√The Potential of Local Landrace Varieties in Pearl Millet Improvement

E S Monyo[1], S A Ipinge[2], S Mndolwa[3], N Mangombe[4], and E Chintu[5]

Abstract

SADC/ICRISAT SMIP jointly evaluated with NARS the pearl millet germplasm from Tanzania and Zimbabwe in 1988/89, and from Namibia in 1991/92. The objectives were to identify some superior accessions that could be rapidly improved through grid mass selection or limited backcrossing and then release these back to the farming community for cultivation; and to select accessions that could be incorporated into the breeding program by crossing to create a diversified segregating population from which new improved varieties could be developed.

Much heterosis vigor was observed in crosses between local landrace variety (LLV) accessions with improved released varieties. Yield superiority of 6.8–46.6% over the released variety in Zimbabwe (PMV 2) was observed among intervarietal hybrids with LLVs from Zimbabwe. Heterosis values as high as 98.9% over superior parents and a yield superiority of up to 89.8% over the released variety in Tanzania (Serere 17) were observed within crosses involving Tanzanian LLVs. In backcross studies to improve Okashana 1, progenies similar to Okashana in grain size and time to maturity, but with up to 24% superiority in yield and other trait advantages, were identified in the third backcross generation.

This study suggests that considerable potential exists for improving yield and other traits preferred by farmers through greater utilization of LLVs in breeding programs.

1. Senior Scientist (Breeding), SADC/ICRISAT, PO Box 776, Bulawayo, Zimbabwe.
2. Agricultural Research Officer, Omahenene Research Station, PO Box 144, Oshakati, Namibia.
3. Agricultural Research Officer, Agricultural Research and Training Institute, Ilonga, Kilosa, Tanzania.
4. Plant Breeder, Crop Breeding Institute, Department of Research and Specialist Services, PO Box CY 550, Causeway, Harare, Zimbabwe.
5. Senior Resarch Officer, Kasinthula Research Station, PO Box 28, Chikwawa, Malawi.

ICRISAT Conference Paper no. 1070.

Monyo, E.S., Ipinge, S.A., Mndolwa, S., Mangombe, N., and Chintu, E. 1996. The potential of local landrace varieties in pearl millet improvement. Pages 153–162 *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

Pearl millet is the third most important cereal after maize and sorghum in terms of area under production in the SADC region. Tanzania, Zimbabwe, and Namibia are the largest producers and consumers of this crop, where it occupies roughly 12.1, 9.1, and 42.3% respectively of the total area under cereal production (FAO 1989).

The crop is grown on marginal lands with poor soils, which are often too infertile for other crops to survive. Annual rainfall in these localities is low (<600 mm) and very erratically distributed. To compound these problems, the farmers in these areas still grow their LLVs, which are locally adapted but have poor yield potential.

In collaboration with SADC/ICRISAT, NARS have released improved pearl millet varieties in Zambia, Zimbabwe, and Namibia. More varieties are at the on-farm verification stage and may soon be released in Malawi and Tanzania. The greatest advantage these new released varieties have over LLVs is early maturity, which assures family food security, especially in years of severe drought.

The yield potential of these varieties, though only slightly better than LLVs, can be significantly improved. LLVs from Tanzania, Zimbabwe, and Namibia in this study were used to diversify the genetic base of the breeding materials from which new varieties are to be developed. The main objective of the study was to exploit the heterotic vigor inherent in local germplasm, much of which has remained underutilized. Essentially, the equatorial photosensitive germplasm from Tanzania has remained isolated from the rest of the SADC region because of its daylength specificity (i.e., it requires short days to flower).

Materials and Methods

Germplasm collection missions were carried out by SADC/ICRISAT and the concerned NARS for Malawi (Appa Rao et al. 1986), Tanzania (Prasada Rao and Mengesha 1980), Zimbabwe (Appa Rao and Mengesha 1982; IBPGR 1987), and Namibia (Appa Rao et al. 1992). A total of 361 accessions were collected from Tanzania, 277 from Malawi, 961 from Zimbabwe, and 1000 from Namibia. Each of the germplasm collections was evaluated in its country of origin and at SADC/ICRISAT locations in Zimbabwe (except for the Tanzanian germplasm which was evaluated in Tanzania because of its particular daylength requirement).

Sowing and evaluation of the Tanzania germplasm

The 361 entries were arranged in a simple lattice design (19 × 19), replicated twice. The trial was sown at two locations in Tanzania: Ukiriguru Research Station (2°S 33°E) on 1 Feb 1989 (delayed from Dec 1988), and at Ilonga Research Station (7°S, 37°E) on 27 Feb 1989 (normal month). At both locations, seeds were sown 75 cm between rows and plants were thinned to 40 cm apart within the row, retaining only one plant per hill. Plot size was one row 5 m long. Thinning was done during the third week after emergence. The crop at Ukiriguru was harvested from the entire row on 20 Jun 1989. The Ilonga trial was harvested on 14 Jul 1989.

The germplasm was evaluated for maturity, yield, and agronomic desirability. Selection of materials for promotion into the breeding program was based mainly on a visual score because bird damage and ergot attack were very severe on some entries.

Sowing and evaluation of the Zimbabwe germplasm

The 961 entries were similarly arranged in a 31 × 31 simple lattice design replicated twice. Plot size was one row 4 m long. Sowing was done in a similar manner at two locations in Zimbabwe: Aisleby near Bulawayo (20°S, 26.5°E) and Makoholi near Masvingo (20°S, 31°E). The trials were sown on 29 Nov 1988 and 2 Dec 1988 respectively. Harvesting at Aisleby was done on 17 Apr 1989 and at Makoholi on 24 Apr 1989. The data were analyzed as a randomized complete block design because the MSTAT ANOVA lattice cannot handle a 31 × 31 lattice. As in Tanzania above, reliance was placed on visual scores in selecting breeding materials.

Collection and evaluation of the Namibian germplasm

During collection efforts were made to identify genotypes that could be used directly in breeding work to produce varieties in three or four seasons only. Forty-nine such accessions were identified. This special collection of 49 out of the total of 1000 was sown in our off-season nursery in Muzarabani during the winter of 1991, along with the others for multiplication, in order to obtain sufficient seed for evaluation of the entire germplasm. About 3000 individual plants were selected from the special collection, and crosses were made with 12 outstanding varieties from SADC/ICRISAT, resulting in 1208 individual crosses. The objective of the crosses was to create segregating populations that combined good characters from both sources. Adequate seed quantities of the entire germplasm were produced by hand-sibbing for evaluation at three locations: two in Namibia and one in Zimbabwe. The germplasm was split into three sets of 256 entries each, and all these sets were sown at each of the two locations in Namibia (Omahenene and Mashare) and one location in Zimbabwe (Muzarabani). Omahenene is located at 17°S 14°E, Mashare at 17.5°S 19°E, and Muzarabani at 16.5°S 31.5°E.

Sowing was done at the end of Dec 1990 at all three locations. There was adequate rainfall for germination and crop establishment was good at all locations. The rainy season ended in late January and the Muzarabani evaluation failed totally. Data collection and further selection were therefore possible only from the Namibia trials, which did not suffer as much drought as Zimbabwe.

Selection of LLVs for use in breeding

Several accessions from each LLV evaluated were selected according to plant type, time to maturity, and grain type and quality. Preference was given to plants that had strong stalks, resistance to lodging, and good tillering and yield abilities. Varieties with bold or large grains are known to be preferred and were therefore targeted for selection. White- and cream-colored accessions were similarly selected for their known good grain quality, including a hard corneous endosperm. Seventeen entries were selected from the Tanzanian germplasm, 18 from Zimbabwe, and 49 from Namibia. Each of these has been crossed with selected SADC/ICRISAT varieties, with two objectives:

1. To improve the designated LLV for particular traits using the improved variety as donor parent.
2. To create a range of diversified segregating populations from which new improved varieties can be developed.

Results and Discussion

Performance of intervarietal hybrids

In improving the LLV accessions from Zimbabwe and Tanzania we also examined their potential for creating intervarietal hybrids. Pearl millet has a great potential for intervarietal hybridization because of its protogynous nature. By carefully selecting the 'male' and 'female' parents that differ in time to flowering—such that there is always plenty of pollen when the female is at stigma stage—hybrids can be produced.

From the Zimbabwe germplasm some intervarietal hybrids were obtained which had yield superiority ranging from 6.8 to 46.6% over the improved released control variety PMV 2 (Table 1). The 1989/90 season was a normal season, and performance of varieties was indicative of their normal potential. PMV 2 gave a yield of 2.94 t ha^{-1}, whereas the highest-yielding intervarietal hybrid (a cross between IBMV 8502 and SDMV 87006) produced 4.31 t ha^{-1} grain. This clearly demonstrated the advantages and potential of intervarietal hybrids.

The highest-yielding intervarietal hybrid constituted from a cross between an improved variety (SDMV 89003) and a LLV (SDPM 626) produced 3.93 t ha^{-1} grain. This yield was 33.7% higher than the released variety PMV 2. There is some heterotic vigor inherent in crosses of such diverse backgrounds as LLVs and improved varieties introduced from outside the region. As can be seen in the last-mentioned cross, the heterosis value over the superior parent (SDPM 626) was 57.2%. Heterosis values ranging from 18 to 72% were observed between LLVs and improved varieties, and grain yield superiority over that of the PMV 2 control ranged from 6.8 to 33.7%. The highest heterosis value over the best parent recorded was 87.4%, with a yield superiority over PMV 2 of 46.6% (Table 1).

An almost similar situation was observed with regard to crosses between improved varieties and 17 of the best LLVs out of the germplasm from Tanzania. Heterosis values as high as 98.9% were recorded and yield superiority of 89.8% over the improved released variety Serere 17 was realized (Table 2). As stated above, one of the objectives in making these crosses was to improve the good LLV, as already identified, with a few desirable traits. The improved varieties used were therefore

Table 1. Performance data for pearl millet intervarietal hybrids utilizing local landrace varieties and improved varieties at Lucydale, Zimbabwe, 1989/90.

Entry	Time to 50% flowering (d)	Plant height (cm)	Panicle count ($6 m^{-2}$)	Panicle length (cm)	Threshing percentage	Heterosis over best (%)	Grain yield ($t ha^{-1}$)	Superiority over control (%)
Intervarietal hybrids								
IBMV 8502 × SDMV 87006	60	278	40	34	70	87.4	4.31	46.6
IBMV 8502 × ICMV 87901	53	245	44	30	76	60.4	4.25	44.5
IBMV 8501 × SDMV 89003	55	268	44	32	71	78.8	4.06	38.1
SDPM 626 × SDMV 89003	55	290	47	33	68	57.2	3.93	33.7
SDGP 1514 × WGC	56	284	75	37	70	47.4	3.73	26.9
SDPM 625 × WGC	58	279	44	36	66	58.8	3.70	25.8
SDPM 630 × SDMV 89003	56	263	54	30	60	72.5	3.57	21.4
SDMV 89005 × SDMV 87006	55	266	43	39	66	28.2	3.50	19.0
SDMV 89005 × SDMV 87018	53	242	52	29	70	26.0	3.44	17.0
SDGP 1514 × ICMV 87901	56	282	42	37	65	23.0	3.26	10.9
SDGP 1489 × ICMV 87901	54	230	41	33	72	18.5	3.14	6.8
Improved variety parents								
PMV 2 (control)	56	241	48	30	66	-	2.94	-
SDMV 89005	57	243	44	27	74	-	2.73	-
ICMV 87901	51	216	43	24	73	-	2.65	-
SDMV 87006	65	291	37	36	65	-	2.30	-
SDMV 89003	60	160	40	36	66	-	2.28	-
IBMV 8501	56	257	34	32	65	-	2.27	-
WGC	53	243	41	26	72	-	2.24	-
IBMV 8502	61	222	28	32	68	-	1.94	-
SDMV 87018	55	241	36	27	63	-	1.87	-
Local landrace variety parents								
SDGP 1514	69	240	28	29	64	-	2.53	-
SDPM 626	55	237	36	30	69	-	2.50	-
SDPM 625	58	279	35	36	66	-	2.33	-
SDPM 630	56	247	36	28	71	-	2.07	-
SDGP 1489	59	253	26	34	64	-	1.48	-
Mean (90)	55.74	259.80	41.20	33.16	67.84		3.00	
SE	±1.40	±12.84	±6.42	±2.92	±4.19		±0.42	
CV (%)	4.39	8.56	27.03	15.45	10.71		24.40	

Table 1. Performance data for pearl millet intervarietal hybrids utilizing local landrace varieties and improved varieties at Lucydale, Zimbabwe, 1989/90.

Entry	Time to 50% flowering (d)	Plant height (cm)	Panicle count ($6\ m^{-2}$)	Panicle length (cm)	Threshing percentage	Heterosis over best (%)	Grain yield ($t\ ha^{-1}$)	Superiority over control (%)
Intervarietal hybrids								
IBMV 8502 × SDMV 87006	60	278	40	34	70	87.4	4.31	46.6
IBMV 8502 × ICMV 87901	53	245	44	30	76	60.4	4.25	44.5
IBMV 8501 × SDMV 89003	55	268	44	32	71	78.8	4.06	38.1
SDPM 626 × SDMV 89003	55	290	47	33	68	57.2	3.93	33.7
SDGP 1514 × WGC	56	284	75	37	70	47.4	3.73	26.9
SDPM 625 × WGC	58	279	44	36	66	58.8	3.70	25.8
SDPM 630 × SDMV 89003	56	263	54	30	60	72.5	3.57	21.4
SDMV 89005 × SDMV 87006	55	266	43	39	66	28.2	3.50	19.0
SDMV 89005 × SDMV 87018	53	242	52	29	70	26.0	3.44	17.0
SDGP 1514 × ICMV 87901	56	282	42	37	65	23.0	3.26	10.9
SDGP 1489 × ICMV 87901	54	230	41	33	72	18.5	3.14	6.8
Improved variety parents								
PMV 2 (control)	56	241	48	30	66	-	2.94	-
SDMV 89005	57	243	44	27	74	-	2.73	-
ICMV 87901	51	216	43	24	73	-	2.65	-
SDMV 87006	65	291	37	36	65	-	2.30	-
SDMV 89003	60	160	40	36	66	-	2.28	-
IBMV 8501	56	257	34	32	65	-	2.27	-
WGC	53	243	41	26	72	-	2.24	-
IBMV 8502	61	222	28	32	68	-	1.94	-
SDMV 87018	55	241	36	27	63	-	1.87	-
Local landrace variety parents								
SDGP 1514	69	240	28	29	64	-	2.53	-
SDPM 626	55	237	36	30	69	-	2.50	-
SDPM 625	58	279	35	36	66	-	2.33	-
SDPM 630	56	247	36	28	71	-	2.07	-
SDGP 1489	59	253	26	34	64	-	1.48	-
Mean (90)	55.74	259.80	41.20	33.16	67.84		3.00	
SE	±1.40	±12.84	±6.42	±2.92	±4.19		±0.42	
CV (%)	4.39	8.56	27.03	15.45	10.71		24.40	

mainly selected on the basis of desired traits for this transfer. It is expected that not more than three backcrosses will be required to transfer these selected traits to the LLV (SADC/ICRISAT 1993; 1994).

In this manner we obtain most of the genes of the elite variety while retaining some of the qualities of local adaptation. However, if more of the traits of the LLV are required, then, after the required trait from the donor parent has been obtained, the LLV should be used as the pollen donor in the subsequent backcrossing, each time with selection for the required trait until it is fixed. The traits most sought for inclusion into LLVs are early maturity, tillering ability, grain size, and, sometimes, yield potential.

As can be seen from Table 2, the LLVs were very late, all requiring at least 70 days to reach 50% flowering, and some requiring as many as 102 days. This means that the LLVs require a growing season of between 110 and 130 days to reach maturity. As a result, when the rainy season ends early there is normally a massive crop failure. There is thus a need to reduce the time they take to mature.

Performance of LLV backcross progenies

By 1992/93 the first backcrosses made had already reached the third backcross generation and were evaluated across locations in Zimbabwe and compared with their parents and released variety controls Okashana 1, Kaufela, and PMV 2.

The obvious superiority of these backcross progenies over the improved variety parents was now obvious (Table 3). Yield improvements in comparison with the LLV in these locations ranged from 37.8 to 71.3%. Similarly, improvements over the released variety PMV 2 ranged from 4.4 to 24.3%. At the same time yields of particular improved varieties and the LLVs used in the study were very significantly improved.

From the example of the cross SDPM 626 (LLV) × SDMV 87006 (improved variety), which gave a yield of 5.07 t ha^{-1} averaged over locations, it is seen that this yield is 37.8% superior to that of SDPM 626 (3.68 t ha^{-1}), and 57.4% superior to that of SDMV 87006 (3.22 t ha^{-1}). Another example of a desired improvement is shown in the backcross involving SDGP 1514 and ICMV 88908 (Okashana 1). The resulting BC_3F_1 progenies look closely similar to Okashana 1, as intended. This backcross progeny retained the earliness of Okashana 1, flowering in 58 days vs 56 days for Okashana 1, and it has the same large bold grain in a slightly taller plant (169 vs 159 cm), better tillering ability (assessed by counting the number of harvestable panicles per 6 m^2), and a yield improvement over Okashana of 24%.

In the evaluation of F_4 progenies resulting from advancing some of the segregating backcross progenies at Lucydale during 1993/94, many of the progenies had yield superiority that more than doubled that of the farmers' LLV (Table 4).

Out of the top 20 entries from a nursery of 144, there was only one variety, SDMV 90016 (which ranked 14th and yielded 1.30 t ha^{-1} vs 1.99 t ha^{-1} from the progeny of the top-ranking backcross) that had a 24% grain yield superiority over control entry PMV 2. The only nonbackcross-derived entries in the top 20 were hybrids (Table 4). Yield superiority of the top 20 entries in this trial over PMV 2 ranged from 7.6 to 89.5%.

Table 2. Performance data for pearl millet intervarietal hybrids at Ukiriguru, Tanzania, 1989/90.

Entry	Time to 50% flowering (d)	Plant height (cm)	Panicle count ($6 m^{-2}$)	Panicle length (cm)	Threshing percentage	Heterosis over best (%)	Grain yield ($t ha^{-1}$)	Superiority over control (%)
Intervarietal hybrids								
SDGP 23 × SDMV 89003	70	190	27	16	52	28.1	2.05	89.8
SDGP 156 × SDMV 89005	73	199	26	15	50	17.8	1.92	77.8
SDGP 61 × SDMV 89003	70	178	20	20	56	76.6	1.89	75.0
SDGP 135 × ICMPES 28	77	182	25	21	51	48.4	1.87	73.1
SDGP 704 × SDMV 89005	81	185	25	25	52	13.9	1.80	66.7
SDGP 192 × SE 360	84	187	29	30	51	39.4	1.77	63.9
SDGP 13 × SDMV 89005	77	192	24	10	56	98.9	1.67	54.6
SDGP 199 × SE 360	77	194	31	31	44	13.3	1.53	41.7
SDGP 639 × ICMPES 28	71	185	23	20	54	34.6	1.44	33.3
SDGP 626 × SDMV 89005	74	192	24	24	50	49.1	1.61	49.1
SDGP 103 × SDMV 89003	82	188	32	10	56	15.9	1.60	48.1
Local landrace variety parents								
SDGP 156	76	201	32	30	54	-	1.63	50.9
SDGP 23	83	199	28	30	50	-	1.60	48.1
SDGP 704	83	187	25	25	58	-	1.58	46.3
SDGP 103	77	189	35	30	51	-	1.38	27.8
SDGP 199	71	217	24	25	53	-	1.35	25.0
SDGP 192	102	196	30	35	45	-	1.27	17.6
SDGP 135	102	221	23	25	38	-	1.26	16.7
Serere 17 (control)	63	141	18	28	45	-	1.08	-
SDGP 626	97	197	25	39	47	-	1.08	0.0
SDGP 639	83	198	27	35	43	-	1.07	−0.9
SDGP 61	71	183	23	30	47	-	1.07	−0.9
SDGP 13	79	202	26	35	36	-	0.84	−22.2
Mean (90)	78.29	191.32	26.02	22.53	47.08		1.32	
SE	±6.09	±11.95	±3.10	±4.72	±4.89		±0.25	
CV (%)	10.99	8.83	11.66	29.65	14.67		26.42	

Table 3. Performance data of pearl millet local landrace varieties (LLVs) improved by limited backcrossing vs their parents across two locations in Zimbabwe, 1992/93.

Entry	Time to 50% flowering (d)	Plant height (cm)	Panicle count (6 m^{-2})	Grain yield (t ha^{-1})			Improvement (%)	
				Makoholi	Lucydale	Mean	LLV	PMV 2
Improved LLVs (BC$_3$F$_1$ selections)								
(SDPM 626 × SDMV 87006)-13	71	218	103	7.39	2.74	5.07	71.3	24.3
(SDGP 1704 × SDMV 89003)-6	67	208	130	7.15	2.82	4.98	68.2	22.1
(SDGP 1514 × SDMV 87006)-14	71	244	146	6.63	2.43	4.53	53.0	11.0
(SDGP 1514 × SDMV 89003)-5	68	193	116	6.39	2.63	4.51	52.4	10.5
(SDPM 626 × SDMV 89003)-1	74	220	108	5.84	3.07	4.45	50.3	9.1
(SDPM 625 × WGC)-3	66	202	109	5.83	3.04	4.44	50.0	8.8
(SDGP 1514 × ICMV 88908)-7	58	169	120	5.11	3.62	4.37	47.6	7.1
(SDPM 626 × WGC)-9	60	175	118	5.49	3.03	4.26	43.9	4.4
(SDPM 626 × ICMV 88908)-8	58	165	111	4.40	3.21	3.81	28.7	-
(SDGP 1489 × SDMV 89003)-10	66	207	112	5.23	2.34	3.78	27.7	-
(SDPM 630 × SDMV 89003)-4	65	179	138	4.68	2.58	3.63	22.6	-
(SDPM 625 × SDMV 89003)-15	71	201	89	4.35	2.85	3.60	21.6	-
LLV parents								
SDGP 1514	80	218	93	5.44	2.36	3.90	-	-
SDPM 626	66	210	120	4.82	2.55	3.68	-	-
SDGP 1704	70	193	80	4.23	2.88	3.56	-	-
SDPM 625	76	215	86	4.50	2.26	3.38	-	-
SDGP 1489	68	200	97	4.44	2.25	3.34	-	-
SDPM 630	65	197	134	3.87	2.72	3.30	-	-
Farmers' LLV (control)	69	175	94	4.10	1.82	2.96	-	-
Improved nonrecurrent parents								
PMV 2 (control)	59	182	96	4.92	3.24	4.08	37.8	-
ICMV 88908 (Okashana 1)	56	159	92	4.39	2.65	3.52	-	-
SDMV 89003	64	148	94	4.42	2.20	3.31	-	-
SDMV 87006	78	234	71	4.23	2.20	3.22	-	-
Mean (36)	66.30	193.89	108.91	5.13	2.75	3.94		
SE				±0.586	±0.296			
CV (%)				19.78	18.65			

Table 4. Performance data of the top 20 backcross F_4 progenies derived from local landrace variety (LLV) germplasm, hybrids, and improved varieties at Lucydale, Zimbabwe, 1993/94.

Entry	Time to 50% flowering (d)	Plant height (cm)	Panicle count (6m^{-2})	Threshing percentage	Grain yield (t ha^{-1})	Improvement (%)	
						LLV	PMV 2
Backcross derivatives							
(IBMV 8502 × ICMV 87901)-BC_4F_1-1	52	156	83	63	1.99	298	89.5
(SDMV 89005 × SDGP 1207)-1-2-BC_1F_4-22	63	196	63	59	1.70	240	61.9
(SDGP 1514 × SDMV 89003)-1-2-BC_2F_4-46	63	150	66	71	1.55	210	47.6
(SDGP 1311 × ICMV 87901)-5-4-BC_1F_4-34	58	150	73	53	1.47	194	40.0
(ICMV 88908 × SDGP 1560)-1-2-BC_1F_4-9	64	184	66	52	1.47	194	40.0
(SDMV 89004 × SDGP 1298)-8-4-BC_1F_4-25	65	160	59	57	1.33	166	26.7
(SDPM 2264 × SDGP 1751)-2-1-BC_1F_4-7	68	153	78	57	1.31	162	24.8
(SDGP 1514 × WGC-C1)-1-1-BC_2F_4-35	64	170	67	55	1.31	162	24.8
(SDMV 89005 × SDGP 1289)-4-1-BC_1F_4-13	74	143	46	55	1.30	160	23.8
(SDGP 1514 × SDMV 87006)-2-2-BC_2F_4-2	71	152	59	49	1.24	148	18.1
(SDGP 1514 × SDMV 87018)-2-1-BC_2F_4-28	66	180	67	48	1.19	138	13.3
(IBMV 8502 × WGC-C1)-1-1-BC_2F_4-61	64	192	62	51	1.16	132	10.5
(SDMV 89003 × SDGP 1688)-1-3-BC_1F_4-5	65	146	73	51	1.15	130	9.5
(SDGP 1311 × ICMV 87901)-5-1-BC_2F_4-32	59	147	75	47	1.14	128	8.6
(SDGP 1311 × SDMV 87006)-1-1-BC_2F_4-40	64	154	46	69	1.13	126	7.6
Hybrids, improved varieties and LLV control							
SDMH 92018 (hybrid)	56	153	80	65	1.86	272	77.1
SDMH 92020 (hybrid)	49	167	73	67	1.79	258	70.5
SDMH 92012 (hybrid)	59	154	63	58	1.50	200	42.9
ICMH 88088 (hybrid)	60	144	81	57	1.44	188	37.1
SDMV 90016 (improved variety)	60	158	67	56	1.30	160	23.8
Okashana 1 (released variety)	57	158	59	56	1.13	-	-
PMV 2 (released variety)	57	170	60	41	1.05	-	-
Kaufela (released variety)	62	165	69	44	1.04	-	-
LLV (control)	76	181	35	42	0.50	-	-
Mean (144)	66.9	161.2	57.7	47.7	0.91		
SE	±1.55	±7.61	±9.19	±6.23	±0.19		
CV (%)	4.02	8.18	27.57	22.61	36.37		

Conclusion

This study suggests that considerable potential exists for improving yields through using LLVs available in the region. Some of the gains reported probably arise from the fact that most improved and available varieties are derived from crosses between introduced materials. There is noticeable unrelatedness between these improved varieties and the LLVs which is manifested in the heterosis observed. This is to be expected, because much of the germplasm within the SADC region was collected less than 10 years ago and has therefore not been fully utilized in regional breeding programs. These materials thus represent a valuable source of variability for the future improvement of varieties for use by farmers in the region.

References

Appa Rao, S., and Mengesha, M.H. 1982. Germplasm collection in Zimbabwe. Genetic Resources Unit Progress Report 41. Patancheru 502 324, Andhra Pradesh, India: International Crops Research Institute for the Semi-Arid Tropics. (Semiformal publication.)

Appa Rao, S., Mengesha, M.H., Siball, P.K., and Rajagopal, R. 1986. Collection and evaluation of pearl millet (*Pennisetum*) germplasm from Malawi. Economic Botany 40:27-37.

Appa Rao, S., Monyo, E..S., House, L.R., Mengesha, M.H., and Negumbo, E. 1992. Collecting germplasm in Namibia. FAO/IBPGR Plant Genetic Resources Newsletter 90:42-45.

FAO. 1989. Production yearbook 1988. Rome, Italy: Food and Agriculture Organization.

IBPGR. 1987. A catalogue of passport and characterization data of sorghum, pearl millet, and finger millet germplasm from Zimbabwe. Rome, Italy: International Board for Plant Genetic Resources (now IPGRI).

Prasada Rao, K.E., and Mengesha, M.H. 1980. Sorghum and millet in Tanzania. Plant Genetic Resources Newsletter 42:21-23.

SADC/ICRISAT Southern Africa Programs. 1993. Annual Report 1992. PO Box 776, Bulawayo, Zimbabwe. SADC/ICRISAT Sorghum and Millet Improvement Program. (Semiformal publication.)

SADC/ICRISAT Southern and Eastern Africa Regional Program. 1994. Annual report 1993. PO Box 776, Bulawayo, Zimbabwe: SADC/ICRISAT Sorghum and Millet Improvement Program.