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A High Yielding Dual Purpose Hybrid Sorghum CO 5 for Tamil Nadu

K. Ganesamurthy*, D. Punitha, S. Sivakumar, P. Jayaprakash, P. Veerabadhiran, K. Thiyagarajan V. Rajaram, R. Velazhahan and R. Kalpana

Department of Millets, Centre for Plant Breeding and Genetics
Tamil Nadu Agricultural University, Coimbatore - 641 003.

A dual purpose sorghum hybrid TNSH 482 derived from the cross ICSA 51 x TNS 30, evolved with an objective to develop high yielding dual purpose hybrid with improved grain and stover yield besides resistant to shootfly and grain mould was released as TNAU sorghum hybrid CO 5. It is a medium tall, non-lodging and tan plant type hybrid which matures in 95 - 100 days and remains green even at maturity. The grains are creamy white in colour, borne on medium cylindrical and semi-loose ear heads. It recorded an average grain yield of 2769 Kg/ ha under rainfed which was 13.16 and 17.03 per cent increase over the checks, COH 4 and MSH 51 respectively while its mean grain yield was 4338 Kg/ha under irrigation which was 17.18 and 13.32 per cent increase over the checks, COH 4 and MSH 51 respectively. The mean stover yield was 7563 and 10548 Kg/ha under rainfed and irrigated situations respectively. The hybrid TNSH 482 is resistant to downy mildew and moderately resistant to shoot fly and grain mould disease.

Key words: Sorghum, Hybrid CO 5, grain yield, dry-fodder yield, grain mould, shoot-fly.

Sorghum (*Sorghum bicolor* (L) Moench) is the fourth most important food crop in India, being the best-suited cereal for semi-arid environments. It has substantial popularity amongst farmers due to its greater adaptability and various forms of utilization like green fodder, stover and silage. It is an important staple food grain after rice and wheat for millions of poor and most food-insecure people in the semiarid tropics (SAT) in India. Sorghum also offers great potential to supplement fodder requirement of the growing dairy industry in India because of its wide adaptation, rapid growth and high green-fodder yields as well as good quality (Reddy *et. al.,* 2010). In Tamil Nadu, it is grown in 2.38 lakh ha constituting 4.7 per cent of the total cropped area of the state. Coimbatore, Dindigul, Thiruchirapalli, Thiruppur, Karur, Salem, Dharmapuri, Madurai, and Virudhunagar districts have contributed more area to this crop accounting for 75.6 per cent of the total area under this crop in the state during 2009-10 with the productivity of 930 Kg/ha. In Tamil Nadu, sorghum is truly a dual-purpose crop where both grain and stover are highly valued outputs. Sorghum plays an important role in the fodder and feed budget of Tamil Nadu farmers who often demand dual-purpose sorghum varieties and hybrids. It is therefore of paramount importance that technological developments are extended to increase the productivity and sustainability of sorghum production. Hybrid sorghum development was initiated in Tamil Nadu Agricultural University by utilizing improved male sterile lines developed under National Agricultural Research System and ICRISAT to augment higher productivity. Hybrid sorghum breeding was oriented towards development of dual purpose and photo insensitive types with resistance to shootfly and grain mould suitable for grain and stover for growing in all seasons. This effort has resulted in the development of a high yielding dual purpose hybrid TNSH 482. Due to its high grain and fodder yields besides other desirable traits, this hybrid has been released as TNAU Hybrid Sorghum CO 5 for cultivation in Tamil Nadu.

Materials and Methods

Sorghum hybrid TNSH 482 was developed by utilizing the cytoplasmic and geneic male sterile line ICSA 51 developed at ICRISAT as female parent and the high yielding shootfly resistant restorer line TNS 30 as male parent. The promising hybrid was developed at Department of Millets, Tamil Nadu Agricultural University, Coimbatore. It was tested initially in station trials at Department of Millets, TNAU, Coimbatore from the year 2005 to 2007 along with the checks COH 4 and MSH 51 and in Multi Location Trials during 2007-08 at research stations of Tamil Nadu Agricultural University. The Adaptive Research Trials were conducted in the farmers' fields during three sorghum growing seasons *viz.*, *kharif, rabi* and summer during 2008-09 and 2009-10 both under rainfed and irrigated conditions. It was also tested in six different locations across the

*Corresponding author email: kganesamurthy@yahoo.co.in

country under All India Co-ordinated Sorghum Improvement Project during 2008-09 in the name of SPH 1631 along with the national check hybrid CSH 23. Screening was done against important pests during *kharif* 2007 and 2008 and for diseases during *kharif,* 2008. The grain and stover samples were analyzed for their quality parameters by following standard procedures.

Results and Discussion

Sorghum hybrid TNSH 482, a cross between ICSA 51 and TNS 30 is a photo -insensitive dual purpose hybrid that matures in 95 to 100 days and takes 60 days to attain 50 per cent flowering. It is a medium tall growing hybrid with mean plant height varying between 210 and 230 cm. Like many other improved sorghum hybrids, it has a plant with tan colour foliage and remains green even at maturity. The grains are medium bold (thousand grain weight: 30.3g) and creamy white in colour, borne on medium cylindrical and semi-loose ear heads.

Table 1. Performance of Sorghum Hybrid TNSH 482 in Station trials (Irrigated)

Season/Year	Grain Yield (Kg/ha)			Dry fodder yield (Kg/ha)		
	TNSH 482	COH 4	MSH 51	TNS 482	COH 4	MSH 51
*Kharif,*2005	5438	4889	5090	12950	10670	9480
Summer,2006	4560	4230	3890	10680	11560	10480
Kharif, 2006	6528	5290	4850	13470	12340	11360
Summer,2007	5648	4626	5015	11670	9870	9630
Mean	5544	4759	4711	12193	11110	10238
% increase over COH 4	16.5			9.75		
% increase over MSH 51	17.7			19.1		

The results of the station trials conducted with sorghum hybrid TNSH 482 during *kharif* and summer seasons under irrigated condition revealed that the hybrid TNSH 482 registered a mean grain yield of 5544 Kg/ha as against 4759 and 4711 Kg/ha by the check hybrids COH 4 and MSH 51 respectively. An increase in grain yield was found in this hybrid to the tune of 16.5 and 17.7 per cent over the check hybrids COH 4 and MSH 51 respectively.

Table 2. Performance of Sorghum Hybrid TNSH 482 in MLT (Irrigated)

Centre	Grain Yield (Kg/ha)			Dry fodder yield (Kg/ha)		
	TNSH 482	COH 4	MSH 51	TNSH 482	COH 4	MSH 51
Kharif 2007						
Coimbatore	6048	4626	5940	14200	13300	12700
Vaigaidam	3437	3092	2659	11245	10870	10756
Bhavanisagar*	1350	1945	1068	9678	8765	8756
Mean	4743	3859	4300	11708	10978	10737
% increase over COH 4	23.0			6.7		
% increase over MSH 51	10.3			9.0		

* Data not included due to poor yield (below national average)

Mean dry fodder yield of the hybrid was 12193 Kg/ha as against 11110 and 10238 Kg/ha, which was 9.75 and 19.1 per cent over the checks COH 4 and MSH 51 respectively (Table 1).

Table 3. Performance of Sorghum Hybrid TNSH 482 in MLT (Rainfed)

Centre	Grain Yield (Kg/ha)			Dry fodder yield (Kg/ha)		
	TNSH 482	COH 4	MSH 51	TNSH 482	COH 4	MSH 51
Rabi, 2007-08						
Paiyur *	788	604	715	6578	5467	6570
Pattukottai	1694	1481	1368	9680	8750	8430
Kovilpatti	4490	3604	3490	9805	9722	8203
Aruppukottai	2665	2265	1937	5448	5160	4331
Mean	2950	2450	2269	7878	7275	6884
% increase over Co H 4	20.4			8.3		
% increase over MSH 51	30.0			14.4		

* Data not included due to poor yield (below national average)

This recorded a grain yield of 4743 Kg/ha under Multi Location Trials conducted during *kharif* and summer seasons under sandy loam soil types under irrigated condition, which were 23 and 10.3 per cent increase over the checks COH 4 and MSH 51 respectively. It also registered a dry fodder yield of 11708 Kg/ha, while the checks COH 4 and MSH 51 recorded 10978 and 10737 Kg/ha respectively (Table 2).The hybrid TNSH 482 was also tested under rainfed vertisol at research stations located in southern districts of the state known for the traditional grain and fodder sorghum cultivation. This

Table 4. Performance of sorghum hybrid TNSH 482 in AICSIP Trials (*Kharif*, 2008)

Entry	Coim (TN)	Bhavani (TAN)	Parbhani (Mah)	Bheema (KAR)	Dharwad (KAR)	Indore (MP)	Mauranipur (UP)	Mean
Grain Yield (Kg/ha)								
SPH 1631	5716	6107	2453	1175	2862	3535	2462	3472
CSH 23	4965	5934	1661	1138	2117	2946	2177	2991
% increase over CSH 23	15.1	2.9	47.7	3.3	35.2	20.0	13.1	16.1
Dry Fodder Yield (Kg/ha)								
SPH 1631	11762	10650	10240	8108	7552	12205	-	10087
CSH 23	8759	8564	7838	6156	2402	10943	-	7444
% increase over CSH 23	34.3	24.4	30.6	31.7	214.4	11.5	-	35.5

hybrid recorded a mean grain yield of 2950 Kg/ha under rainfed vertisol with an yield increase of 20.4 and 30 per cent over COH 4 and MSH 51 respectively (Table 3). These results indicated the superior performance of the hybrid both under irrigation and rainfed and in different soil types as compared to the check hybrids.

Being a dual purpose hybrid, TNSH 482 was evaluated at national level in the name of SPH 1631 under All India Co-ordinated Sorghum Improvement Project's Initial Hybrid Trial conducted during *kharif*, 2008. This hybrid registered a grain yield of 3472 Kg/ha, which was 16.1 per cent increase over the national check *viz.,* CSH 23. This hybrid had also

Table 5. Performance of Sorghum hybrid TNSH 482 in ART

Seasons	No.of locations	Grain yield (kg/ha)			Dry fodder yield (kg/ha)		
		TNSH 482	COH 4	MSH 51	TNSH 482	COH 4	MSH 51
Irrigated							
Kharif, 2008	12	2752	2169	2249	8078	7506	3875
Summer, 2009	21	2356	2499	2489	6388	5943	5388
Summer, 2010	31	3029	2700	2627	-	-	-
Kharif, 2009	15	2772	2523	2583	8763	9577	9573
Mean	79	2727	2473	2487	7743	7673	6279
% increase over CoH 4		10.3			1.31		
% increase overMSH 51		10.0			23.3		
Rainfed							
Rabi,2008-09	44	2405	2266	2160	5592	5324	5243
Rabi,2009-10	35	2770	2660	2725	8904	9056	8529
Mean	79	2588	2463	2443	7248	7190	6886
% increase overCOH 4		5.93			0.80		
% increase overMSH 51		5.07			5.25		

produced a dry fodder yield of 10087 Kg/ha, while the check CSH 23 recorded 7444 Kg/ha (Table 4).

Adaptability of this hybrid was assessed in the farmers' fields under Adaptive Research Trials conducted during all the three sorghum growing seasons namely *kharif, rabi* and summer in 158 locations spread over 21 districts of Tamil Nadu.

This hybrid registered a mean grain yield of 2727 Kg/ha during *kharif* and summer under irrigated condition and 2588 Kg/ha during *rabi* season under rainfed condition with an yield increase of 10.3 and 5.9 per cent respectively over the check hybrid COH 4. The mean stover yields of the hybrid was 7743 during *kharif* and summer under irrigated condition and 7248 Kg/ha during *rabi* season under rainfed

Table 6. Mean Performance of Sorghum hybrid TNSH 482 for grain yield

Experiment	No.of trials	Mean Grain Yield (kg/ha)			% over COH 4	% over MSH 51
		TNSH 482	COH 4	MSH 51		
Irrigated						
Station Trials, TNAU, Coimbatore	4	5544	4759	4711	16.5	17.7
Multilocation Trials	3	4743	3859	4300	22.9	10.3
Adaptive Research Trials	79	2727	2487	2473	9.65	10.3
AICSIP Co-ordinated Trials	7	3472	2991 (CSH 23)	16.1 (CSH 23)		
Mean	93	4338	3702	3828	17.18	13.32
Rainfed						
Multilocation trials	4	2950	2450	2269	20.4	30
Adaptive Research Trials	79	2588	2443	2463	5.93	5.07
Mean	83	2769	2447	2366	13.16	17.03

condition as against 7673, and 7190 Kg/ha respectively registered by the check hybrid COH 4 (Table 5).

Overall performance of a hybrid and its adaptability to different agro-climatic regions of the state are the basic criterion for its identification and release as a variety in a state. Accordingly, the assessment of overall performance of the hybrid TNSH 482 under station trials, MLT and ART revealed that the hybrid registered an overall mean grain yield of 4338 Kg/ha as against 3702 and 3828 Kg/ha recorded by the check hybrids COH 4 and MSH 51 respectively with an yield increase of 17.18 and 13.32 per cent over the check hybrids respectively. The grain yield of the hybrid under rainfed was 2769 Kg/ ha and registered 13.16 and 17.03 per cent increase over the check hybrids respectively (Table 6).

Table 7. Mean Performance of Sorghum hybrid TNSH 482 for Stover yield

Experiment	No.of trials	Mean Dry Fodder Yield (kg/ha)			% over	% over
		TNSH 482	COH 4	MSH 51	COH 4	MSH 51
Irrigated						
Station Trials, TNAU, Coimbatore	4	12193	11110	10238	9.75	19.1
Multilocation Trials	3	11708	10978	10737	6.65	9.04
Adaptive Research Trials	17	7743	7643	6279	1.31	23.3
AICSIP Co-ordinated Trials	6	10087	7444 (CSH 23)	-	35.5 (CSH 23)	-
Mean	30	10548	9910	9085	6.6.44	16.10
Rainfed						
Multilocation trials	4	7878	7275	6884	8.29	14.43
Adaptive Research Trials	30	7248	7190	6886	0.81	5.25
Mean	34	7563	7233	6885	4.56	9.85

Sorghum is often grown for its grain apart from green and dry fodder to sustain large population of animals in Tamil Nadu. Sorghum hybrids without dry fodder yield have no value in southern peninsular India. The dry fodder yield of the hybrid had also shown improvement over the existing sorghum hybrids. The hybrid TNSH 482 registered an overall mean dry fodder yield of 10548 Kg/ ha under irrigated condition and 7563 Kg/ha under rainfed situation with an yield increase of 6.44 and 16.10 per cent over the check hybrids COH 4 and MSH 51 respectively under irrigation and 4.56 and 9.85 per cent under rainfed condition respectively (Table 7).

Sorghum production is greatly affected by a variety of insect pests and diseases. The hybrid TNS 482 was screened for their reaction to major pests and diseases along with check hybrids in addition to susceptible and resistant varieties (Table 8 &9). This hybrid showed a moderate level of resistance against shootfly and stem borer as the incidences of these pests in the hybrid were found to be moderate and even lesser than the incidence score of check hybrids *viz.,* COH 4 and CSH 23 and far lesser than the susceptible check (DJ 6514).The incidences of head bug and midge were also found to be less as compared to check hybrids.

Table 8. Reaction of Sorghum hybrid TNSH 482 to pest incidence

Year	Entry	Shootfly (%)	Stem borer		Head bug No/ Panicle	Midge Spikelet Damage (%)
			Dead heart %	Leaf injury %		
Kharif 2007	TNSH 482	17.6	14.2	20.0	11.5	13.4
	CSH 16	19.9	10.8	21.4	13.3	16.3
	CSH 23	20.7	28.3	22.4	10.6	14.2
	COH 4	19.4	18.6	23.8	16.2	12.8
	DJ 6514 (S)	55.8	59.5	33.3	22.8	5.9
	IS 2312 (R)	5.1	7.7	12.4	10.2	4.8
	IS 2205 (R)	6.4	9.9	10.2	9.6	4.6
Kharif 2008	TNSH 482	19.7	18.8	24.7	15.1	14.5
	CSH 16	22.2	17.9	20.4	14.8	15.6
	CSH 23	18.9	28.6	31.8	21.6	16.3
	COH 4	23.0	19.9	27.3	18.1	14.8
	DJ 6514 (S)	59.4	41.8	35.2	32.4	5.8
	IS 2312 (R)	10.9	8.8	8.6	21.3	10.6
	IS 2205 (R)	8.1	10.3	10.8	11.5	6.8

Grain mold is a major disease wherever sorghum is grown if moist weather conditions prevail after flowering until grain maturity and before harvest. In Tamil Nadu, the incidences of grain mould is found to be predominant and there is no incidence of ergot, rust and leaf blight as seen from the disease score recorded for these diseases. Sorghum varieties with loose panicles are generally found to be resistant

Table 9. Reaction of sorghum hybrid TNSH 482 to diseases (season: *Kharif*, 2008)

Entry	Grain mould Grade (1-9)		Rust (1-9)	Ergot (1-9)	Leaf Blight (1-9)
	Field	Threshed			
TNSH 482	4.51	4.31	1.33	1.33	1.47
CSH 16	4.22	4.15	2.00	2.00	1.47
CSH 23	4.93	4.56	2.00	2.00	1.63
COH 4	4.83	4.68	2.67	2.33	1.57
B 58586 (R)	3.90	3.42	2.33	2.33	1.67
IS 14338(R)	2..68	2.15	2.42	2.33	1.77
Bulk Y (S)	6.33	6.12	3.67	3.67	1.70

to grain mould (Thakur *et.al,* 2006). Hybrid TNSH 482 with loose panicles registered low incidence of grain mold than the check hybrids COH 4 and CSH 23 and it was categorized as moderately resistant while the incidence scores of rust and ergot in TNSH 482 were lesser than the check hybrids and was found to be resistant to these diseases.

Nutritional status of sorghum is considered to be important as the grain remains as the staple

Table 10. Nutritional quality of grains and stover of sorghum hybrid TNSH 482

Sorghum grain						
Entry	Fat (%)	Carbohydrate(%)	Fibre (%)	Protein (%)	Tannin (mg/100 g)	
TNSH 482	2.30	86.30	1.73	8.70	63.75	
CO 30	2.45	87.50	1.55	8.20	76.25	
CO(S) 28	2.46	87.50	1.90	8.60	62.53	
COH 4	2.45	62.70	1.42	7.70	74.20	
Sorghum stover						
Entry	Ash(%)	NDF(%)	ADF(%)	Lignin(%)	Protein(%)	IVDMD(%)
TNSH 482	11.1	73.2	47.1	5.63	7.60	50.00
COH 4	10.7	68.7	46.2	5.77	6.94	48.50
CSH 16	10.7	67.6	45.1	5.81	7.46	49.80

food for the millions of rural people in the state. The nutritional analysis of grain revealed (Table 10) that the hybrid TNSH 482 possessing superior nutritive qualities evidenced from the higher values scored for starch, fiber (1.73 %) and protein (8.7%) and less for tannin (63.75 mg/100g). Sorghum varieties with improved fodder parameters have a direct impact on animal productivity, a positive influence on the pricing of stover sold as animal feed, thereby contributing to income from both crop and livestock enterprises (Blummel and Rao, 2006). The fodder quality is always determined by the important traits namely, protein and dry matter digestibility. The dry fodder samples of TNSH 482 registered high value for *in-vitro* Dry Matter Digestibility (50 %) as compared to the check hybrids COH 4 (48.50%) and CSH 16 (49.80%). The protein content of the stover sample was 7.6 per cent.

Identification of superior dual-purpose (food and fodder) sorghum hybrids is the need of the farmer as it is the only way to meet the ever growing food, feed and fodder demands of the country (Blummel and Reddy, 2006) . The hybrid TNSH 482, owing to its superiority in grain and fodder yields than the check hybrids COH 4, MSH 51and CSH 23 under both rainfed and irrigated ecosystems and showing moderately resistant reaction to shoot fly, stem borer and grain mould and superiority in grain and fodder nutritional qualities over the checks, it was released as a new TNAU Sorghum Hybrid CO 5 for commercial cultivation in Tamil Nadu.

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