Agronomy

Participatory Evaluation of Sorghum Cultivars in Northern Nigeria

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Sorghum [*Sorghum bicolor* (L.) Moench] is the most widely grown and major staple crop in the Sudanian Savanna agro-ecological zone of Nigeria. Sorghum, traditionally a food crop, has also become a cash and industrial crop since 1986 when Nigeria banned the importation of wheat (*Triticum aestivum* L.) and barley (*Hordeum vulgare* L), and sorghum was identified as a substitute raw material for the brewing industry. The major constraints limiting sorghum production in Nigeria include the progressive decline in the amount of rainfall and its poor distribution, poor soil fertility, and incidence of parasitic weeds such as *Striga* (Yayock and Owonubi 1986; Andrews 1976).

The International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) in collaboration with the Institute for Agricultural Research (IAR), Zaria, Nigeria, had developed improved sorghum cultivars that are early-maturing, drought-tolerant, and high-yielding. These promising cultivars were evaluated in farmers' fields in northern Nigeria during 1996 in collaboration with IAR. The objectives of the study were to assess cultivar performance cultivar, their acceptability by farmers, and the costs of production .

The three cultivars tested were: ICSV 111, ICSV 400, and ICSV 247. They are all early-maturing (100-110 days to maturity), and can therefore escape terminal drought stress, a common occurrence in the region. The study was conducted in Jigawa, Kano, and Katsina states in northern Nigeria. Three villages were chosen in each state on the basis of rainfall gradient. Table 1 shows the biophysical characteristics of the nine study villages. There were 14 participating farmers in Jigawa, 19 in Kano, and 14 in Katsina. These farmers were selected based on their previous interaction with extension agents and on their willingness to collaborate in the work. Plot sizes were approximately 0.1 ha.

Table 2 shows the mean sorghum grain yields obtained in the nine selected villages. Overall, there was no significant difference among yields of varieties across the nine villages. In general, ICSV 111 performed better than the other varieties in each village of all the three states. On average, across the nine villages all three improved varieties all out-yielded the local varieties. All three improved varieties maintained stable yields across the three states. They performed better than the local varieties in the drier north. Rainfall was adequate and reasonably well-distributed in all three states and therefore did not constitute any major limiting factor to crop performance during 1996.

Labor constituted approximately 83% of the total production costs for each of the cultivars whereas inputs (seeds and fertilizer) represented only a small proportion

Table 1. Location and bio-physical details of nine villages in northern Nigeria selected for participatory evaluation of improved sorghum cultivars, 1996.

State	Village name	Agroecological zone	Coordinates		Soil type	Rainfall (mm)
			Latitude	Longitude		
Kano	Kofa	Southern Sudan	11° 34'	8° 17'	Loamy	898
	Panda	Southern Sudan	11° 31'	8° 04'	Loamy	875
	Badume	Northern Sudan	12° 12'	8° 19'	Sandy	704
Jigawa	Kantoga	Southern Sudan	11° 30'	9° 23'	Sandy loam	850
	Dalari	Northern Sudan	12° 36'	9° 48'	Sandy	639
	Gijigami	Northern Sudan	12° 34'	9° 25'	Sandy	673
Katsina	Gora	Southern Sudan	11° 55'	7° 43'	Loamy	1050
	Rimaye	Northern Sudan	12° 19'	7° 54'	Loamy	728
	Barhim	Northern Sudan	12° 58'	7° 41'	Sandy	734

Table 2. Mean grain yields (t ha^{-1}) of sorghum cultivars in nine villages in Kano, Jigawa, and Katsina states in northern Nigeria, 1996.

State/village	ICSV 400	ICSV 247	ICSV 111	Local
Kano				
Kofa	1.08	0.88	0.92	1.04
Panda	1.07	0.83	1.13	0.57
Badume	1.34	1.37	1.61	1.01
Jigawa				
Kantoga	1.02	0.96	0.97	1.01
Dalari	1.78	1.55	1.49	0.55
Gijigami	1.40	1.81	1.77	1.03
Katsina				
Gora	1.04	0.99	1.22	1.00
Rimaye	1.07	1.39	1.41	-[1]
Barhim	1.10	1.00	1.18	-
Mean	1.21	1.20	1.30	0.89
SE	± 0.252	± 0.343	± 0.288	± 0.224

1. = Data not available

Table 3. Costs and returns of producing improved and local sorghum cultivars in northern Nigeria, 1996.

Costs/returns	ICSV 400	ICSV 247	ICSV 111	Local
Output (t ha^{-1})	1.21	1.20	1.30	0.89
Gross revenue (₦ ha^{-1})	14544	14376	15600	10668
Labor cost (₦ ha^{-1})	7880	7840	7960	7540
Other costs (₦ ha^{-1})				
Seeds	300	300	300	180
Fertilizer	800	800	800	800
Depreciation	500	500	500	500
Total cost (₦ ha^{-1})	9480	9440	9560	9020
Net income (₦ ha^{-1})	5064	4936	6040	1648
Returns (₦ ha^{-1})	32.85	32.59	35.18	24.37
Yield required to cover costs (t ha^{-1})	0.79	0.79	0.80	0.75

1. US $1 = ₦80

of the total production costs (Table 3). The variety ICSV 111 had the highest gross revenue per ha (N15600) followed by ICSV 400 (N14544), ICSV 247 (N14376), and the local varieties (N10668). The positive returns per ha indicate that more labor could still be profitably used to produce these varieties. All the farmers obtained grain yields higher than the 0.75 t ha^{-1} required to recover the costs of production.They considered the early maturity of the improved varieties to be a very important and desirable characteristic. They believe that these varieties are drought-tolerant because they can escape terminal drought since they mature earlier than the local varieties.

Another outstanding characteristic pointed out by farmers was the case with which the improved varieties can be threshed by hand. The grain size and medium height (about 1.90 m) of the improved cultivars were acceptable to the farmers. The fodder of the improved cultivars was considered more succulent and palatable than that of the local variety. However, because of the semi-compactness of their panicles, the improved varieties were more susceptible to insect damage, mainly from head bug (*Eurystylus oldi* Poppius syn. *E. rufocunealis* Poppius syn. *E. immaculatus* Odhiambo syn. *E. maculatus* Odhiambo syn. *E. marginatus* Odhiambo), and bird attack.

Participating and non-participating farmers were excited about the performance of the improved sorghum cultivars. They exchanged seeds of the improved varieties among themselves to sow in the following season.

This participatory on-farm evaluation of sorghum cultivars, that was a part of a larger diagnostic study, facilitated the characterization of production systems and the selection of benchmark sites in the study area. New improved sorghum varieties were demonstrated to farmers who were enthusiastic to grow them.

References

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Biotechnology

Counting Stomata to Determine Regenerant Pioidy Levels in Haploid Sorghum Tissue Culture

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Counting chromosomes in root tips is the routine way to determine the ploidy level of plants regenerated from tissue culture. However, in many cases regenerated plants have poor root systems that significantly hamper the use of this method. Pioidy level is highly important for cultures of haploid origin, especially for anther culture, that could produce both haploid and diploid regenerants.

To solve this problem, we attempted to develop a simple, rapid, and inexpensive technique to determine pioidy levels by counting stomata under a microscope. It is well-known that in haploid plants stomatal size is significantly less than in diploids, and that in a microscope's visual field there are significantly fewer stomata in diploid leaves than in haploid leaves. To prove this, we studied the stomatal numbers in the leaves of regenerants from callus cultures obtained from the panicle of a haploid plant of sorghum [*Sorghum bicolor* (L.) Moench] cv. Milo-145.

The lower epidermis from the middle part of mature leaf laminae (with ligule) from regenerated plants was used. The mean number of stomata per seven microscope

Table 1. Stomata number per microscopic visual field in plants with different ploidy levels regenerated from sorghum callus cultures of haploid origin.

Ploidy level[2]	Stomata number[1]						
	3.1-4.0	4.1-5.0	5.1-6.0	6.1-7.0	7.1-8.0	8.1-9.0	9.1-10.0
	Number of regenerants						
n			1	3	3	6	3
2n	2	1	2				
4n	1						
Control plants[3]		D				H	
r_b[4]							0.681
P							0.01

1. Number of stomata per single microscope visual field (mean of 2 leaves and of 7 fields for each leaf)
2. Ploidy level determined by counting chromosomes in the roots 3-4 weeks later when they were transfered to soil
3. Donor haploid leaf (H) and leaf of the seedling of the autodiploid line (D) obtained in vivo from this haploid used as controls
4. Biserial coefficient of correlation, calculated for n and 2n plants, significance evaluated using Students' t-test (Zaitsev 1984)