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SORGHUM/MILLET MIXTURE AS AFFECTED BY CROP PROPORTION AND SORGHUM CULTIVAR IN A SEMI-ARID ENVIRONMENT

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ABSTRACT

Field experiment was conducted at the Lake Chad Research Institute Farm Maiduguri (11º 54' N, 13º 05' E, 336m above mean sea level) in 1997 and 1998 cropping seasons to determine the productivity of Sorghum/Millet intercrop. Four sorghum cultivars (ICSV111, NR71182, NR71176 and ICSV400) and three crop proportions (1:1, 2:1 and 1:2 Sorghum/Millet) were compared in factorial combinations using a randomized complete block design. The study revealed that sorghum cultivar had no significant effect on millet plant height but significantly influenced sorghum plant height. Sorghum genotype ICSV111 matured significantly earlier than other cultivars in the mixture. Intercropping reduced sorghum and millet grain yield in both years. Sorghum cultivar ICSV111 produced the highest mean grain yield in the mixture. Crop proportion (1:2) Sorghum/Millet out yielded 1:1 and 2:1 Sorghum/Millet in terms of millet grain yield in both seasons. Both sorghum and millet grain yields increased significantly as their proportion in the mixture increased. The combination of sorghum cultivar NR71176 with millet produced the highest mean grain yield of millet. This is ideal for Sudan Savanna where the growing season is about 90 days. The highest land equivalent ratio of 49 and 60 percent were obtained at 2:1 and 1:2 crop proportions in 1997 and 1998, respectively.

Keywords: Sorghum, Millet, cultivars, semi-arid

INTRODUCTION

Grain sorghum (*Sorghum bicolor L. Moench*) and *millet* (*Pennisetun glaucum (L.) R. Br*.) are important cereal crops in Sudan and Sahelian Savanna Zones of Nigeria. These crops are commonly intercropped in the Savanna Region of Nigeria (Curtis, 1965). It is estimated that one-third to one-fourth of the grain production comes from fields planted solely to sorghum, the rest being from crop mixtures (Andrews, 1972; Elemo and Chobe, 1995) Gero millet has been a traditional crop in the agricultural system. Baker and Norman,1975; Yayock *et al*., 1988; Singh, 1993 reported that two crop mixtures predominate in the Savanna region more than three, four or more crop mixtures. Sorghum/Millet is the most popular system in the region (Norman, 1968; 1974).

Maturity difference (Andrews, 1972; Rao and Willey, 1983; Tsay et al., 1988 and Olufajo, 1995) and plant height (Wahua and Miller, 1978; Elmore and Jackobs, 1984) are known to exert great influence on the performance of component in a mixed cropping system.

Recent breeding effort had resulted in the development of some high yielding sorghum genotypes. These genotypes have been developed under condition of sole cropping while most farmers cultivating sorghum grow their crops in mixtures. Therefore, there is need to evaluate the performance of these genotypes under intercropping conditions in the north east Nigeria.

This study was therefore designed to evaluate the productivity of sorghum/millet intercrop and to assess the effects of plant arrangement in the intercropping system.

MATERIALS AND METHODS

Experimental Site

Field experiment were conducted in 1997 and 1998 cropping season on the Lake Chad Research Institute Research Farm Maiduguri (11º 54' N, 13º 05' E; 336 m above sea mean level). Maiduguri is a semi-arid town characterized by distinct annual long dry season (9 months or more) and short rainy season (3 months or less) with annual amount of rainfall in the range of 234-722 mm and a mean of 533 mm over the past ten years (Odo and Gwary, 1994). Relative humidity is usually low except at the peak of rainy season (July-August) and temperature is high during the growing season with monthly minimum and maximum of 23 ºC and 33 ºC, respectively. The soils of the experimental site is sandy loam.

The experimental area was cleared and harrowed twice to a fine tilth and marked out into plots of 4.5 m x 5.0 m. The sorghum genotypes used were NR71182, NR71176, ICSV111 and ICSV400 while the millet genotype was Ex-Borno. These crop varieties are early maturing. The genotypes were developed at the institute for Agricultural Research Samaru, Zaria.

Treatment and experimental design

The treatments were made up of four sole crops of sorghum genotypes, a millet genotype and the 12 crop mixture treatments obtained by factorial combination of three crop proportions (1:1, 2:1 and 1:2 of sorghum: millet).Treatments were arranged in a randomized complete block design with three replications.

Cultural and management practices

Sorghum and millet were sown simultaneously on 26 June in 1997 and 9 July 1998 at 5 and 8 seeds per hole and later thinned to two seedlings per hill at 7-10 days after sowing (DAS). The component crops were intercropped in alternate row spaced at 0.75 m apart. In both sole and intercrops, the component crops were established at the recommended sole crop plant densities of 88,888 and 53,333 plants per hectare for sorghum and millet respectively; so that the total plant populations in intercrops were additive. Fertilizer was applied to all plots at the recommended rate of 30 Kg N, P and K /ha as compound fertilizer 15:15:15 at sowing. The remaining half N dose (30 Kg N) was top dressed with urea at 6 WAS. Plots were hoe weeded at 3 and 6 WAS.

Grain yield were determined from 5.0 m of the four central rows of each plot. The efficiency of the intercrop relative to monocrop was assessed by using the land Equivalent Ratio (LER) which is the proportional land area that would be required as sole crops to produce the yield achieved in intercropping (Willey, 1979). Data were taken per plot on plant heights, maturity and grain yield. Data were subjected to analysis of variance procedure appropriate for a randomized complete block design. The treatment means were compared using least significant difference (LSD) at 5% level of probability when F-Values were significant (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

The effect of intercropping on sorghum and millet plant heights in 1997 and 1998 seasons are presented in Table 1. The results indicated that neither sorghum cultivar or crop proportion significantly influenced millet plant height in the mixture. For sorghum, the treatment effects on plant height were significant ($P<0.05$) in both years. Sorghum cultivar ICSV111 and NR71176 consistently produced the tallest and shortest plants respectively in both seasons. However, the difference between ICSV111 and NR71182 in 1998 was not significant (Table 1). Crop proportion 2:1 produced the tallest and the least heights in 1997 and 1998, respectively. The variation in plant height among the genotypes may be due to differences in genetic composition of the plant materials. It could also be attributed to differences in rainfall distribution between years. Similar findings were reported by Elemo and Chobe (1995) in a maize/sorghum mixture in northern guinea savanna.

There was significant variation among the genotypes on days to maturity (Table 1). Sorghum genotype ICSV111 consistently matured significantly earlier than the other genotypes in the mixture. Crop proportion had no significant effect on days to maturity except in 1998. The genotypes took significantly more days to mature at 1:2 crop proportion compared with either 1:1 or 2:1 crop proportions. The difference in days to maturity could be attributed to differences in genetic make-up of the materials as reported by Gworgwor (2001).

The effect of intercropping on sorghum and millet grain yields in 1997 and 1998 seasons are summarized in Table 2. The results, indicated significant ($P<0.05$) differences in the grain yields of both crops in 1997 and 1998 and when averaged over two years.

Millet yielded better in 1997 than in 1998. The highest grain yield of millet was recorded when intercropped with NR71176 in both year and when average over the two years (Table 2). Sorghum genotype ICSV111 consistently produced the highest mean grain yield in both years. Both grain yields of sorghum and millet increased significantly as their proportion in the mixture also increased. The reduction in the yield of millet in the mixture could be attributed to high rate of nutrient absorption. This supports similar observation made by Odo and Nanjwan (1999) and Bibinu and Odo (2005). It could also be due to difference in rainfall distribution between years.

The Land equivalent ratio (LER) computed indicated that intercropping caused yield reduction in both 1997 and 1998. The highest reduction for sorghum was in 1998 compared with 1997. However, the combined LER of millet and sorghum intercrop exceeded the monocrop performance in both seasons (Table 3). Similar advantage of more effective land utilization has been reported with maize/sorghum (Elemo and Chobe, 1995). Results from the comparison of the mixture yield of the component crops with sole crops showed that increasing millet proportion in the mixture resulted in an increased in the LER of millet while the LER of sorghum decreased with increase in its proportion in 1997 but not consistent in 1998. Crop proportions 2:1 and 1:2 (sorghum: millet) produced the highest yield advantage of 49 and 60 percent in 1997 and 1998 respectively, reflecting superiority of this mixture to sole cropping of either millet or sorghum.

In conclusion, result of the study have shown that grain yields of both sorghum and millet increased significantly as their proportion in the mixture also increased. Sorghum genotype ICSV III consistently produced the highest mean grain yield in the mixture. Crop proportions 2:1 and 1:2 produced the highest yield advantage of 49 and 60 percent in 1997 and 1998 respectively. Thus, if a farmer gives priority to sorghum, the choice of 2:1 crop proportion is recommended whereas the interest is on millet grain, 1:2 crop proportion is suggested.

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Table1. Plant Height and Maturity of Sorghum and Millet in Mixture as affected by Sorghum Cultivar and Crop Proportion at Maiduguri during the 1997 and 1998 Cropping seasons.

	Sorghum				Millet			
Treatment	Plant height(cm)		Maturity(days)		Plant height(cm)		Maturity(days)	
	1997	1998	1997	1998	1997	1998	1997	1998
Sorghum Cultivar								
ICSV111	214.89	187.78	99	102	264.56	217.22	100	102
NR71182	173.22	173.33	105	104	257.44	212.22	105	106
NR71176	158.67	158.89	105	106	263.00	211.11	104	104
ICSV400	171.78	163.89	105	105	259.58	207.78	107	107
SE±	1.46	5.60	0.58	0.58	5.04	5.65	0.70	0.71
LSD(0.05)	4.27	16.43	1.70	1.70	NS	NS	1.99	2.00
Crop Proportion								
1:1	175.85	170.83	104	104	259.58	210.83	104	105
2:1	189.83	167.50	103	104	260.75	214.58	104	105
1:2	171.75	174.58	103	106	260.08	210.83	104	104
SE±	1.26	4.85	0.50	0.50	4.39	4.60	0.60	0.60
LSD(0.05)	3.70	NS	NS	1.47	NS	NS	NS	NS

NS= Not significant

Table2. Grain Yield of Sorghum and Millet (Kg/ha) in Mixture as affected by Sorghum Cultivars and Crop Proportion at Maiduguri during the 1997 and 1998 Cropping seasons.

Treatment	Sorghum (Kg/ha)			Millet(Kg/ha)		
	1997	1998	Comb	1997	1998	Comb
Sorghum Cultivar						
ICSV111	2,361	1,720	2,041	2,370	1,416	1,893
NR71182	1,934	1,433	1,684	2,491	1,579	2,035
NR71176	1,490	1,800	1,645	2,861	2,367	2,614
ICSV400	651	1,520	1,088	2,259	2,103	2,431
SE±	20,760	30,030	18,098	37,779	48,332	30,122
LSD(0.05)	60,888	89,830	53,226	110,800	141,750	85,747
Crop Proportion						
1:1	1,590	1,459	1,525	2,003	1,487	1,745
2:1	1,741	1,754	1,747	856	708	7,82
1:2	1,497	1,653	1,575	2,807	2,404	2,604
SE±	17,979	20,527	16,193	32,717	41,857	76,089
LSD(0.05)	52,731	77,800	46,095	95,957	122,760	74,259
Interaction Cultivar×CP	105,460	155,600	92,151	191,910	245,520	148,570

Table 3. Yield and Land Equivalent Ratio (LER) of Sorghum and Millet in Crop Mixture relative to the Sole Crop at Maiduguri during 1997 and 1998 Cropping seasons.

1997						1998				
Partial LER	Total LER					Partial LER	Total LER	Treatment	Sorghum/Millet(Kg/ha)		Sorghum	Millet
Sorghum/ Millet(kg/ha)		Sorghum	Millet							
P1V1	2339	1482	0.74	0.42	1.16	1111	1791	0.44	0.55	1.01
P1V2	2197	889	0.72	0.25	0.97	1835	893	0.69	0.28	0.97
P1V3	2619	2500	0.75	0.71	1.46	2215	1765	0.70	0.51	1.21
P1V4	1622	1830	0.68	0.52	1.20	1284	1889	0.59	0.60	1.19
P2V1	1558	738	0.50	0.21	0.71	1753	577	0.70	0.18	0.88
P2V2	2627	2122	0.88	0.61	1.49	1262	2272	0.48	0.72	1.20
P2V3	1800	2075	0.51	0.59	1.10	1935	1567	0.63	0.50	1.11
P2V4	1398	782	0.54	0.22	0.76	1440	1069	0.67	0.34	1.01
P3V1	1271	2185	0.40	0.61	1.01	2049	2467	0.82	0.78	1.60
P3V2	603	2300	0.20	0.73	0.93	1507	1703	0.57	0.54	1.11
P3V3	904	1017	0.26	0.29	0.55	1587	495	0.50	0.16	0.66
P3V4	453	2260	0.19	0.65	0.84	1448	2111	0.67	0.67	1.34
Sole V1	3150		1.00		1.00	2500		1.00		
Sole V2	2967		1.00		1.00	2650		1.00		
Sole V3	3500		1.00		1.00	3150		1.00		
Sole v4	2400		1.00		1.00	2150		1.00		
Sole millet		3500		1.00	1.10					
LSD(0.05)	105.46	191.91				155.60		191.91	1.00	1.00

KEY: P1=1:1 Sorghum: Millet
P2=2:1 Sorghum: Millet
P3=1:2 Sorghum: Millet

V1= ICSV11 Sorghum cultivar
V2= NR71182 Sorghum cultivar
V3= NR71176 Sorghum cultivar