

RELEASE OF TWO NEW GRAIN SORGHUM HYBRIDS FOR EGYPT

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Abstract

Fifty five grain sorghum yield trials at seven locations during 1992 through 1995 were used to evaluate the performance of two grain sorghum hybrids developed by the Grain sorghum Section, FCRI, ARC relative to the Commercial dual purpose short cultivar Dorado.

The two new hybrids Shandaweel-1 and Shandaweel-2 consistently proved their superiority and wide adaptability for Egyptian conditions, showing 4.19-6.12 ardab (587 to 857 kg) grain yield per feddan increase over Dorado in on station trials and 1.11 - 2.26 aradab (155 to 316 kg) in on farm trials. The two hybrids were released for cultivation.

INTRODUCTION

In Egypt, grain sorghum (*Sorghum bicolor* (L.) Moench) ranks third in importance as a summer cereal crop after maize and rice. The cultivated area is about 335 thousand feddans producing 705 thousand tons of grains with an average yield of 2.1 tons/feddan (Agric. Economy year Book 1995). Sorghum is grown in Upper Egypt from Giza to Aswan, but most of the area is concentrated in Assiut and Sohag Governorates. Local demands for cereals, including grain sorghum is progressively increasing due to population growth and total production is not sufficient to meet the required demands. As a result, the National Sorghum Program has been geared towards two major objectives: 1) Developing high yielding varieties and hybrids, and Working out a comprehensive package of agronomic practices based on an inter-disciplinary approach to adequately exploit the genetic potential of the developed varieties and hybrids.

Conventional hybridization among local and exotic and exotic germplasms

followed by selection in the segregating generations has been the standard method for improving and developing grain sorghum varieties in Egypt. Giza 15, Giza 114, Giza 3, local 29, local 129 etc. were among the line varieties which were developed through this conventional method. The discovery of cytoplasmic male-sterility in sorghum by Stephens and Holland in 1954 (Doggett, 1969) made possible the commercial utilization of hybrid vigour. By 1960, 95% of the U.S. sorghum acreage was cultivated with hybrids. Later on, hybrids became dominant in most sorghum growing countries. Yield increases shown by hybrids relative to line varieties were constant over a wide range of growing conditions and management levels. Sorghum hybrids can yield more than double that of the varieties (Doggett, 1969).

The advantage of sorghum hybrids over varieties was recognized in tropical countries such as India with the release of the first commercial hybrid (CSH-1) (Rao, 1982). The All India Coordinated Sorghum Improvement Project analyzed the performance stability of varieties and hybrids and confirmed the superior and stable performance of hybrids (Murty *et al.*, 1994).

In Egypt, interest in hybrid sorghum only began in the 1980 (El-Attar, 1983) when cytoplasmic male sterile lines were introduced from the U.S.A. Some high yielding hybrids utilizing local restorer lines were produced, but tended to be as tall as their male parents. Beginning 1990, sorghum hybrids development program was started through the cooperation with the international organizations such as the International Sorghum and Millet Collaborative Research Support Program (INTSORMIL) and the International Crop Research Institute for the Semi-Arid Tropics (ICRISAT). The development of hybrids in Egypt is still dependent on exotic cytoplasmic malesterile and restorer lines from U.S.A. and ICRISAT. Such lines have to be evaluated for adaptation and agronomic performance before testing their combining ability and heterotic response. Based on tests of the general and specific combining abilities, good combiner lines which can contribute to hybrid vigour are identified.

The release of a hybrid or a variety depends on its performance and yielding ability in multilocation and replicated yield evaluation trials. Doggett (1970) pointed out that use of two replicates at several sites is more effective than several replications at a single site. Rao (1972) stated that genetic superiority over a large number of locations even during a single year could enable earlier release of new hybrids or varieties resulting in saving time and effort. Kambal and Mahmoud (1978) suggested that the years of testing could be reduced by increasing the number of test

locations. Heinrich et al (1983) showed that all hybrids had comparable yield potential in good environments, but the stable hybrids were higher yielding in poor environments.

The national target is to increase sorghum production by increasing yield per unit area and expanding the sorghum acreage planted with high yielding hybrids. To achieve the projected yield maximization, a continuous strong and effective breeding program is essential. Ongoing efforts must be focused on selecting materials for the hybrid program to develop high yielding grain sorghum hybrids.

The study reported here resulted in the release of the first two high yielding Egyptian sorghum hybrids, Shandaweel-1 and Shandaweel-2.

MATERIALS AND METHODS

Several introduced cytoplasmic male sterile lines (CMS), their maintainers and fertility restorer lines of grain sorghum were grown at the crossing block at Giza Agriculture Research station in 1991 season. Several grain sorghum hybrids have been developed between the cytoplasmic male-sterile lines and the restorer lines since that date. These hybrids have been evaluated through several evaluation yield trials, starting from preliminary field observation and then the promising ones are tested in three levels of the on-station yield evaluation trials (A, B and C levels). The outstanding hybrids which pass the three levels of the on-station trials are tested in D-level at farmers' fields. The two hybrids viz Shandaweel-1 and Shandaweel-2 were among the developed and evaluated hybrids. The origin, source and characteristics of the parental lines of these two hybrids are presented in Table 1.

Table 1. Origin, source and characteristics of the parental lines.

No.	Line	Source	Days to 50% flowering	Plant height (cm)	Panic- le shape	Glume colour	Plant height (cm)	1000 grain weight (gm)
1	A-line 1	ICRISAT1	67	120	Symmetric	yellow	white	35.30
2	A-line 2	ICRISAT1	70	130	Symmetric	orange	white	25.30
3	R-line 1	IASIP2	72	150	Symmetric	yellow	white	28.30

1- International Crop Research Institute for the Semi-Arid Tropics.

2- Latin American Sorghum Improvement program.

The two hybrids were first tested in B-level at 3,2,3 and 3 research stations

in 1992, 1993, 1994 and 1995, respectively. Also it was tested in C-level trials in 1993 and 1995 and 1995 at 3 research stations, and in D-level (on farmers' fields) at 7, 6 and 9 locations through 1993, 1994 and 1995, respectively. These two hybrids were used as two check hybrids for A-level evaluation trials in 1994 and 1995 (Table 2) along with the common check variety Dorado. The on station trials which include A, B and C level are conducted in the three main stations viz., Shandaweel (Sohag) Kom-Oshim (Fayoum) and Nubaria Agriculture Research Stations. As testing proceeded from A to B to C, the number of tested entries was reduced, while plot size and number of trials were increased to insure productivity level of the most promising hybrids and obtaining accurate results.

Table 2. Yield evaluation trial levels number of trials (Locations) and number of tested entries during the years 1992 to 1995 growing seasons.

Evaluation level	1992		1993		1994		1995	
	No. of trials (locations)	No. of Entries	No. of trials (locations)	No. of Entries	No. of trials (locations)	No. of Entries	No. of trials (locations)	No. of Entries
A1 trial					3	28	3	16
A2 trial							1	21
A4 trial							3	34
A5 trial							1	58
B1 trial	3	14	2	20	3	14	3	11
B2 trial							2	10
B3 trial							3	22
C1 trial			3	12			3	10
C2 trial							3	8
On farm			7	6	6	6	9	7

The plot size was 1-2 rows in A-level, 4 rows in B-level and 6-8 rows in C-level trials. Each row is 6 meter long and 70cm wide. In all trials planting was done in hills spaced 20 cm within rows. Thinning to two plants per hill was done three weeks after planting. The D-level trials were conducted on farmers fields at several sites in each sorghum growing governorate. The number of tested entries in D-level were reduced and ranged from 6 to 8 entries, using large sized plots (10-12 rows) replicated six times. After the D-test, demonstration plots (1/2 Faddan for each

hybrid) were planted and 3 random samples of 3x3.5 m per plot were taken for yield estimation. All cultural practices were done as recommended and plant protection operations were done as needed in the one station trials, while farmers' practices were used in the D-level in farmers fields. In all trial levels, the randomized complete block design was used (Steel and Torrie, 1960). Grain yield (ardab/feddan) was estimated on plot-basis and percentage of hybrid yield over the Dorado check variety was calculated.

RESULTS AND DISCUSSION

Grain yield of a variety is the end product of many yield contributing factors. The most important factors are those related to genetical constitution which characterize the main features of the variety such as plant height, days to blooming, head length, head width and compactness, kernel size, number of kernels/head, kernel color, glume color, disease and insect reaction and adaptability to environmental fluctuation. All of these genetically controlled traits are related to grain yield, the end product which is a quantitative character. Therefore data reported here is based on grain yield, however, other features of the two hybrids were recorded and considered in the release of these two hybrids.

Grain yield (ard./fed.) for the two new hybrids Shandaweel-1 and Shandaweel-2 and the common check variety Dorado (the commercial short dual purpose variety) are presented in table 3 and 4. The performance of Shand. 1 and Shand. 2 averaged over locations and years for the (A) level evaluation trials (Table 3) showed that the two hybrids yielded 129 and 133% of the check, respectively. The data also revealed that grain yield for the hybrids was higher at Shandaweel followed by Nubaria than at Fayoum which had the lowest yield when averaged over years. Also the hybrid Shand. 2 performed better than Shand. 1 at Shandaweel and Fayoum while it was lower yielding at Nubaria.

For the (B) level evaluation trials the two hybrids surpassed the check variety Dorado by 41% for Shand. 1 and 35% for Shand. 2 when averaged over years and locations without much difference between grain yield of the two hybrids. The data also indicated that grain yield of the hybrids was higher at Nubaria and Shandaweel while it was lower at Fayoum location when averaged over years. For the (C) level yield evaluation trials the average performance was 22.06, 19.65 and 17.25 ard./fed. for Shand. 1, Shand.2 and Dorado respectively, with a percentage increase of 28 and 14% over Dorado when average over locations and years. The average per-

formance over years for the (C) level trials showed that the hybrids performed better at Shandaweel and Nubaria rather than Fayoum location.

The average performance of the on station yield evaluation trials averaged over years and locations (Table 3) showed that grain yield (ard./fed) were 20.92, 19.99 and 15.80 for Shand.1, Shand.2 and Dorado, respectively with a percentage increase of 32 and 27% over Dorado for the two hybrids. Also the data indicated that the performance of the hybrids were higher at Shandaweel and Nubaria rather than at Fayoum when average over years and the two hybrids performed almost the same at each location.

The average performance of the two hybrids in comparison with the check variety Dorado for the D-level (on farm) yield evaluation trials average over locations and years (Table 4) showed that grain yield was 14.80, 15.95 and 13.69 (ard./fed.) for Shand.1, Shand.2 and Dorado with an increase of 8 and 17% for the two hybrids over Dorado. The performance of the hybrids at locations when average over years showed that the hybrids had higher grain yield in the following order; Assiut, Sohag, Qena, Fayoum and Aswan. Also we could notice that Shand.2 showed better performance than Shand.1 when combined over locations. It can be noticed that average grain yield of Shand. 1 (20.9) and Shand.2 (20.0) in on-station evaluation trials was much higher than their yield in on-farm trials (14.8 and 15.9 for the two hybrids, respectively). This indicates that agronomic practices carried out in farmers' fields were not properly done to show yield potentiality of the two hybrids. In other words, it seems that farmers are still not acquainted with cultural practices for the new hybrids.

Table 5 shows the agronomic characters of the two new grain sorghum hybrids, Shand.1 and Shand.2 in comparison with the check variety Dorado.

The two hybrids Shand.1 and Shand.2 are dual purpose hybrids because the stalks and leaves stay green and juicy at maturity and the whole plant could be used for livestock feeding after grain harvesting. The two hybrids were released for commercial utilization by the Ministerial decree no. 964 in 1996 based on the results reported here.

Table 3. Yield performance (ardab/feddan) of Shandaweel 1 and Shandaweel 2 and as percentage of Dorado in On-station yield evaluation trials during 1992-1995 seasons.

Season	No. of trials	Variety	Location						Average	
			Shandaweel		Fayoum		Nubaria			
			M	%	M	%	M	%	M	%
A-yield evaluation trials										
1994	3	Shand-1	25.97	145	9.32	144	24.29	174	19.86	157
		Shand-2	25.76	144	11.69	180	18.93	139	18.79	148
		Dorado	17.89	100	6.48	100	13.63	100	12.67	100
1995	8	Shand-1	21.00	112	15.65	111	22.40	107	19.68	112
		Shand-2	25.10	134	16.63	118	23.44	112	21.68	129
		Dorado	18.71	100	14.08	100	20.89	100	17.89	100
Average of A trials over years	11	Shand-1	23.49	128	12.49	121	23.35	135	19.77	129
		Shand-2	25.43	139	14.16	138	21.19	123	20.26	133
		Dorado	18.30	100	10.28	100	17.26	100	15.28	100
B- yield Evaluation trials										
1992	3	Shand-1	27.87	145	17.48	147	25.24	125	23.53	137
		Shand-2	25.83	134	18.64	157	20.00	99	21.49	126
		Dorado	19.23	100	11.90	100	20.00	100	17.12	100
		L.S.D 0.05	1.99	--	2.05	--	20.22	--	1.09	--
1993	3	Shand-1	--	--	--	--	--	--	--	--
		Shand-2	15.05	99	12.97	265	--	--	24.01	139
		Dorado	15.23	100	4.90	100	--	--	10.07	100
		L.S.D 0.05	5.17	--	3.99	--	--	--	4.71	--
1994	3	Shand-1	24.59	137	14.74	227	22.86	168	20.73	164
		Shand-2	25.26	141	12.78	197	25.58	195	21.54	170
		Dorado	17.89	100	6.48	100	13.63	100	12.67	100
		L.S.D 0.05	7.21	--	2.84	--	3.83	--	4.89	--
1995	3-B1	Shand-1	13.71	98	16.74	130	21.76	109	17.40	111
		Shand-2	16.88	121	17.68	137	22.31	112	18.96	121
		Dorado	13.95	100	12.88	100	19.97	100	15.61	100
		L.S.D 0.05	3.80	--	1.65	--	2.54	--	1.59	--
	3-B2	Shand-1	14.85	78	--	--	22.75	104	18.80	92
		Shand-2	22.06	116	--	--	24.00	110	23.03	113
		Dorado	18.97	100	--	--	21.78	100	20.37	100
		L.S.D 0.05	2.46	--	--	--	1.93	--	1.53	--

Table 3. Cont.

Season	No. of trials	Variety	Location						Average	
			Shandaweel		Fayoum		Nubaria		M	%
			M	%	M	%	M	%		
1995	3-B3	Shand-1	20.49	129	16.80	112	22.57	111	19.95	117
		Shand-2	--	--	--	--	--	--	--	--
		Dorado	15.86	100	15.02	100	20.28	100	17.05	100
		L.S.D 0.05	2.93	--	2.28	--	1.82	--	1.36	--
Average of A trials over years	16	Shand-1	22.94	134	16.33	175	23.49	129	20.92	141
		Shand-2	21.40	125	15.52	167	23.25	128	20.06	135
		Dorado	17.15	100	9.31	100	18.18	100	14.88	100
C- yield evaluated trials										
1993	2	Shand-1	29.30	166	21.31	159	--	--	25.31	163
		Shand-2	24.85	141	9.52	71	--	--	17.19	111
		Dorado	17.65	100	13.42	100	--	--	15.54	100
		L.S.D 0.05	2.36	--	3.99	--	--	--	5.25	--
1995	3-C1	Shand-1	21.69	127	14.62	102	23.59	113	19.97	115
		Shand-2	20.10	118	16.25	113	23.96	115	20.10	115
		Dorado	17.07	100	14.39	100	20.87	100	17.44	100
		L.S.D 0.05	1.28	--	1.38	--	1.45	--	0.77	--
	3-C2	Shand-1	20.14	114	15.80	121	22.00	108	19.31	113
		Shand-2	21.52	122	15.83	121	22.69	111	20.01	117
		Dorado	17.64	100	13.03	100	20.46	100	17.04	100
		L.S.D 0.05	1.95	--	0.89	--	0.59	--	0.71	--
Average of C-trials over year	8	Shand-1	25.11	143	18.26	135	22.80	110	22.06	128
		Shand-2	22.83	130	12.78	94	23.33	113	19.65	114
		Dorado	17.51	100	13.57	100	20.67	100	17.25	100
Average on - Station trials		Shand-1	23.85	135	15.69	142	23.21	124	20.92	132
		Shand-2	23.22	132	14.15	128	22.59	121	19.92	127
		Dorado	17.65	100	11.05	100	18.70	100	15.80	100

M = Mean

Shand-1 = Shandaweel-1

Shand-2 = Shandaweel-1

Table 4. Yield performance (Ard./fed.) of Shandaweel-1, Shandaweel-2 and in percentage of Dorado for D level (on farm) yield trials during 1993-1995 season.

Season	Type of trial	Variety	Location												Average					
			Fayoum			Assiut			Sohag			Qena					Aswan			
			M		%	M		%	M		%	M		%	M		%	M		%
1993	D1 trial	Shand-1	12.79	95	19.68	131	20.27	115	17.41	127	12.97	132	20.78	119						
		Shand-2	16.14	120	19.78	131	19.50	110	15.87	116	12.16	127	20.86	120						
		Dorado	13.42	100	15.05	100	17.69	100	13.69	100	9.80	100	17.41	100						
		L.S.D 0.05	3.54	--	3.72	--	3.90	--	3.18	--	N.S.	--	1.36	--						
	D2 trial	Shand-1	--	--	15.87	105	17.69	101	--	--	--	--	16.78	103						
		Shand-2	--	--	15.51	103	19.59	111	--	--	--	--	17.55	107						
		Dorado	--	--	15.05	100	17.90	100	--	--	--	--	16.33	100						
		L.S.D 0.05	--	--	1.04	--	2.45	--	--	--	--	--	0.63	--						
1994	D1 trial	Shand-1	--	--	18.35	131	--	--	--	--	--	--	18.35	131						
		Shand-2	--	--	19.00	136	--	--	--	--	--	--	19.00	136						
		Dorado	--	--	14.01	100	--	--	--	--	--	--	14.01	100						
		L.S.D 0.05	--	--	3.74	--	--	--	--	--	--	--	3.74	--						
	D2 trial	Shand-1	10.35	104	22.39	106	15.93	97	18.34	105	7.60	100	14.92	103						
		Shand-2	11.38	115	22.54	107	17.72	108	18.88	108	9.71	128	16.05	110						
		Dorado	9.92	100	21.12	100	16.47	100	17.53	100	7.60	100	14.53	100						
		L.S.D 0.05	1.07	--	N.S.	--	N.S.	--	2.22	--	2.40	--	0.90	--						

Table 4. Cont.

Season	Type of trial	Variety	Location												Average	
			Fayoum		Assiut		Sohag		Qena		Aswan					
			M	%	M	%	M	%	M	%	M	%	M	%	M	%
1993	D1 trial	Shand-1	--	--	14.47	95	13.90	88	16.24	106	--	--	14.87	96		
		Shand-2	--	--	17.09	112	18.97	120	18.73	122	--	--	18.26	118		
		Dorado	--	--	15.24	100	15.79	100	15.31	100	--	--	15.45	100		
		L.S.D 0.05	--	--	3.09	--	1.17	--	1.36	--	--	--	0.94	--		
	D2 trial	Shand-1	--	--	18.23	120	14.38	91	16.12	105	--	--	16.24	105		
		Shand-2	--	--	18.82	123	18.59	118	17.44	114	--	--	18.48	118		
		Dorado	--	--	15.24	100	15.79	100	15.31	100	--	--	15.48	100		
		L.S.D 0.05	--	--	1.10	--	1.51	--	1.11	--	--	--	0.56	--		
	D3 trial	Shand-1	--	--	18.49	121	14.64	93	16.18	106	--	--	16.44	106		
		Shand-2	--	--	18.64	122	19.06	121	17.01	111	--	--	18.24	118		
		Dorado	--	--	15.24	100	15.79	100	15.31	100	--	--	15.45	100		
		L.S.D 0.05	--	--	N.S.	--	1.03	--	N.S.	--	--	--	0.51	--		
	Shand-1	11.57	99	18.40	115	16.41	99	17.31	112	10.29	118	14.80	108			
	Shand-2	13.76	118	18.87	118	18.71	112	17.49	112	10.94	126	15.95	117			
	Dorado	11.67	100	15.95	100	16.64	100	15.51	100	8.70	100	13.69	100			
	L.S.D 0.05															

M = Mean

Shand-1 = Shandaweel-1

Shand-2 = Shandaweel-2

Table 5. Agronomic characters of the newly released hybrids Shand. 1 and Shand.2 in comparison to Dorado.

Hybrid	Days to		Plant height (cm)	Panicle shape	Glume colour	1000 grain weight (gm)	Lodging	Resistance to smuts
	50 % flow.	Maturity						
Shand.1	68-70	120	170	Symmetric	Yellow	30-33	R	R
Shand.2	68-70	120	170	Symmetric	Red	33-35	R	R
Dorado	70-75	110-120	130-150	Symmetric	pale yellow	28-30	R	R

R = resistant

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أستنباط هجينين من الذرة الرفيعة

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قسم بحوث الذرة الرفيعة - معهد بحوث المحاصيل الحقلية - مركز البحوث الزراعية - الجيزة .

تم إجراء التهجين بين السلالات العقيمة المستوردة والسلالات المعيدة للخصوبة الواردة من المركز الدولى لأبحاث المناطق القاحلة وشبه القاحلة (الأيكريسات) وتم متابعة الهجن الناتجة وإنتخاب المبرر منها وقد تم تقييمها فى تجارب مقارنة المصنوع بدرجاتها المختلفة وعددها ٥٥ تجربته فى ٧ مناطق إنتاج الذرة الرفيعة فى الفترة من ١٩٩٢ حتى ١٩٩٥ وكانت من بين الهجن المبررة الهجينين شندويل ١ ، شندويل ٢ وقد تم مقارنة المصنوع بالصنف القصير ثنائى الغرض الموزع دورادو وقد أثبت الهجينين تفوقا واضحا فى المحصول على الصنف دورادو فى جميع مناطق الإنتاج وأثبتا تأقلمهما واسعا للظروف المصريه وقد تم تسجيلهما وإنتاجهما على نطاق تجارى.