant.

Table 4: Variation of fodder yield (kg/ha) among nine cowpea varieties according to years (2001 and 2002) and sites (Ticko and Bogodjotou).

Varieties	2001		2002	
	Ticko	**Bogodjotou**	**Ticko**	**Bogodjotou**
"Baban waké"	1032a[†]	1201a	467ab	326c
IN92E-3	744b	508d	609a	452bc
IT89KD-288	811b	1268a	393b	404bc
IT89KD-349	499c	776bc	458b	700a
IT93K-398-2	866ab	651cd	435b	351bc
Kanannado	879ab	1150a	416b	554ab
Locale	715bc	568cd	354bc	474b
TN256-87	716bc	657cd	446b	462bc
TVu 1234-9	677bc	903b	223c	386bc
Mean	**771**	**854**	**422**	**457**

[†]: Values in the same column with the same letter (s) are not significantly different at 0.05 probability level.

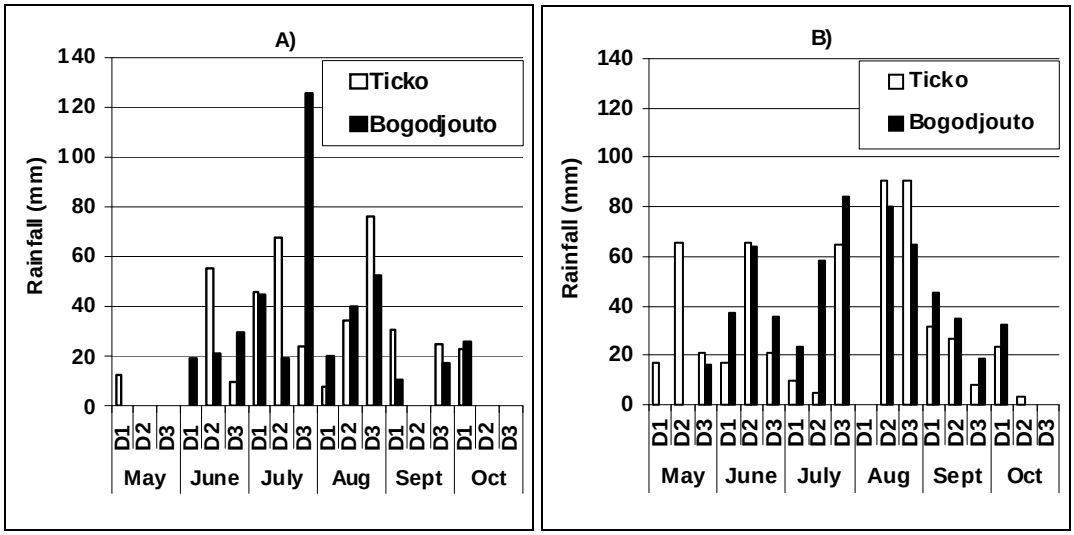

Figure 1: Repartition of rainfall per decade in 2001 (A) and 2002 (B) at Ticko and Bogodjotou.
(D1, D2 and D3 corresponded to 1st, 2nd and 3rd decade respectively of the month).

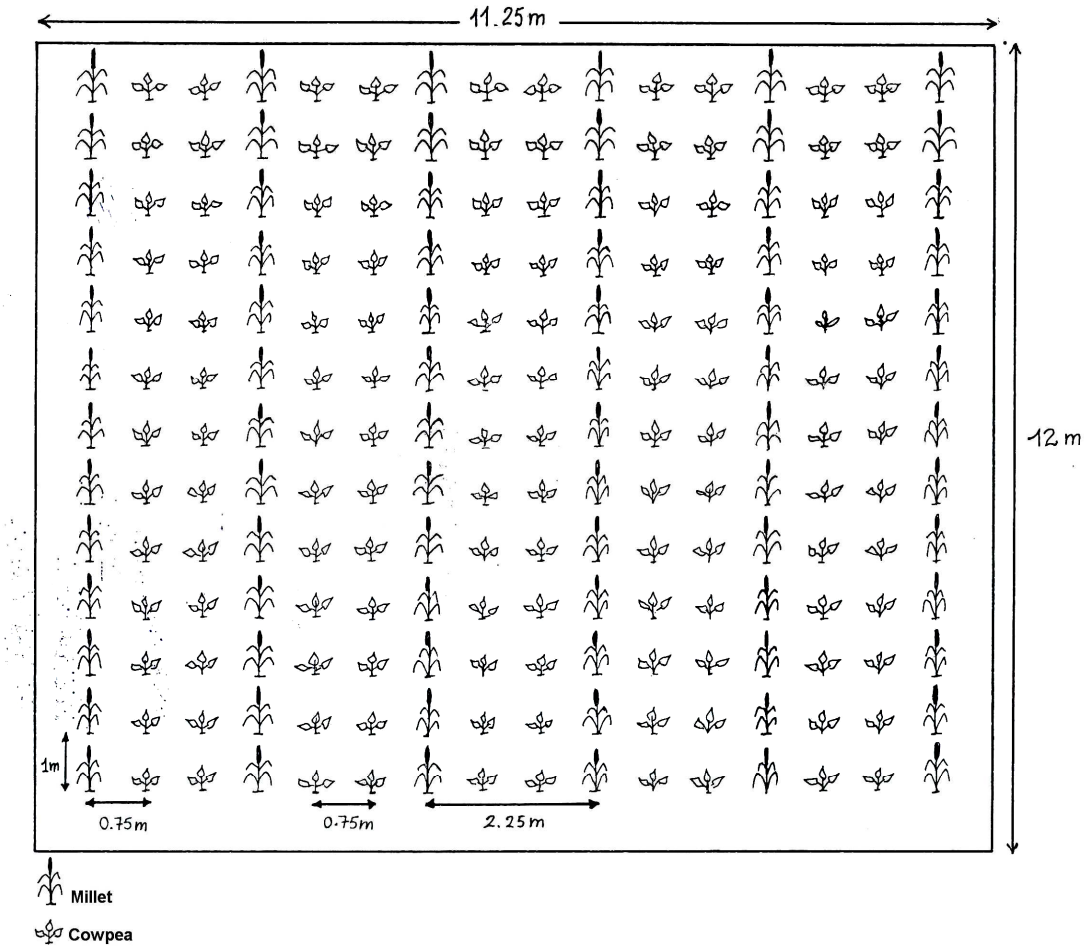

Figure 2: Schematic presentation of one plot showing the intercropping between millet and cowpea.

kg/ha, respectively. The IITA varieties, Kanannado, IT89KD-349, IT89KD-288 and IT93K-398-2 had intermediate fodder yields. The results indicated that at Bogodjotou, Kanannado and IT89KD-349 had higher fodder yield, while the lowest fodder yields were recorded for "Baban waké", IN92E-3, TVu 1234-9, IT89KD-288 and IT93K-398-2.

DISCUSSION

The results showed that, with the exception of TVu 1234-9, all the others cowpea varieties originating from IITA had a later flowering date, compared to the Locale variety. The variety "Baban waké", cultivated in the Soudano-sahelian zone of Gaya in Niger was within the latest maturity group. Moreover, the flowering date was similar for IT89KD-349 and IT93K-398-2, about 68 days after sowing. This observation corresponded with those of Singh and Tarawali (1997) who recorded similar flowering date at Olelewa located also in Niger. But for the variety Kanannado, the date of flowering observed in this study was longer than to those recorded by Umar et al. (2010). This could be attributed to the good growing conditions including regular distribution of rainfall and longer

rainy season in 2001. Singh and Matsui (2002) found that under drought stress, the period from planting to flowering was significantly reduced (47 days after sowing) for Kanannado.

The results have shown variation in fodder yield depending on the year as well as between varieties within the same year. Overall, in the two sites, the fodder yield of all varieties was higher in 2001 compared to those of 2002. This higher fodder yield could be attributed to an earlier planting date. In 2001, the planting dates were earlier by approximately 2 weeks and one week, in Ticko and Bogodjotou respectively compared to those of 2002. As most of the selected cowpea varieties are day length sensitive and they received a longer vegetative period, this could explain the higher quantity of dry matter accumulated in 2001. Kanannado was classified as an acutely sensitive variety to photoperiod (Craufurd et al., 1997). In legumes, photoperiod and temperature primarily influences the duration from planting to flowering and maturity which in turn determines the duration of biomass accumulation. Secondly, it influences the duration of different development phases which affects the partitioning of the biomass and therefore the proportion of seed to vegetative yields (Mutters et al., 1989).

In comparing varieties, "Banban waké", Kanannado and IT89KD-288 produced the highest fodder yields in 2001 in the two sites. In term of comparison with the Locale variety of cowpea grown by farmers, the increase of fodder yield recorded by these varieties was respectively 44%, 13% and 23% in Ticko. The increase was higher at Bogodjotou, with 111%, 123% and 102% respectively, indicating the significant interaction between variety and site.

The results of fodder yield recorded in this study in 2001 are similar to those previously reported: IT89KD-288 and Kanannado in Bogodjoto (Mohammed et al., 2008), IT93K398-2 at Ticko (Singh and Tarawali, 1997). However, for the other IITA varieties, the fodder yield recorded at the two sites and during the two years remained lower to those previously reported by other colleagues (Singh and Ajeigbe, 2002; Singh and Matsui, 2002; Omokanye et al., 2003). The highest yields obtained by these colleagues could be attributed to a longer rainy season and lower temperatures in the north of Nigeria where the experiments were carried out. Craufurd and Wheeler (2009) indicated that during climate change, warmer temperatures that shorten developmental stages of determinate crops will most likely reduce the yield of a given variety.

The results from Ticko and Bogodjoto demonstrated the possibility to increase fodder production through the use of dual-purpose cowpea varieties and thus increasing farmer's income and contributing to the alleviation of poverty. On a dry weight basis, the price of cowpea haulms ranges between 50 to 80% of the grain price (Singh et al., 2003). Fodder therefore, constitutes an important source of income. Inaizumi et al. (1999) have indicated in Kano State, Nigeria, that 1,500 farmers have adopted IT89KD-288, only 4 years after its accidental release to one farmer. This high level of adoption shows that farmers derived substantial benefits from using dry-season dual-purpose varieties. These benefits include food security, cash income, crop diversification, fodder, and *in situ* grazing after harvesting, during a critical period of the year when the prices of cowpea grain peaks, and when good quality fodder is scarce.

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