



TNAU Sorghum CO 30 - A High Yielding Dual Purpose Variety for Tamil Nadu

K. Ganesamurthy*, N. Meenakshiganesan, D. Punitha, S. Sivakumar, V. Rajaram, R. Velazhahan, P. Veerabahiran and K. Thiyagarajan

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

A dual purpose sorghum culture TNS 598 (hybrid derivative of the cross APK 1 x TNS 291) developed with an objective of combining high grain and fodder yield was released as TNAU sorghum CO 30. It is a tall growing non-lodging tan plant type variety, matures in 100 - 105 days and remains green even at maturity. The grains are creamy white in colour, borne on medium cylindrical semi-compact ear heads. It recorded an average grain yield of 2805 Kg/ha under rain-fed with 20.7 per cent and 19.3 per cent increase over CO(S) 28 and APK 1 respectively while its mean grain yield was 3364 Kg/ha under irrigation which is 19.2 per cent and 23.7 per cent increase over CO(S) 28 and APK 1 respectively. The mean stover yield was 6988 Kg/ha and 9292 Kg/ha under rain fed and irrigated situation respectively. The culture TNS 598 is resistant to downy mildew and moderately resistant to shoot fly, stem borer and grain mould disease.

Key words: Sorghum, CO 30, Grain yield, dry-fodder yield, Grain Mould, Shoot-fly.

Sorghum (*Sorghum bicolor* (L) Moench) ranks fifth in worldwide economic importance among cereal crops with an annual production of 60 million tons. Besides being an important food, feed and forage crop, sorghum also provides raw material for the production of starch, fiber, dextrose syrup, biofuels, alcohol, and other products. More than half of the world's sorghum is grown in semi-arid tropics of India and Africa, where it is a staple food for millions of poor people (Reddy *et al.*, 2010). In Tamil Nadu, it is grown in 2.84 lakhs ha constituting 4.9% of the total cropped area of the state.

Dindigul, Coimbatore, Dharmapuri, Theni, Namakkal, Thiruchirappalli, Vellore, Perambalur and Madurai districts have contributed more to this crop accounting for 75.4% of the total area under this crop in the state during 2007-08 with the productivity of 874 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 sorghums. Therefore, it can play a vital role for the uplift of socio-economic status of the farmers through development of high yielding dual purpose varieties with reasonable amount of grain and dry fodder during winter season for the livestock (Blummel and Reddy, 2006). It is therefore of paramount importance that technological developments are extended to increase the productivity and sustainability of sorghum production. Sorghum breeding has to be oriented towards development of dual purpose

photo insensitive types suitable for growing in all seasons with shorter duration and tall stature. Sorghum breeding programme initiated at Tamil Nadu Agricultural University has resulted in the development of a high yielding dual purpose culture TNS 598. Due to its high grain and fodder yields besides other desirable traits, the culture has been released as TNAU Sorghum CO30 for cultivation in Tamil Nadu.

Materials and Methods

Sorghum culture TNS 598 was evolved through hybridization followed by pedigree method of selection by involving a high yielding drought resistant sorghum variety APK 1 as female parent and a culture identified for resistance to shoot fly and stem borer viz., TNS 291 as male parent. The promising culture was developed at the Department of Millets, Tamil Nadu Agricultural University, Coimbatore. It was tested initially in station trials at the Department of Millets, TNAU, Coimbatore from the year 2005 to 2007 along with the checks CO(S) 28 and APK 1 and in Multi Location Trials during the years 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 seasons of the years 2008-09 both under rainfed and irrigated conditions. It was also tested in eight different locations across the country under All India Co-ordinated Sorghum Improvement Project's Breeding Trials conducted during 2007-08 in the culture name of SPV 1816 along with the

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

national check varieties CSV 15 and SPV 462. Screening was done against important pests during kharif 2007 and 2008 and for diseases during kharif, 2007. The grain and stover samples were analyzed for their quality parameters by following standard procedures.

Results and Discussion

Sorghum culture TNS 598, a cross derivative of APK1 X TNS 291 is a photo-insensitive dual purpose culture matures in 100 to 105 days and takes 60 to 65 days to attain 50% flowering. It is a tall growing

Table 1. Performance of Sorghum Culture TNS 598 in Station trials (Irrigated)

Season/Year	Grain Yield (Kg/ha)			Dry fodder yield (Kg/ha)		
	TNS 598	CO (S) 28	APK 1	TNS 598	CO (S) 28	APK 1
Summer 2005	3845	3265	3146	12430	11250	10670
Kharif 2005	2835	2745	2640	6703	6860	6768
Summer 2006	4567	3423	3248	12640	11560	11480
Kharif 2006	3264	2963	2680	13020	12840	12320
Summer 2007	5478	4190	3850	12820	11160	10590
Mean	3998	3317	3113	11523	10734	10357
% increase over CO(S) 28	20.5			7.4		
% increase over APK 1	28.4			11.3		

culture with mean plant height varying between 210 and 230 cm. Like many other improved sorghum varieties, it has a plant with tan colour foliage and remains green even at maturity. The grains are medium bold (thousand grain weight: 28.3g) and creamy white in colour, borne on medium cylindrical semi-compact ear heads.

The results of the station trials conducted with sorghum culture TNS 598 during kharif and summer seasons under irrigated condition revealed that the culture TNS 598 registered a mean grain yield of 3998 kg/ha as against 3317 and 3113 kg/ha by the check varieties CO (S) 28 and APK1 respectively. An increase in grain yield was found in this culture to

Table 2. Performance of Sorghum Culture TNS 598 in MLT (Irrigated)

Centre	Grain Yield (Kg/ha)			Dry fodder yield (Kg/ha)		
	TNS 598	CO (S) 28	APK 1	TNS 598	CO (S) 28	APK 1
<i>Kharif 2007</i>						
Coimbatore	5478	4190	3970	11500	10900	9610
Bhavanisagar	2446	1929	2010	10640	9750	8765
Paiyur *	897	740	644	8375	7710	6930
Pattukottai	1570	1396	1322	10685	8745	8436
Vaigaidam	3163	2511	2548	8430	8135	8686
<i>Summer 2008</i>						
Coimbatore	4815	4352	3553	10950	8960	9630
Bhavanisagar	3548	3025	2843	9576	8856	8095
Mean	3503	2901	2708	10297	9224	8867
% increase over CO(S) 28	20.8			11.6		
% increase over APK 1	29.4			16.1		

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

the tune of 20.5 and 28.4 per cent over the check varieties CO (S) 28 and APK 1 respectively. Mean dry fodder yield of the culture was 11523 kg/ha as against 10734 and 10357 kg/ha, which is 7.4 per cent and 11.3 per cent respectively (Table 1).

This recorded a grain yield of 3503 kg/ha under Multi Location Trials conducted during kharif and summer seasons under sandy loam soil types under irrigated condition, which were 20.8 and 29.4 per cent increase over CO(S) 28 and APK 1

Table 3. Performance of Sorghum Culture TNS 598 in MLT (Rainfed)

Centre	Grain Yield (Kg/ha)			Dry fodder yield (Kg/ha)		
	TNS 598	CO (S) 28	APK 1	TNS 598	CO (S) 28	APK 1
<i>Rabi 2007-08</i>						
Kovilpatti	3890	3009	2536	9073	7500	8981
Aruppukottai	2373	1679	1750	5156	4156	4190
<i>Rabi 2008-09</i>						
Kovilpatti	3576	2572	3045	8960	7190	6850
Aruppukottai	2859	2447	2614	6780	5670	6110
Mean	3175	2427	2486	7492	6129	6533
% increase over CO(S) 28	30.8			22.2		
% increase over APK 1	27.7			14.7		

respectively. It also registered a dry fodder yield of 10297 kg/ha, while the checks CO(S) 28 and APK 1 recorded 9224 and 8867 kg/ha respectively (Table 2). The culture TNS 598 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

culture recorded a mean grain yield of 3175 kg/ha under rainfed vertisol with an yield increase of 30.8 and 27.7 per cent over CO(S) 28 and APK 1 respectively (Table 3). These results indicated the superior performance of the culture both under irrigation and rainfed and in different soil types as compared to the check varieties.

Table 4. Performance of Sorghum culture TNS 598 in AICSIP Trials (Kharif, 2007)

Entry	Palem (AP)	Coim (TN)	Akola (MAH)	Dharwad (KAR)	Surat (GUJ)	Indore (MP)	Mauranipur (UP)	Udaipur (RAJ)	Mean
Grain Yield (Kg/ha)									
SPV 1816	6817	6483	3453	8874	1709	4731	3874	4411	5044
SPV 462	5556	6393	3243	7027	1327	4394	3318	4444	4463
CSV 15	5075	5843	2973	7447	1351	4238	4024	4478	4429
% increase over SPV 462	22.7	1.4	6.5	26.3	28.8	7.7	16.8	-	13.0
% increase over CSV 15	34.3	11.0	16.1	19.2	26.5	11.6	-	-	13.9
Dry Fodder Yield (Kg/ha)									
SPV 1816	19357	10449	13213	10030	10000	12574	16517	21104	14031
SPV 462	18931	9890	12114	9279	8889	12416	15616	20788	13490
CSV 15	18559	10282	12814	10390	8889	11785	15018	20822	13694
% increase over SPV 462	2.3	5.6	9.1	8.1	12.5	1.3	5.8	1.5	4.0
% increase over CSV 15	4.3	1.6	3.1	-	12.5	6.7	10.0	1.1	2.5

Being a dual purpose culture, TNS 598 was evaluated at national level in the name of SPV 1816 under All India Co-ordinated Sorghum Improvement Project's dual sorghum breeding trial conducted during kharif, 2007. This culture registered a grain yield of 5044 kg/ha, which was 13.0 and 13.9 per cent increase over the national checks viz., SPV 462 and CSV 15 respectively. This culture had also

produced a dry fodder yield of 14031 kg/ha, while the checks SPV 462 and CSV 15 recorded 13490 kg/ha and 13694 kg/ha respectively (Table 4).

Adaptability of this culture was assessed in the farmers' field under Adaptive Research Trials conducted during all the three sorghum growing seasons namely *kharif*, *rabi* and summer in 150

Table 5. Performance of Sorghum culture TNS 598 in ART

Season & Year	No. of Districts	No. of locations	Mean Grain Yield (kg/ha)			Remarks
			TNS 598	CO(S) 28	APK 1	
Karif 2008	15	43	2587	2175	2235	Rainfed
Rabi 2008-09	21	63	2654	2370	2333	Rainfed
Summer 2009	16	44	2591	2250	2337	Irrigated
			Mean Stover Yield (kg/ha)			
			TNS 598	CO(S) 28	APK 1	
Karif 2008	3	10	7345	6856	6577	Rainfed
Rabi 2008-09	7	20	6127	5890	5734	Rainfed
Summer 2009	4	12	6056	5167	5442	Irrigated

locations spread over 21 districts of Tamil Nadu. This culture registered a mean grain yield of 2587 kg/ha, 2654 kg/ha and 2591 kg/ha in kharif, rabi and summer seasons respectively with an yield increase of 18.9, 12.0 and 15.2 per cent over the check variety CO(S) 28. The mean stover yield of the culture were 7345 kg/ha, 6127 kg/ha and 6056 kg/ha during *kharif*, *rabi* and summer seasons respectively as against 6856 kg/ha, 5890 kg/ha and 5167 kg/ha registered by the check variety CO(S) 28 (Table 5).

Overall performance of a culture 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 culture TNS 598 under stations, MLT and ART revealed that the culture registered an overall mean grain yield of 3364 kg/ha as against 2823 kg/ha and 2719 kg/ha recorded by the check varieties CO(S) 28 and APK 1 respectively with an yield increase of 19.2 and 23.7 per cent over the check varieties respectively. The grain yield of the culture under rainfed was 2805 kg/ha and registered 20.7 and 19.3 per cent increase over the check varieties (Table 6).

Sorghum is often grown for its grain apart from green and dry fodder to sustain large population of animals in Tamil Nadu. Sorghum varieties without dry fodder yield have no value in southern peninsular India. The dry fodder yield of the culture had also

Table 6. Mean Performance of Sorghum culture TNS 598 for grain yield

Experiment	No. of trials	Mean Grain Yield (kg/ha)			% over CO(S) 28	% over APK 1
		TNS 598	CO(S)	28APK 1		
Irrigated						
Station Trials, TNAU, Coimbatore	5	3998	3317	3113	20.5	28.4
Multilocation Trials	7	3503	2901	2708	20.8	29.4
Adaptive Research Trials(Summer,2009)	44	2591	2250	2337	15.2	10.9
AICSIP Co-ordinated Trials	8	5044	4463*	4429**	13.0	13.9
			(SPV462)	(CSV 15)	(SPV462)	(CSV 15)
Mean		3364	2823	2719	19.2	23.7
Rainfed						
Multilocation Trials	4	3175	2427	2486	30.8	27.7
Adaptive Research Trials (Kharif ,2008)	43	2587	2175	2235	18.9	15.7
Adaptive Research Trials (Rabi,2008-09)	63	2654	2370	2333	12.0	13.8
Mean		2805	2324	2351	20.7	19.3

shown improvement over the existing sorghum varieties. The culture TNS 598 registered an overall mean dry fodder yield of 9292 kg/ ha under irrigated condition and 6988 kg/ha under rainfed situation

with a yield increase of 11.0 and 13.0 per cent over the check varieties CO(S) 28 and APK 1 respectively under irrigation and 11.1 and 11.2 per cent under rainfed condition (Table 7).

Table 7. Mean Performance of Sorghum culture TNS 598 for Stover yield

Experiment	No. of trials	Mean Grain Yield (kg/ha)			% over CO(S) 28	% over APK 1
		TNS 598	CO(S)	28APK 1		
Irrigated						
Station Trials, TNAU, Coimbatore	5	11523	10734	10357	7.4	11.3
Multilocation Trials	7	10297	9224	8867	11.6	16.1
Adaptive Research Trials (Summer,2009)	12	6056	5167	5442	17.2	11.3
AICSIP Co-ordinated Trials	8	14031	13490	13694	4.0	2.5
			(SPV462)	(CSV 15)	(SPV462)	(CSV 15)
Mean		9292	8375	8222	11.0	13.0
Rainfed						
Multilocation Trials	4	7492	6129	6533	22.2	14.7
Adaptive Research Trials (Kharif ,2008)	10	7345	6856	6577	7.1	11.7
Adaptive Research Trials (Rabi,2008-09)	20	6127	5890	5737	4.0	6.9
Mean		6988	6292	6282	11.1	11.2

Sorghum production is greatly affected by a variety of insect pests and diseases. The culture TNS 598 was screened for their reaction to major pests and diseases along with check varieties in

addition to susceptible and resistant varieties (Table 8 & 9). This culture showed a moderate level of resistance against shootfly and stem borer as the incidence of these pests in the culture were found

Table 8. Reaction of Sorghum culture TNS 598 to pest incidence.

Year	Entry	Shootfly (%)	Stem borer		Head bug No/Panicle	Midge Spikelet Damage (%)
			Dead heart (%)	Leaf injury (%)		
Kharif 2007	TNS 598	20.2	7.3	12.6	9.2	9.5
	CO 26	24.0	7.4	17.7	5.1	10.8
	CO(S) 28	28.2	9.5	14.1	12.3	15.5
	CSV 15	29.3	9.9	15.8	14.6	11.8
	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	TNS 598	16.8	14.2	16.2	11.8	12.6
	CO 26	16.2	16.7	20.2	14.6	14.8
	CO(S) 28	22.4	14.8	23.3	12.6	15.6
	CSV 15	23.6	16.6	21.6	20.0	10.5
	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

to be moderate and even lesser than the incidence score of check varieties viz., CO (28) and CSV 15 and far lesser than the susceptible check (DJ 6514). The incidence of head bug and midge was also found to be less as compared to check varieties.

Table 9. Reaction of sorghum culture TNS 598 to Diseases (Kharif, 2007)

Entry	Grain mold field grade (1-9 scale)	Rust (1-9 scale)	Ergot (%)	Leaf Blight (1-9 scale)
TNS 598	5.2	4.56	No incidence	No incidence
CO 26	6.1	3.54	No incidence	No incidence
CO(S) 28	5.4	4.56	No incidence	No incidence
CSV 15	5.5	4.02	No incidence	No incidence
B 58586 (R)	3.9	1.80	No incidence	No incidence
IS 14338(R)	2.8	1.80	No incidence	No incidence

In Tamil Nadu, the incidence of grain mould and rust are found to be predominant and there was no incidence of ergot and leaf blight as seen from the disease score recorded for these diseases. The level of incidence of grain mold in TNS 598 was lesser than the check variety CO(S) 28 and it was

categorized as moderately resistant while the incidence score of rust in TNS 598 and the check CO(S) 28 was similar and moderately low hence both were found to be moderately resistant to rust disease.

Nutritional status of sorghum is considered to be important as the grain remain as the staple food for the millions of rural people in the state. The nutritional analysis of grain revealed the culture TNS 598 possessing superior nutritive qualities evidenced from the higher values scored for starch, fiber, protein and less tannin. 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). Furthermore, because the feed part of the crop plant is produced using the same resources (land, labour, capital, water) as the grain, there is a reduction in the pressure for potentially environmentally demanding

Table 10. Nutritional quality of grains and stover of sorghum culture TNS 598

Grain						
Entry	Crude fat (%)	Starch(%)	Amylose(%)	Fiber (%)	Protein(%)	Tannin(mg/100g)
TNS 598	2.49	68.85	27.80	1.6	9.79	63
CO(S) 28	2.79	67.07	26.00	1.7	9.82	65
Stover						
Entry	Ash (%)	NDF (%)	ADF (%)	Lignin (%)	Protein (%)	IVDMD (%)
TNS 598	10.8	67.4	44.8	5.73	7.54	49.30
CO(S) 28	10.3	71.7	48.0	6.46	6.50	48.10

animal feed production. The fodder quality is always determined by the important traits namely, protein and dry matter digestibility. The dry fodder samples of TNS 598 registered high values for In-vitro Dry Matter Digestibility (49.3) as compared to the check variety (48.1) viz., CO(S) 28. The other quality parameter namely protein was higher (7.54) as against the check CO(S) 28 (6.50).

Identification of superior dual-purpose food and fodder sorghum varieties 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. By evolving superior dual-purpose sorghum varieties like TNS 598 suited to Tamil Nadu's millions of smallholder farmers, the crop improvement research in sorghum has been path-breaking in demonstrating that traits for grain yield, grain quality, stover quality and quantity can be incorporated into a single variety. The culture TNS 598 owing to its superiority in grain and fodder yields than the check varieties, CO(S) 28

and APK 1 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 check CO (S) 28, it was released as a new sorghum variety TNAU Sorghum CO 30 for commercial cultivation in Tamil Nadu.

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