Sorghum Variety Release in Malawi: the Case of Pirira 1 and Pirira 2

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Abstract

The major area of sorghum production in Malawi is the Lower Shire. Major constraints to production have been: lack of suitable cultivars, unsatisfactory cultivation practices, drought, and pest damage. Current sorghum breeding work has identified new varieties which are superior to those currently being grown. Two new varieties have been tested on-station between 1984/85 and 1992/93 cropping seasons in replicated trials in six environments, compared with other varieties and controls. Their performances have also been verified in 1992/93 in on-farm trials, compared with farmer varieties, at eight locations in two districts of Chikwawa and Nsanje in the Lower Shire. Results from these 14 environments provide usable data to confirm superiority of the two elite sorghum varieties tested. In the station environments, variety SPV 351 yielded 2.28 t ha^{-1} and SPV 475 2.44 t ha^{-1}, relative to five other test varieties ranging from 1.5 t ha^{-1} to 1.84 t ha^{-1}, and two controls with 1.41 t ha^{-1} (PN 3) and 1.85 t ha^{-1} (DC 75). In the on-farm locations they also yielded better at 2.03 t ha^{-1} and 2.60 t ha^{-1}, respectively, than the farmers' local landrace variety (LLV Thengalamanga: 1.99 t ha^{-1}). The two varieties also mature earlier (71 and 76 days to 50% flowering) than the control PN 3 (74 days) and other test entries (ranging from 80 to 87 days), and have better storage and grain characters.

Based on significant yield differences (62 and 73% higher grain yield) of the two sorghum varieties relative to PN 3 (in station trials) and (2 and 31% higher yield) relative to LLV Thengalamanga (in on-farm tests), the two varieties from ICRISAT, SPV 351 and SPV 475, were released in Malawi as Pirira 1 and Pirira 2.

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[redacted] Conference Paper no. CP 1005 . 6

Chintu, E.M., Chigwe, C.F.B., Obilana, A.B., Chirwa R.W., and Msiska, F.S. 1996. Sorghum Variety Release in Malawi: the Case of Pirira 1 and Pirira 2. Pages 19–25 in Drought-tolerant crops for southern Africa: proceedings of the SADC/ICRISAT Regional Sorghum and Pearl Millet Workshop, 25–29 Jul 1994, Gaborone, Botswana (Leuschner, K., and Manthe, C.S., eds.). Patancheru 502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics.

Introduction

Sorghum and pearl millet are important cereals in the Shire Valley (a semi-arid area in Malawi) where approximately 521 000 people live (Venema 1991). In this area, which is marginal for maize production, the two cereals form the main staple food.

Despite their importance as a staple food for 6.5% of the country's population, yields of sorghum and millet in the Shire Valley are limited by several factors such as lack of improved cultivars, unsatisfactory crop production practices, drought, pests, and diseases (Chintu 1985).

Average grain production at farm level is below 600 kg ha^{-1} compared with 2000 kg ha^{-1} at the research level. This yield difference can be attributed largely to the use by farmers of unimproved LLVs and poor agronomic practices. Production is also limited by poor and erratic distribution of rainfall. Crop loss due to pests (birds) and insects (stem borers and weevils) in the field and storage can be quite high.

In view of the above constraints, Chintu and Chigwe (1986) outlined the following strategy for improving sorghum and millet in Malawi:

- screening LLV and exotic breeding material, to develop new and adapted high-yielding varieties;
- improving cultivation practices for soil and water conservation and increased soil fertility;
- using the correct plant population, early sowing, and timely weed control; and
- studying the processing and storage techniques, and the food and other uses of the grain.

The objectives of this paper are to: report the agronomic performance of promising test sorghum varieties in multilocational and replicated trials, and describe the development, quality, and release of the two superior varieties.

Materials and Methods

Seven sorghum varieties were evaluated for grain yield performance, grain quality, pest resistance, and agronomic characters, together with two controls. These varieties were screened at several environments in the Lower Shire for on-station testing (six environments) and on-farm verification (eight locations). The six on-station environments are: 1: Ngabu 1984/85; 2: Kasinthula 1985/86; 3: Kasinthula 1986/87; 4: Ngabu 1990/91; 5: Kasinthula 1990/91; 6: Kasinthula 1992/93. The eight on-farm locations are: farmer fields F1 to F7 and Kasinthula field.

They were arranged in a randomized complete block design with four replications. A gross plot size of 4 rows × 5 m long × 0.75 m between rows was used. Data were collected from a net plot size of 2 rows × 4 m long × 0.75 m between rows. Nitrogen and phosphorus were applied before sowing at the rates of 40 and 17 kg ha^{-1} respectively, from urea and DAP fertilizers. Four seeds were sown per stand at 25 cm between plants. Seedlings were thinned to two plants per stand when about 15 cm high. Data were statistically analyzed using simple ANOVA.

For the purposes of end-use quality, the grains of test varieties, with SPV 351 and SPV 475 as controls, were evaluated using qualitative and quantitative methods for physical and chemical traits. All tests were based on representative samples of harvested and untreated grains from trials, then stored up to the time of analysis at 4°C. Grains were equilibrated to room temperature and humidity standardized to a moisture content of 10.5 ± 0.8% prior to all tests. Quality parameters screened for include: grain color, pericarp and testa presence, endosperm color, grain size, grain visual hardness, % milling yield, % dehulling loss, and tannin content.

Results and Discussion

Significant differences were observed (Table 1) between varieties for grain yield in all six environments. More than 2000 kg ha^{-1} grain yield was achieved in three (1, 2, and 6) out of six environments tested. The other three environments produced poor results due to bad weather.

SPV 346 produced the highest grain yield in environment 1. This yield was not significantly different from SPV 475 and SPV 351, which ranked second and third respectively. These varieties (SPV 351 and SPV 475) ranked first and second in environment 2 and vice versa in environments 4 and 5.

On average, the grain yields of SPV 351 and SPV 475 were 2284 kg ha^{-1} and 2443 kg ha^{-1} respectively, across the six environments. These were 62% and 73% above PN 3, and 24% and 32% above DC 75, respectively.

Table 1. Summary of grain yield (kg ha^{-1}) of sorghum varieties tested with SPV 351 and SPV 475 in six environments in Malawi.

Variety	Env. 1	Env. 2	Env. 3	Env. 4	Env. 5	Env. 6	Mean
SPV 351	2680	3433	1231	1882	1792	2884	2284
SPV 346	2860	2501	1463	-	521	-	1836
SPV 475	2690	2804	1298	2514	1937	2221	2443
SPV 472	2470	1985	713	-	-	-	1723
SPV 386	2120	1754	1212	-	-	-	1695
SPV 615	1800	2780	426	-	-	-	1669
SPV 245	2040	1961	500	-	-	-	1500
Control							
PN 3 (variety)	990	2355	898	-	-	-	1414
DC 75 (hybrid)	-	-	-	1013	917	3608	1846
Trial mean	2206	2447	967	1316	1112	2081	
	(n=8)	(n=8)	(n=8)	n=15	n=16	n=12	
LSD (*P* 0.05)	680	1014	595	579	718	1114	
CV (%)	20.9	28.1	35.0	58.7	45.3	37.2	

Table 2. Mean performance of SPV 351 and SPV 475 relative to other test entries in six locations in Malawi.

Variety	Grain yield (kg ha^{-1})	Days to 50% flower	No. of panicles plot^{-1}	Grain mass (g)	Threshing panicle (%)	Plant ht (cm)
SPV 351	2284	71	34	36	52	153
SPV 346	1836	80	33	44	56	162
SPV 475	2443	76	32	39	57	149
SPV 472	1723	82	25	29	49	191
SPV 386	1695	81	36	39	44	188
SPV 615	1689	87	10	47	43	155
SPV 245	1500	81	11	59	43	131
Control						
PN 3 (Variety)	1414	74	25	39	48	116
DC 75 (Hybrid)	1846	-	-	-	-	-
Trial mean	1836	79	26	42	49	158
LSD (*P* 0.05)		7	15	14	14	17
CV (%)		4.8	32.6	18.4	14.4	66.1

Table 2 shows the mean performance for five agronomic traits plus yield. Significant varietal differences were observed in all agronomic characters measured. The earliest varieties to reach 50% flowering in 71–76 days were SPV 351, PN 3, and SPV 475. These varieties were semidwarf, dwarf, and semidwarf, respectively, and 116–153 cm in plant height.

Although the grain weight per panicle of SPV 351, SPV 475, and SPV 346 was not large (36–44 g) compared with SPV 245 (59 g), these varieties had threshing values of more than 50%. The implication is that SPV 351 and SPV 475 have more grains per panicle.

With the exception of PN 3 all varieties tested scored more than 3 out of 5 for grain hardness, including SPV 351 at 3.4 and SPV 475 at 3.2 (Table 3). These grains are thus hard in comparison with the soft grain of PN 3 (scoring 2.5). These observations agree with the observed greater incidence of storage weevil in PN 3 (with an average of 0.26 weevils/panicle) compared with SPV 351 and SPV 475 (with 0.06 and 0.02 weevils/panicle) in the field (pers. comm. Thindwa). Incidentally, PN 3 is white with brown specks while SPV 351 and SPV 475 are creamy-white. The milling quality of the test materials (Table 3) are indicated by the three tests of milling yield, dehulling loss, and grain hardness (score 1: soft; 5: very hard).

The results of grain quality evaluation in Table 3 indicate that SDSL 89420, SPV 351, and SDSL 88298 had the least loss of 12.25%, 15.50%, and 15.75% respectively. The others, such as SPV 475 and two SADC/ICRISAT SMIP varieties, had 20% loss each, while PN 3 had the largest loss of 27%.

The dehulled grain is processed into white flour during milling. The flour is a measured proportion of grain. Varieties SDSL 89420 and SPV 351 produced the

Table 3. Grain quality evaluations of SPV 351 and SPV 475 with other advanced cultivars of sorghum in Malawi.

	Cultivars					
Traits	SPV 351	SPV 475	SDSL 87021	SDSL 89420	SDSL 88298	PN 3
Grain color	Creamy White	Creamy White	Creamy White	Creamy White	Red	White Brown Speck
Pericarp	Thin	Thin	Thin	Thin	Thin	-
Testa	No	No	No	No	No	-
Endosperm color	White Pearly	White Intermed.	White Pearly	White Pearly	White Pearly	-
Grain mass (g/100)	2.64	2.90	2.47	2.48	1.82	-
Visual hardness	3.4	3.2	4.6	4.4	3.4	2.5
% Milling yield	83.00	78.10	74.85	84.70	80.55	71.3
% Dehulling loss	15.50	20.48	22.00	12.25	15.75	26.9
Tannin content	L/N	L/N	L/N	L/N	M	-

highest amount of flour (85% and 83%, respectively) while SDSL 88298 and SPV 475 produced 81% and 78% compared to 71% of PN 3.

Grain weevils were collected from 100 panicles per variety, at hard dough stage. Only at Makoka and in variety control PN 3, did 47% of the panicles collected show signs of weevil attack (weeviling). At Kasinthula and Bvumbwe weeviling in PN 3 was 10% and 20% respectively compared with 1% and 4% in SPV 475 and 5% and 13% in SPV 351. On average, Thengalamanga, the LLV, showed no weeviling symptoms. Relatively, SPV 475 with 2% and SPV 351 with 6% could be moderately resistant. PN 3 was susceptible with a 26% weeviling count.

In addition to carrying out on-farm verification to create awareness and assess the acceptance of the improved varieties among growers, a survey was conducted to determine growers' preferences and choice. Results summarized by Smale (1993) showed that growers ranked SPV 351 first and SPV 475 second, based on grain yield. The two varieties were preferred because of their large grain size and early maturity. Smale reported that the few growers who consumed these varieties said that both varieties produced white flour and that threshing was easier and the flour extraction rate was higher in these, compared with the LLV (i.e., Thengalamanga).

On-farm results shown in Table 4 are from a research-managed and farmer-implemented trial. Complete data for all test entries were obtained only at Kasinthula

Table 4. Grain yield data (t ha^{-1}) of the new varieties in on-farm trials at seven farmer locations and at Kasinthula Station in the Lower Shire in 1992/93.

	Locations								
Varieties	F1	F2	F3	F4	F5	F6	F7	F8	Mean
SPV 351	0.40	1.40	1.79	3.8	5.80	0.78	4.10	2.58	2.60
SPV 475	0.50	1.45	1.54	4.4	-	1.01	3.93	1.40	2.03
Kuyuma	0.35	1.15	0.73	-	-	0.55	-	1.31	0.85
Thengalamanga	-	0.90	-	-	3.29	-	-	1.80	
Seredo	-	-	-	-	2.96	-	2.88	0.18	2.00

Station, where SPV 351 produced 2.58 t ha^{-1}. Good results were also achieved by farmer 7, where SPV 351 and SPV 475 produced 4.10 and 3.93 t ha^{-1} respectively. On average, the yield of SPV 351, SPV 475, and Seredo was above 2 t ha^{-1}. This was similar to research results.

Based on the above research and on-farm results, sorghum varieties SPV 351 and SPV 475 were released in the Lower Shire. The proposed names for these varieties are: Pirira 1 = SPV 351 and Pirira 2 = SPV 475.

Improved varieties of sorghum were selected from the ICRISAT collaborative trials, which were sown at Ngabu and a few other experimental sites in the Lower Shire between 1980 and 1984. Selection of these varieties, namely SPV 351, SPV 346, SPV 475, SPV 472, SPV 386, SPV 615, and SPV 245 was based on grain yield, grain quality, maturity, and agronomic plant aspect scores. After selection, testing of these varieties for grain yield and agronomic characters was done at Ngabu and Kasinthula in several environments, from 1984/85 to 1986/87.

It was shown that varieties SPV 346, SPV 475 and SPV 351 gave the highest grain yields. Although the largest variation in grain yield was observed in 1986/87, the same varieties listed gave the highest overall grain yields during the 3-year period of testing. During the 3rd year in 1986/87 SPV 351 outyielded PN 3 by over 70%.

Without putting much emphasis on 1986/87 data, the experiment was modified and repeated to confirm the above findings during the 1990/91 and 1992/93 seasons, respectively.

The combined Ngabu and Kasinthula results obtained in 1990/91 indicated that SPV 475 and SPV 351 were again top-yielding varieties. These results therefore confirm the previous findings of 1984/85 and 1985/86: that the two improved varieties are adapted and superior to PN 3 in all respects.

However, the best results were obtained in 1992/93 due to favorable weather. Significant varietal differences were observed on grain yield. Varieties such as DC 75, SPV 351, and Thengamalanga produced the highest grain yields at Kasinthula, while SPV 475 ranked 6th.

During the test periods of 1984/85 to 1986/87 and 1990/91 to 1992/93, average annual rainfall in the Shire Valley ranged from 393.9 mm in 1986/87 to 1108.4 mm in 1984/85 with variations between the 5-year period.

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