ARPN Journal of Agricultural and Biological Science

www.arpnjournals.com

EFFECT OF PLANT DENSITY AND GENOTYPES OF COWPEA (*Vigna unguiculata* (L.) Walp.) ON THE GROWTH AND YIELD OF MILLET (*Pennisetum glaucum* (L.) R. Br.)

TOUDOU DAOUDA Abdoul Karim[1], ATTA Sanoussi[2], INOUSSA Maman Maârouhi[1], BAKASSO Yacoubou[1] and SAADOU Mahamane[1, 3]
[1]Faculty of Sciences and Technology, University Abdou Moumouni BP 10662 Niamey, Niger
[2]AGRHYMET Regional Centre BP 11011 Niamey, Niger
[3]Faculty of Sciences and Technology, University Dan Dicko Dankoulodo BP 465 Maradi, Niger
E-mail: toudoudaoudakarim@yahoo.fr

ABSTRACT

Millet and cowpea intercropping system, the most widespread in Niger has high potential and can increase smallholders' farmer productivity if proper techniques are applied. In order to evaluate the effect of density and cowpea genotypes on the growth and yield of millet and cowpea in intercropping, an experiment was conducted in the field during rainy season 2015 in Boki village located at approximately 40 km in the west of Niamey (Niger). Ten cowpea genotypes were grown in association with a single variety of millet in two densities in the ratio line millet intercropped with a cowpea line (density 1) and line millet intercropped with two cowpea lines (density 2). The experimental design was a split plot with three replications. Cowpea genotypes were in main plots, and the sowing densities in small plots. Millet was sown at the same density. Millet growth parameters (height, number and weight of panicles) were not significantly affected either by plant density or cowpeas genotypes. However, the number of tillers/m² were affected by cowpea genotypes. Cowpea pods yield and yield components such as number of pods/m², thousand seed weight were affected by the genotypes but not by plant density. The results indicated that cowpea genotypes ISV128 and Suvita2 could improve productivity of the cropping system millet / cowpea in the Sahel region by favouring density 2.

Keywords: cowpea, millet, growth, yields, genotypes, plant density, Niger.

INTRODUCTION

Pearl Millet (*Pennisetum glaucum* (L.) R. Br) and legumes intercropping, mainly cowpea (*Vigna unguiculata* (L.)Walp) is a current practice of the small farmers in the Sahel and particularly in Niger (Baidu and Renard, 1995).The two crops are grown in clusters of plants, or hills, at a relatively wide spacing. Cowpea is sown between millet rows at low densities (Ntare, 1989) because high density of cowpea in the intercropping system can reduce cereals yields. The traditional cowpea cultivars which still widely use in the zone are late maturing, photoperiod sensitive, indeterminate and low yielding (Singh *et al.*1997).

Intercropping affects the vegetative growth of both component crops. Because to its major root system and its faster growth, the cereal is more competitive than legume plant for soil mineral nitrogen and light. Legume depend advantage atmospheric nitrogen for the nitrogen nutrition through symbiotic fixation (Corre-Hellou, 2005).This complementarity of niche between the two species associated for the use of these two sources of nitrogen, mainly explains the generally higher performances observed for associations compared to the sole crop (Pelzer *et al.,* 2014).

Differences in phenological and morphological characteristics of crop species in the mixtures may lead to an increased capture of growth-limiting resources leading to greater potential to acquire higher total yields than when crops are grown separately on the same area of land. Because of the strongest competitiveness of the millet for the use of soil nitrogen and the light, it can reduce cowpea growth that results in the reduction of the dry matter yield due to shading (Shumba Dhilwayo and Mukoko, 1990). Solar radiation is one of the major resources determining growth and yield of component crops when planted simultaneously and together especially when other resources are not limiting plant growth (Watiki *et al.* 1993). According to Silwana and Lucas (2002), plant height of maize intercropped with both beans and pumpkin were adversely affected by intercropping conditions.

Intercropping system depends on the choice of varieties to intercrop and plant density (Pierreux *et al.,* 2012). Different planting dates of component crops are said to improve the utilization of resources and minimize competition (Andrews, 1972). According to Mbaye *et al.* (2014) in millet/cowpea intercropping, the lag in planting date of cowpea allows a better production of tiller, biomass, ears and seeds whatever the conditions of fertilization and seeding rate. However the lag should not be too long in order to maintain cowpea performance at an acceptable level. Singh and Ajeigbe (2000) indicated that the simultaneous sowing of cowpea and millet maximized cowpea yield. Thus, an appropriate cowpea cultivar for intercropping with pearl millet would be one that weakly competitive and yielded both grain and fodder (Ntare, 1989; 1990).Competitiveness being large with late maturing cultivar, the choice early and medium cultivars could improve the productivity of the millet in intercropping system. The objective of this study was to compare the effect of intercrop of millet with various

ARPN Journal of Agricultural and Biological Science

genotypes of cowpea in two sowing densities with the sole millet crop.

MATERIALS AND METHODS

Study area

The experiments was carried out in field during the rainy season 2015 in the village of Boki (department of Say) located at 75 km in the south of Niamey (Niger).The soil of the site is sandy and deep with low level of fertility and organic matter. The farming precedent was four years fallow. Figure 1 indicated the monthly distribution of rainfall during the experiment. The total rainfall was about 527 mm, mainly distributed in July and August.

Experimental design

The experimental device was split design with three replications. Cowpea genotypes were in main plots and planting densities in small plots.The millet was intercropped with cowpea according to two densities in the ratio of 1:1 (a line millet and a line cowpea) for density 1 and 1:2 (a line of millet and two lines cowpea) for density 2. The control was constituted by pure millet. Each replication contains 24 subplots (10 cowpea genotypes × 2 densities and four control). Each subplot area is 6 m^2 (4 m × 1.5 m). The subplots are 0.5 m apart and 1 m between two consecutives replications. The field was plowed and leveled before sowing. The millet variety ICMV IS 99001which has cycle of development of 90 days was intercropped with genotypes of cowpea. Table-1 gives the origin and the precocity of the cowpea genotypes.

Millet and cowpea genotypes were sown at the same date, on July 23, 2015. The spacing was 80 cm ×75 cm for the millet and 30 cm × 50 cm for cowpea.

Table 1. Origin and precocity of cowpea genotypes.

Genotypes	Origin	Precocity	Drought tolerance
ISV128	ISC Niger	-	-
IT93K-503-1	IITA Nigeria	Medium	Tolerant
IT96D610	IITA Nigeria	Medium	Tolerant
Mouride	ISRA Sénégal	Early	Tolerant
IT90K-284-2	IITA Nigeria	Medium	Sensible
Tiligré	-	-	-
ISV20	ISC Niger		
IT98K-428-3	IITA Nigeria	Medium	Tolerant
IT18E18	IITA Nigeria	Early	Sensible
Suvita2	INERA Burkina	Medium	Tolerant

[1]ISC: ICRISAT Sehelian Centre
[2]ISRA: Institut Sénégalais de Recherches Agricoles
[3] IITA: International Institute for Tropical Agriculture
[4] INERA: Institut de l'Environnement et des Recherches Agricoles

During plant growth, the height of millet and cowpea plants were measured at two stages, 15 and 45 days after sowing which corresponds respectively to the beginning of branching cowpea and end of tillering in millet.

At maturity, plants were harvested in the central rows of each plot of 2.4 m^2 (1.6 m × 1.5 m) corresponding to 14 cowpea plants for density 1 and 28 plants for density 2.

After complete drying in the shade, the following measurements were performed: (i) For millet: number of tillers and panicles/m², panicles weight/m², (ii) for cowpea: number of pods/m², pods yield, fodder yield, hundred seed weight. In addition, for cowpea, the harvest index (HI) of seeds, expressed in percentage, was also calculated by dividing the seeds weight by the total plant weight above ground (pods + haulms).

Data analysis

The results were tested by analysis of variance (ANOVA) followed by student's *t*-test in JMP9.0.0 software. The application of the cross adjusted model made it possible to highlight the interaction genotype density.

RESULTS AND DISCUSSION

RESULTS

ARPN Journal of Agricultural and Biological Science

www.arpnjournals.com

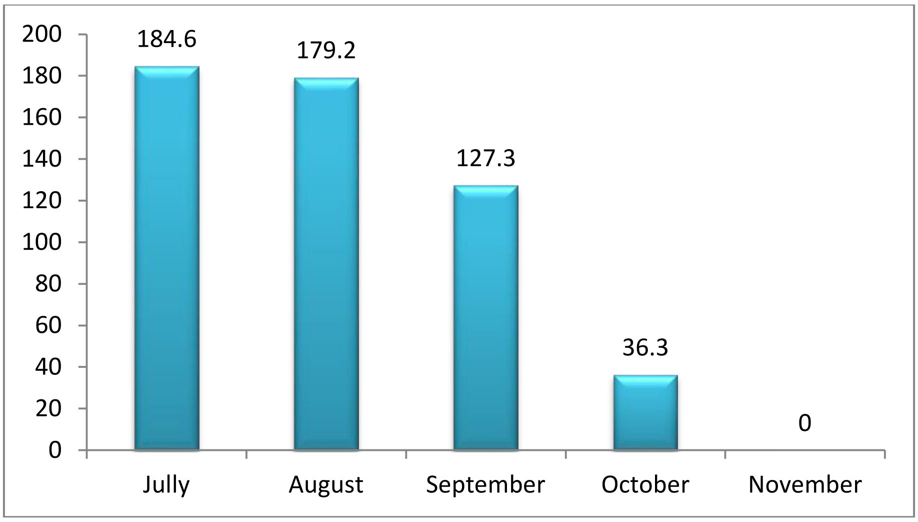

Figure-1. Monthly distribution of rainfall (mm) during the experiment.

Effect of genotypes and plants density on the growth of millet and cowpea

The height of millet and cowpea have gradually increased over time and were not affected by the cowpea density effect (Table 1). However there was a significant effect of genotype on cowpea growth between the two sowing densities. The highest height were registered for Tiligré and IT93K-503-1 either at 15 DAP or 45 DAP (Tables 3).

Table 2. Effect of plants density and cowpea genotypes on millet and cowpea height.

Treatment	Height 15 DAP (cm)		Height 45 DAP (cm)	
	Millet	**Cowpea**	**Millet**	**Cowpea**
Cowpea genotypes				
ISV128	17.88	11.61bcd†	79.5	27.38ab
ISV20	17.50	10.11d	79.00	-
IT82E18	19.12	12.55abcd	83.75	23.50b
IT90K-284-2	16.96	12.80abc	79.13	23.10b
IT93K-503-1	21.25	13.99ab	86.75	39.88a
IT96D-610	19.28	12.55abcd	83.00	28.63ab
IT98K-428-3	18.08	11.94bcd	87.25	20.88b
Mouride	20.83	10.88cd	82.25	28.50ab
Suvita2	17.40	12.83abc	85.50	33.45ab
Tiligré	17.56	14.91a	78.00	40.75a
Sole Millet	21.00		85.00	
Density				
D1	18.12	11.82	81.88	28.88
D2	19.05	13.02	80.95	30.25
Genotypes	ns	*	ns	*
Density	ns	ns	ns	ns
Genotype x Density	ns	*	ns	ns

** = significant at 0.05probability level. ns = not significant at 0.05 probability level.*
†: Values in the same column with the same letter (s) are not significantly different at 0.05 probability level.

The millet number and weight of panicles / m^2 were not affected by the density nor the genotype (Table 3). But, the number of tillers/m² was significantly affected by the genotypes. The highest number of tillers/m² was registered for the control (pure millet). Among the intercropped plots, higher number of tillers/m² was obtained by millet intercropping with IT82E18, IT90K-

 ISSN 1990-6145

ARPN Journal of Agricultural and Biological Science

284-2, IT96D-610 and Mouride and the lowest one with Tiligré and ISV128 genotypes (Table 3).

Table 3. Effect of plants density and cowpea genotypes on millet growth parameters.

Cowpea genotypes	Number of tillers/m^2	Number of panicles/m^2	Panicles weight (g/m^2)
ISV128	13.61cd†	3.07	130.24
ISV20	14.61bc	4.42	139.52
IT82E18	15.50ab	4.37	135.54
IT90K-284-2	15.17ab	4.06	122.80
IT93K-503-1	14.67abc	3.75	120.41
IT96D-610	15.11ab	5.97	113.84
IT98K-428-3	14.56bc	4.77	116.73
Mouride	15.50ab	5.42	148.14
Suvita2	15.28bc	5.17	134.47
Tiligré	12.89d	3.50	125.82
Control	16.00a	3.89	130.43
Density			
D1	14.94	4.68	129.08
D2	14.27	3.91	130.03
Genotypes	**	ns	ns
Density	ns	ns	ns
Genotype x density	ns	ns	ns

*, **, *** = *significant at respectively 0.05, 0.01 and 0.001 probability level. ns = not significant at 0.05 probability level.*
†*: Values in the same column with the same letter (s) are not significantly different at 0.05 probability level.*

Cowpea yield component

Cowpea genotypes had significant effect on pods/m² and 100 seeds weight (Table 4). The highest number of pods/m^2, pod and fodder yields, seed harvest index and 100 seeds weight. The highest pods/m², seed harvest index, pod and fodder yields were obtained by ISV128 and Suvita2 and the lowest ones by Mouride. The 100 seeds weight was higher for Tiligré and IT82E18 and lower for ISV128 and Mouride. The sowing density had no significant effect on all measured parameters except fodder dray matter (Table 4). The fodder yield was higher in density 2 (1137.47 kg/ha) than in density 1 (66.56 kg/ha). The results indicated also interactions between genotype and density for all parameters except 100 seeds weight (Table 4).

ARPN Journal of Agricultural and Biological Science

Table 4. Effect of plants density and genotypes on cowpea yields components.

Cowpea genotypes	Number of pods/m^2	Pod yield (Kg/ha)	Fodder yield (kg/ha)	Seeds harvest index (%)	100 seeds weight (g)
ISV128	20.30a	276.83a†	1211.08ab	12.01a	12.50c
ISV20	8.20b	85.00bc	1226.08ab	3.55c	14.80bc
IT82E18	2.30b	41.97c	698.52bcd	2.85c	20.25a
IT90K-284-2	2.29b	34.58d	492.01cd	3.55c	16.05b
IT93K-503-1	4.67b	50.80c	1374.27a	2.56c	16.75b
IT96D610	8.47b	109.72b	545.92cd	11.23ab	16.40b
IT98K-428-3	2.55b	27.87d	443.96cd	9.51b	-
Mouride	3.19b	30.56d	376.46d	4.98c	12.75c
Suvita2	17.34a	249.41a	841.42abcd	15.84a	16.60b
Tiligré	4.12b	63.52bc	1089.38abc	3.42c	20.90a
Density					
D1	7.87	112.1	660.56b	6.59	16.92
D2	9.01	121.39	1137.47a	5.86	15.74
Genotypes	***	***	*	*	*
Density	ns	ns	**	ns	**ns**
Genotype x Density	***	***	*	**	ns

, **, * = significant at respectively 0.05, 0.01 and 0.001 probability level. ns = not significant (p>0.05).*
†: Values in the same column with the same letter (s) are not significantly different at 0.05 probability level.

DISCUSSION

The sowing density had no significant effect on the growth of millet and cowpea at 45 DAP. These results are similar to those of Nouri and Reddy (1991). At density 2, heights of millet and cowpea are higher than density 1. Therefore high sowing density increases competition between plants for soil moisture, nutrients and light. The difference in heights among cowpea genotypes indicated genetic variability in potential of growth.

The low sowing density resulted in an increase of the weight of a hundred seeds. These results conform those of Naim El Abdelrhim (2010) who also found higher hundred seeds weight at lower density of sowing. This can be explained by better availability of soil nutrients and environmental conditions. The harvest index of seeds was significantly affected by cowpea genotypes (p <0.001). It is a good indicator of translocation of nutrients for vegetative parts to seeds. The harvest index was higher in low density because of higher production of biomass. This is consistent with the finding of Weber et *al*.. (1966) which indicated that the low density of sowing tend to increase the harvest index.

In general, outside the tiller number, nor seeding rates, neither cowpea genotypes affected millet growth parameters. Our results corroborated those of Mohamed *et al*., (2002) and Olufajo *et al.,* (2008). The number of tillers was significantly affected by the genotypes. Genotypes Mouride and IT82E18 had the highest number of tillers (Table 3). These genotypes had also the lower seed and fodder yields.

Biomass production and grains in millet were generally higher in density 1 than density 2 because of competition millet during the vegetative growth phase. The fodder yield of cowpea was higher at density 2 compared to density 1. These results are explained by the fact that when the density of plants per m^2 increases yields decreases while those of the surface unit increases (Khamooshi *etal,* 2012; and Derrogar and Mojjadam. 2014).

The results indicated that there was not significant difference in millet panicles weight between sole plot and intercropped ones. Some intercrop has given more grains than sole millet. This indicates that there was less competition for millet when associated with some cowpea genotypes. These results are conforms to those of Garba and Renard (1991) and Noury and Reddy (1997).

According to Ntare (1989) appropriate cowpea genotypes for intercropping with millet are those that are less competitive and giving a good seed and fodder yields. From the results, some cowpea genotypes could be encouraged to improve productivity of the cropping system millet / cowpea in the Sahel region by favouring density 2. Indeed the best seed yields were obtained by ISV128 and Suvita2 genotypes. These genotypes had the highest seed harvest index also pods and fodder yields.

REFERENCES

Ahmed M. El Naim and Abderlrhim A. Jabereldar. 2010. Effect of Plant density and Cultivars on Growth and Yield

ARPN Journal of Agricultural and Biological Science

of Cowpea (*Vigna unguiculata* L. Walp). Australian Journal of Basic and Applied Sciences. 4(8): 3148-3153.

Andrews D.J. 1972. Intercropping with Sorghum in Nigeria. Exp. Agric. 8: 129-150.

Baidu-Forson J. and Renard C. 1996. Comparing Productivity of Millet-Based Cropping Systems in Unstable Environments of the Sahel: Possibilities and Challenges. Agricultural Systems. 51: 85-95.

Corre-Hellou G. 2005. Acquisition de l'azote dans des associations pois-orge (*Pisum sativum* L. -*Hordeum vulgare* L.) en relation avec le fonctionnement du peuplement. Thèse de doctorat Université d'Angers (France), 155 p.

Khamooshi H., Mohammadian N., Saamdaliri M., Foroughi Z. 2012. Study of effect plant density and nitrogen on yield components of *Visia faba* (Faba Bean). Journal of Ornemental and Horticultural Plants. 2(3): 161-167.

Mbaye M.S., Kane A., Gueye M., Bassene C., Ba N., Diop D., Sylla S.N., Noba K. 2014. Date et densité optimales de semis du niébé [*Vigna unguiculata* (L.) Walp.] en association avec le mil [*Pennisetum glaucum* (L.) R. Br.]. Journal of Applied Biosciences, 76: 6305-6315.

Mohamed L.Z. 2002. The effect of intra-row spacing and starter nitrogen fertilizer on growth and yield of cowpea (*Vigna unguiculata* L. Walp). M. Sc Thesis. University of Khartoum, Sudan.

Mohammed I.B., Olufajo O. O.. Singh B.B., Oluwasemire K.O. and Chiezey U.F. 2008. Productivity of millet / Cowpea intercrop as affected by cowpea genotype and row arrangement. World Journal of Agricultural Sciences. 4(S): 818-824.

Nouri M. et Reddy K. C. 1991. Utilisation de l'eau par le mil et le niébé en association et en culture pure. Soil Water Balance in the Sudano-Sahelian Zone (Proceedings of the Niamey Workshop. February 1991). IAHS Publ. 199: 421-429.

Ntare B. R. 1989. Evaluation of Cowpeas Cultivars for Intercropping with Pearl Millet in the Sahelian Zone of West Africa. Field Crops Research. 20: 31-40.

Ntare B. R. 1990. Intercropping Morphologically Different Cowpeas with Pearl Millet in a short Season Environment in the Sahel. Exp Agric.26: 41- 47.

Pelzer E., Bedoussac L., Corre-Hellou G. ,Jeuffroy M.-H., Métivier T., Naudin C. 2014. Association de cultures annuelles combinant une légumineuse et une céréale : retours d'expériences d'agriculteurs et analyse. Innovations Agronomiques. 40: 73-91.

Pierreux J., Delaplace P., Roisinet C., Bodson B. 2013. Perspectives offertes par la culture en association de froment et de pois protéagineux d'hiver. 13ème Journée productions porcines et avicoles. pp. 25-32.

Shumba E. M., Dhiwayo H. H. and Mukoko O. Z. 1990. The potential of maize-cowpea intercropping in low rainfall areas of Zimbabwe. Zimbabwe J. of Agric. Res. 28: 33-38.

Silwana. T.T and Lucas. E.O. 2002. The effect planting combination and weeding and yield of component crops of maize/ bean/ pumpkin Intercrops. J. Agric. Sci. 138: 193-200.

Singh B.B., Asante S.K., Florini D., Jackai L.E.N., Fatokun C. and Wydra K. 1997. Breeding for multiple disease and insect resistance. IITA. Annual Report. p. 22.

Singh B. B. and Ajeigbe. H. A. 2000. Improving cowpea-cereals based cropping. pp. 278-286 in Challenges and Opportunies for enhancing sustainable Cowpea Production. Edited by C.A. Fatokun, S.A. Tarawali, B.B. Singh, P.M. Kormawa and Tamo. Systems in the dry Savanna of West Africa. Challenges and opportunities for enhancing sustainable cowpea production. Proceedings of the World cowpea conference III held at the International Institute of Tropical Agriculture (IITA). Ibadan. Nigeria 4-8 September 2000. IITA. Ibadan. Nigeria. p. 396.

Watiki J.M., Fukai S., Banda J.A., and Keating B.A. 1993. Radiation Interception and growth of maize/ cowpea intercrop as affected by plant density and cowpea cultivar. Field crop Res 35: 123-133.

Weber C.R., Shibles R.M. and Byth D.E. 1966. Effect of plant population and row spacing on soybean development and production. American Society of Agronomy Journal. 58: 99-102. Madison. U.S.A.