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INTERCROPPING MORPHOLOGICALLY DIFFERENT COWPEAS WITH PEARL MILLET IN A SHORT SEASON ENVIRONMENT IN THE SAHEL

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SUMMARY

The effects on yield of varying the planting date and planting pattern of morphologically different cowpea cultivars intercropped with pearl millet were studied in two field trials. The interaction between cowpea cultivars and planting date was highly significant. There was a sharp reduction in cowpea yields with late planting. Millet yields were reduced less when sown simultaneously with early cowpea cultivars than when sown with a late maturing local cultivar. Early maturing cowpea cultivars planted in closely spaced hills had less effect on millet yields than a late maturing cultivar sown in widely spaced hills. An appropriate cowpea cultivar for intercropping with peal millet would be one that was weakly competitive and that yielded both grain and fodder.

Bonny R. Ntare: *Cultivo intercalado de caupís morfológicamente distintos con mijo perla en un entorno de temporada corta en el Sahel.*

RESUMEN

Se realizaron dos ensayos de campo para estudiar los efectos sobre el rendimiento al variar la fecha y el patrón de plantación de cultivares de caupí morfológicamente distintos en cultivo intercalado con mijo perla. La interacción entre los cultivares de caupí y la fecha de plantación resultó altamente significante. Hubo una disminución acusada en los rendimientos de caupí al plantarse tarde. Las reducciones en los rendimientos de mijo fueron menores al sembrarlo simultáneamente con cultivares tempranos de caupí que al sembrarlo con un cultivar local de maduración tardía. Los cultivares de caupí de maduración temprana plantados en grupos de espaciado estrecho tuvieron menor efecto sobre los rendimientos de mijo que un cultivar de maduración tardía sembrado en grupos muy separados. Un cultivar de caupí apropiado para el cultivo intercalado del mijo perla sería uno que fuera débilmente competitivo y que rindiera tanto grano como forraje.

INTRODUCTION

Cowpea (*Vigna unguiculata* (L.) Walp) and pearl millet (*Pennisetum glaucum* (L.) R. Br. are often intercropped by small farmers in the Sahelian zone of West Africa (Steiner, 1982; Stoop, 1986). Both crops are produced under conditions characterized by poor soils, frequent drought, high temperatures and many diseases and insect pests. Cowpeas have a dual role, the grain being used for human consumption and the fodder as animal feed.

Sahelian farmers use intercropping systems to minimize risks and spread labour peaks (Norman, 1974; Matlon, 1980). Intercropping is superior to sole

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cropping as it provides higher relative yields and is a better use of resources (Willey, 1979; Francis, 1981). Fussell and Serafini (1985) reviewed crop associations in semi-arid West Africa and concluded that millet-cowpea intercropping generally improved and stabilized agricultural productivity.

In Niger and elsewhere in the Sahelian zone, farmers commonly plant pearl millet before the cowpea intercrop. The two crops are grown in clusters of plants, or hills, at a relatively wide spacing. Cowpeas are sown between millet rows at low densities two to six weeks after millet is planted. In this combination, cowpea grain and fodder yields are very poor.

Traditional short-day cowpea cultivars flower towards the end of the rains in the West African Sahel. At this time there is a high probability of drought, which greatly affects cowpea yield. Development of photoperiod-insensitive cowpea cultivars with improved plant types and a shorter time to maturity should give researchers the opportunity to improve cowpea performance in cereal intercrops. Andrews (1974), studying the response of sorghum varieties to intercropping, concluded that the practice of intercopping could be made more advantageous by the use of improved crop varieties.

Planting date and cowpea density are two agronomic factors under the direct control of the farmer that can influence cowpea performance in intercropping. Farmers do not favour a high cowpea density in the intercrop because it reduces cereal yields. The present study included improved early maturing cultivars to investigate the effect of planting date and pattern of planting of intercropped cowpea on the performance of both cowpea and millet. The study also investigated the effect of cowpea cultivar plant type on millet yields.

MATERIALS AND METHODS

Two trials were conducted during both 1985 and 1986 at the ICRISAT Sahelian Centre (ISC) near Niamey in the Republic of Niger. This station (13° 15′ N, 2° 18′ E and at an altitude of 240 m) is in the Sahel bioclimatic zone, an extensive semi-arid belt immediately south of the Sahara desert. The cropping season is very short, from June to September, followed by a long dry season. Only one rainfed crop is possible each year. Annual rainfall averages 574 mm and temperatures are warm all year round, averaging 29°C. The total rainfall during the period of the trials was 545 mm in 1985 and 657 mm in 1986. The soil is derived from eolian sand deposits in which the 0-15 cm soil layer is 94% sand and 3% clay, with a pH of 5.4, CEC of 0.9 CMol (+) kg^{-1} and organic carbon 2 g kg^{-1}; it is classified as a siliceous isohyperthermic Psammetic Paleustalf (West *et al.*, 1984).

In both experiments a pre-planting application of 18 kg ha^{-1} P_2O_5 as single superphosphate was incorporated into the soil. Nitrogen at 45 kg ha^{-1}, as urea, was applied to the millet in two doses, 21 and 45 days after planting (DAP). The cowpea was protected from insect pests by spraying with Cymbush super® at the flowering and pod-filling stages.

Trial 1

The cowpea cultivars used were IT82D 716 (an erect, early, determinate cultivar maturing 65–70 DAP), TVX 3236 (a spreading, profusely flowering cultivar maturing in 70 to 80 days) and Sadore local (a highly vegetative, photoperiod-sensitive, spreading type maturing in 120 to 150 days). A 110-day millet cultivar recommended in the area, CIVT, was used in all trials.

A split-split plot design with three replications was used in both years of the trial. The two cropping systems (sole and intercropped) were main plots, the three cowpea cultivars split-plots and the planting dates split-split plots. Sub-sub-plot size was 6 × 6 m. An additional treatment of sole crop millet was included for reference.

Millet was sown on 20 June 1985 and 17 June 1986. In 1985 cowpeas were planted on the same day as the millet, and 6 and 25 days afterwards. In 1986 cowpea was sown on the same day as the millet, and 24 days afterwards. Millet was sown in hills 0.75 m apart within rows and 1.5 m between rows. Cowpea rows were planted between the millet rows at a within-row spacing of 0.30 m for IT82D 716 and TVX 3236 and 0.50 m for Sadore local. The same cowpea densities were used in the sole crop plots.

In both years, IT82D 716 was harvested at 65 and TVX 3236 at 70 DAP. The millet was harvested after 100 days. In each sub-sub-plot and the control plots the three centre rows of millet and two of cowpea were harvested for yield estimation.

Trial 2

Three cowpea cultivars, IT84E 124 (extra-early erect, maturing in 55 to 60 days), IT82D 716 and Sadore local were used. The two early cultivars were planted between millet rows in four spacing and density treatments with one plant $hill^{-1}$ established every 0.1 m, two plants every 0.3 m, three plants every 0.5 m or four plants every 1.0 m. Sadore local was used as a control and was established with four plants every 1.0 m, approximately the traditional density. A sole crop millet treatment was included. The 10 treatments were arranged in randomized complete blocks with a plot size of 6 × 6 m and four replications. Millet spacing was as in Trial 1.

RESULTS

Trial 1

The grain and fodder yield of cowpea differed significantly among cropping systems in both years (Table 1). There were also significant cowpea cultivar × cropping system interactions for fodder yield. The interaction between cowpea cultivars and planting date was significant for fodder yield in both years, showing a sharp reduction in yield with later planting especially in the erect cultivar. For grain yield the interaction between cowpea cultivar and date of planting was significant only in 1985 when no grain was harvested from Sadore local

Table 1. *Cowpea and millet yields (t ha^{-1}) at different dates of planting of different cowpea cultivars intercropped with millet in 1985 and 1986*

Planting system	Cowpea cv. IT82D 716 (Early erect)			Cowpea cv. TVX3236 (Early spreading)			Cowpea Sadore local (Late spreading)		
	Cowpea grain	Cowpea dry fodder	Millet grain	Cowpea grain	Cowpea dry fodder	Millet grain	Cowpea grain	Cowpea dry fodder	Millet grain
				1985					
Simultaneous	0.35	0.73	1.06	0.49	0.93	1.04	–	2.27	0.34
6 days after millet	0.20	0.22	1.26	0.24	0.75	1.21	–	1.97	0.63
25 days after millet	0.07	0.19	1.32	0.08	0.27	1.31	–	0.59	1.31
Sole cowpea (average over three dates of planting)	0.60	1.26	–	0.93	1.16	–	–	2.43	
Sole millet	–		1.38		–	1.38	–	–	1.38
SE	0.09	0.08	0.05	0.09	0.08	0.05		0.08	0.05
				1986					
Simultaneous	0.15	0.27	0.98	0.19	0.38	0.57	0.04	1.28	0.56
7 days after millet	0.18	0.19	0.61	0.12	0.40	0.74	0.03	1.31	0.66
24 days after millet	0.12	0.17	0.88	0.10	0.16	0.81	0.01	0.45	0.84
Sole cowpea	0.40	0.46	–	0.59	0.65	–	0.20	2.03	
Sole millet	–	–	1.10	–		1.10	–	–	1.10
SE	0.02	0.08	0.07	0.02	0.08	0.07	0.02	0.05	0.07

Table 2. *Effect of spacing/density of early-maturing cowpea intercropped with pearl millet on grain yield (t ha^{-1}) in 1985 and 1986*

	Cowpea Cv. IT84E 124	Millet	Cowpea Cv. IT82D 716	Millet
	1985			
One plant, 0.1 m apart	0.21	1.35	0.50	1.09
Two plants, 0.3 m apart	0.21	1.30	0.49	1.21
Three plants, 0.5 m apart	0.27	1.67	0.50	1.31
Four plants, 1 m apart	0.14	1.70	0.33	1.53
Sadore local, 1 m apart	–	0.85	–	0.85
Sole millet	–	1.80	–	1.80
SE	0.06	0.36	0.06	0.36
	1986			
One plant 0.1 m apart	0.13	0.97	0.41	0.88
Two plants, 0.3 m apart	0.17	1.07	0.43	1.01
Three plants, 0.5 m apart	0.10	1.13	0.24	1.08
Four plants, 1.0 m apart	0.08	1.16	0.11	1.12
Sadore local 1.0 m apart	–	0.76	–	0.76
Sole millet	–	1.37	–	1.37
SE	0.06	0.34	0.06	0.34

because the rains stopped early (17 September) before flowering and it could only be harvested for fodder. In 1986, the distribution of rainfall was above average in September and October and Sadore local was able to flower and produce grain in addition to giving a high fodder yield.

Millet yields were significantly lower when cowpea was sown simultaneously than when its sowing was delayed until three weeks after the millet. This effect was more pronounced with Sadore local than with the early cultivars (Table 1).

Trial 2

In Trial 2, Sadore local did not produce grain in either year because of the early cessation of the rains in 1985 and insect damage due to poor spraying in 1986 (Table 2). The earliest cultivar, IT84E 124, was infected by bacterial blight (*Xanthomonas campestris* pv. *vignicola*) and was lower yielding than IT82D 716. The yield of the two cowpea cultivars was significantly lower in hills spaced 1 m apart than in hills spaced 0.5, 0.3 or 0.1 m apart. Millet yields were significantly reduced by closer spacing and high density in the early cultivars, but the reduction was less than that caused by Sadore local.

DISCUSSION

In this study two approaches were taken to improve the yields of cowpea in millet-cowpea intercrop systems. The first focused on the use of early maturing cultivars and changes in the date of sowing. The second modified the intercropping pattern while maintaining the same total plant population of the cereal crop.

The results indicate that early maturing cowpeas are likely to be less competitive with millet and thus more suitable for intercropping. This benefit, however, will depend on when they are planted in relation to millet. The yield of early-maturing cowpea cultivars was much reduced when intercropped with millet, especially when they were sown three weeks after the millet, because of increased competition from the cereal crop. Early inter-planting allows the cowpea to grow without being shaded by the millet during the critical stages of growth. The harvesting of early cowpeas occurred one month before the millet harvest, thus reducing the effects of competition on the millet.

The local photoperiod-sensitive cowpea cultivar was more competitive with millet and caused the greatest reduction in yield when planted simultaneously with or one week after millet. However, it also produced the largest fodder yield in both sole and intercropped treatments. This suggests a close relation between the spreading habit of Sadore local and its superior fodder production. The influence of legume plant type on competitiveness in cereal-legume intercrops has been reported for maize-bean (Francis *et al.*, 1982) and maize-cowpea (Adetiloye, 1980) intercrops. In the short 90-day growing season in Niger, the local photoperiod-sensitive cultivars often do not produce grain

because of the frequent abrupt cessation of the rains. A similar situation was observed by Andrews (1974) in Northern Nigeria.

The early-maturing cowpea cultivars used in this study were less competitive than the local cultivar and required a greater plant density before they seriously affected millet yields. They therefore offer an opportunity to modify the cropping pattern without radically changing the traditional system. However, they do not produce as much fodder as the local cultivar, and so may not be attractive to farmers who value the fodder. Although few cowpea cultivars were used, the results suggest that a compromise will be involved in the selection of cultivars for intercropping. Since drought is of concern, particularly at the end of the season, the use of early-maturing cultivars which escape drought would minimize the risk that both crops would be affected by drought conditions. An appropriate cowpea cultivar for intercropping with millet would be weakly competitive and would yield both grain and fodder. To ensure yields of both grain and fodder, farmers may have to sow both early and late maturing cowpea cultivars as varietal mixtures. The implications of this cropping system are that with a short growing season, grain production would be assured from the early maturing cultivar and fodder from the late cultivar. On the other hand, the late maturing cultivar would produce an additional harvest of grain and fodder in a longer growing season. The analysis of rainfall in the southern Sahelian zone of West Africa has shown that the early onset of the rains offers a longer growing season while a delayed onset results in a considerably shorter growing season (Sivakumar, 1988). While the proposed cropping system may favour a build-up of insect pests, this should not affect fodder production since cowpea pests mainly affect grain rather than fodder production. The question of the effect of moisture stress at different times during the growing season needs investigating in order to devise a means of ensuring yield stability. Agronomic adjustments and practices which improve soil moisture retention also need to be considered.

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REFERENCES

Adetiloye, P. O. (1980). Growth Development and Yield in Sole and Intercropped Cowpea (*Vigna unguiculata* (L.) Walp) and Maize (*Zea mays* L.). PhD thesis, Nsukka, Nigeria, University of Nigeria.

Andrews, D. J. (1974). Response of sorghum varieties to intercropping. *Experimental Agriculture* 10:57–63.

Francis, C. A. (1981). Development of plant genotypes for multiple cropping systems. In *Plant Breeding II* (Ed. by K. J. Frey). Iowa: The Iowa State University Press.

Francis, C. A., Drager, M. & Tejad, G. (1982). Effect of relative planting dates in bean (*Phaseolus vulgaris* L.) and maize (*Zea mays* L.) intercropping patterns. *Field Crops Research* 5:45–54.

Fussell, L. K. & Serafini, P. G. (1985). Crop association in the semi-arid tropics of West Africa. Research

strategies, past and future. In *Appropriate Technology for Farmers in Semi-arid West Africa.* Proceedings of a Symposium, 2-5 April 1985, Ouagadougou, Burkina Faso, 218-235 (Eds W. Ohm and J. C. Nagy). University of Purdue.

Matlon, P. J. (1980). Local varieties, planting strategies and early season farming activities in two villages in central Upper Volta. ICRISAT West Africa Economics Program Progress Report 2, Ouagadougou, Burkina Faso.

Norman, D. W. (1974). Rationalizing mixed cropping under indigenous conditions. The example of Northern Nigeria. *Journal of Development Studies* 11:3-21.

Sivakumar, M. V. K. (1988). Predicting rainy season potential from the onset of rains in Southern Sahelian and Sudanian climatic zones of West Africa. *Agricultural and Forest Meteorology* 42:295-305.

Steiner, K. G. (1982). Intercropping in Smallholder Agriculture with Special Reference to West Africa. GTZ No. 137. GTZ, Eschborn, Germany.

Stoop, W. A. (1986). Agronomic management of cereal/cowpea cropping systems for major toposequence land types in the West African Savanna. *Field Crops Research* 13:301-319.

West, L. T., Wilding, L. P., Landeck, J. K. & Calhoun, F. G. (1984). Soil Survey of the ICRISAT Sahelian Center. Soil Crops Science Department, Tropsoils, Texas A & M, College Station, Texas, USA.

Willey, R. W. (1979). Intercropping, its importance and research needs Part 1. Competition and yield advantages. *Field Crop Abstracts* 32:1-10 Part 2.