

**Research Article****Evaluation of morpho-physiological characters in sorghum (*Sorghum bicolor* (L.) Moench) genotypes under post-flowering drought stress**

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**Abstract**

Post-flowering drought adaptation in sorghum is associated with the stay-green phenotype. Plants with stay green resist drought-induced premature plant senescence. Sorghum varietal improvement for drought conditions could be achieved more efficiently if the trait associated with drought resistance could be identified and utilized as selection criteria. Hence, field studies were carried out in a randomized block design with two replications during the post-rainy season to evaluate responses among 100 sorghum genotypes under post-flowering drought stress which include B35 and CO26 as a drought resistant and susceptible check respectively. A total of 15 morpho-physiological characters putatively related with crop performance under drought were studied. Significant variations were found in all the traits among the sorghum genotypes studied. Based on the *per se* performance the genotypes MS73, CO21, CO22, Tenkasi1, AS2059, AS5078, AS2752, AS5057, AS4289, MS7819, IS5379, AS8038, AS6616, K3, MS7837, Murungapatti local, Uppam chloam, VS1564, VS1560, CO24 and CO1 exhibited high mean values for relative water content, SPAD chlorophyll reading, root length, root volume, root dry weight, 1000 grain weight, grain yield, and lower score for stay-green when compared to other genotypes under stress. These genotypes also recorded low drought susceptibility index, high relative yield, stress tolerance index and yield stability ratio and they can be used as the parents for future breeding programmes.

**Key words:** Sorghum, post-flowering drought stress.

**Introduction**

Drought limits agricultural production by preventing the crop plants from expressing their full genetic potential. Drought response in sorghum has been characterized at both pre and post flowering stages. Post-flowering drought adaptation in sorghum is associated with the stay-green phenotype (Xu *et al.*, 2000). Plants with stay green resist drought-induced senescence, retain their green leaves longer, and produce normal grain (Borell *et al.*, 2003). To reduce the effects of late season drought, it is essential to select for the non-senescence or stay green trait. However selection for drought tolerance is difficult because of inconsistency in testing environments and interactions between stages of plant growth and environment. The genetic mechanisms that condition the expression of drought tolerance in crop plants are poorly understood, since drought tolerance is a complex trait controlled by many genes and are dependent on the timing and severity

of moisture stress. It is one of the most difficult traits to study and characterize (Salunke *et al.*, 2003). The present investigation is an attempt in this direction, where the efforts will continue to be directed towards assessing the relative importance of the various adaptive mechanisms, which could be useful in characterizing the drought tolerant traits of sorghum phenotypically.

**Material and Methods**

A field experiment was conducted in randomized block design with two replications during the post rainy season at Millet breeding station, Tamil Nadu Agricultural University, Coimbatore, to evaluate the responses among 100 sorghum genotypes under post-flowering drought stress, which include B35 and CO 26 as drought resistant and susceptible check respectively. Water stress was imposed by withholding irrigation at anthesis stage and continued till maturity. No rain was recorded from anthesis to crop maturity. One set of treatments with normal irrigations from planting to maturity served as control. The spacing adopted was 45cm between rows and 15 cm between plants. Normal

recommended cultural practices were adopted during the crop period.

Data were recorded for the morpho-physiological characters viz., plant height (cm), days to 50% flowering, ear head length (cm), ear head weight (g), 1000 grain weight (g), leaf area index, relative water content (Barrs and Weatherly 1962), SPAD chlorophyll reading (Xu *et al.*, 2000), root length, root volume, root dry weight, biological yield, grain yield, harvest index and stay-green (Wanous *et al.*, 1991) on five randomly selected plants in two replications. The drought tolerant measurement indices like drought susceptibility index (Fischer and Maurer, 1978), relative yield (Lin and Binns, 1988), stress tolerance index (Fernandez, 1992) and yield stability ratio (Lewis, 1954) were also calculated to evaluate the responses among sorghum genotypes to post flowering drought stress.

### Results and Discussion

In the present study, considerable differences exist among the sorghum genotypes studied in their ability to endure post flowering drought stress. The mean performance of the genotypes B35, MS73, CO21, CO22, Tenkasi1, AS2059, AS5078, AS2752, AS5057, AS4289, MS7819, IS5379, AS8038, AS6616, K3, MS7837, Murungapatti local, Uppam cholam, VS1564, VS1560, CO24 and CO1 for the morpho-physiological traits viz., 1000 grain weight, grain yield, harvest index, leaf area index, relative water content, SPAD chlorophyll reading, root length, root volume, root dry weight and stay green rating were shown in Table 1, which reveals that these genotypes performed well under post flowering drought stress when compared to other genotypes.

The visual ratings of these stay green lines ranged between 1.8 – 2.8 where such cultivars with low stay green rating had their leaves green, good source sink relationship and assimilate partitioning thus resulting in improved grain yield and harvest index. The relative water content and SPAD chlorophyll reading in the apical leaves of stay green lines was about 77% and 46.0 respectively which was much higher than non-stay green lines (47% and 12.0) indicating that in stay green lines the stalk transporting system continued to function under severe drought stress (Xu *et al.*, 2000; Awala and Wilson, 2005). The leaf area index of these genotypes range between 1.60 to 4.55, which favours better light interception and maintains a supply of assimilates to the reproductive organs, hence maximize the grain yield. Increased Root

length (18.6-37.0 cm), high root volume (20.8-35.5 cc) and root dry weight (20.5-34.8 g) recorded by these genotypes tends to increase water availability making the genotypes to be drought tolerant, which is supported by the findings of Nour and Weibel (1978) who stated that the drought resistant cultivars possess heavier roots, and greatest root volume than the drought susceptible lines.

### Measurement of drought tolerant indices

Selection for drought tolerance typically involves evaluating genotypes for either high yield potential or stable performance under varying degrees of water stress. Drought indices viz., Drought susceptibility index (0.21- 0.94), Relative yield (0.79 -1.0), stress tolerance index (0.89 -1.48) and yield stability ratio (0.79 - 0.95) recorded by these genotypes (Table 2.) reveal that they can be selected as donors for drought tolerant breeding programmes, which is in agreement with the findings of Ahmed *et al.* (2003) where they selected the drought tolerant genotypes based on the low drought susceptibility index and high relative yield and showed that the genotypes with high relative yield performed relatively well under drought.

Overall, the results indicate that the genotypes MS73, CO21, CO22, Tenkasi1, AS2059, AS5078, AS2752, AS5057, AS4289, MS7819, IS5379, AS8038, AS6616, K3, MS7837, Murungapatti local, Uppam chloam, VS1564, VS1560, CO24 and CO1 were more or less *on par* with the drought resistant check B 35, for the putative drought tolerant traits viz., relative water content, SPAD chlorophyll reading, 1000 grain weight, root length, root volume, root dry weight, grain yield, harvest index, stay-green rating and drought tolerant indices viz., drought susceptibility index, relative yield, stress tolerance index and yield stability ratio when compared to other genotypes under post flowering drought stress. Hence these genotypes can be considered while identification of good potential genotypes to a drought environment and can be used as the parents for future breeding programmes, where the sorghum varietal improvement for drought conditions could be achieved.

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**Table 1. Mean performance of the selected drought tolerant genotypes for the putative drought tolerant traits under stress**

Traits Genotypes	LAI	RWC (%)	SPAD	RL (cm)	RV (cc)	RDW (g)	TGW (g)	SG	HI	SPY (g)
B35	3.90	77.25	46.40	36.90	33.80	34.85	33.50	1.80	0.37	40.50
MS73	3.80	74.20	45.60	34.30	29.00	29.75	28.50	2.15	0.29	35.00
CO21	3.35	74.00	44.60	34.00	28.15	33.80	31.00	2.15	0.33	42.15
CO22	4.55	74.00	46.50	32.65	31.00	30.30	29.40	1.87	0.35	41.00
TENKASI1	2.33	72.70	45.80	33.30	28.85	24.75	35.25	2.15	0.32	44.55
AS2059	3.44	74.60	43.00	34.75	27.40	21.75	32.75	2.15	0.34	41.60
AS5078	1.71	71.25	40.85	32.65	25.80	21.95	28.50	2.80	0.30	43.15
AS2752	2.46	69.75	36.50	30.10	28.50	23.85	31.50	3.45	0.31	42.10
AS5057	1.60	72.75	42.63	24.65	20.80	25.05	35.50	2.45	0.30	41.50
AS4289	2.21	74.60	43.50	28.00	25.15	30.50	33.00	2.45	0.33	41.50
MS7819	3.22	71.60	40.60	26.30	23.75	25.25	35.00	2.45	0.35	42.65
IS5379	2.00	72.20	40.65	33.90	30.50	20.50	32.75	2.80	0.24	37.45
AS8038	3.45	75.00	44.50	37.00	33.60	34.00	39.50	2.15	0.26	42.00
AS6616	2.89	75.10	45.00	35.50	35.50	34.50	35.20	2.15	0.32	40.50
K3	2.90	77.45	46.15	36.30	33.50	32.90	39.20	1.80	0.41	42.85
MS7837	3.45	76.50	46.65	28.80	29.50	31.75	33.00	1.80	0.39	37.45
Murungapatti local	2.21	74.00	45.00	24.50	25.50	25.80	30.50	2.15	0.35	41.40
Uppam cholam	2.28	73.65	46.80	26.50	27.25	28.50	32.60	1.80	0.31	37.65
vs1564	3.41	72.50	44.15	24.25	32.25	31.80	33.05	1.80	0.37	42.50
vs1560	2.82	73.00	41.50	22.65	30.20	30.50	38.60	2.15	0.30	42.00
co24	2.73	74.35	45.05	18.60	24.70	29.25	36.30	1.80	0.36	44.50
col	2.35	74.00	40.65	23.50	27.50	30.50	32.00	2.15	0.28	36.50

LAI- Leaf Area Index, RWC- Relative Water Content, SPAD - SPAD chlorophyll reading, RL - Root Length, RV - Root Volume, RDW - Root Dry Weight, TGW – Thousand Grain Weight, SG – Stay Green, SPY – Single Plant Yield, HI - Harvest Index.

**Table 2. Estimates of Drought Susceptibility Index (DSI), Relative Yield (RY), Stress Tolerance Index (STI) and Yield Stability Ratio (YSR) of the drought tolerant sorghum genotypes**

<b>Entry</b>	<b>DSI</b>	<b>RY</b>	<b>STI</b>	<b>YSR</b>
B35	0.48	0.91	1.13	0.89
MS73	0.69	0.79	0.89	0.84
CO21	0.44	0.95	1.21	0.90
CO22	0.40	0.92	1.13	0.91
TENKASI1	0.64	1.00	1.42	0.85
AS2059	0.87	0.93	1.32	0.8
AS5078	0.4	0.97	1.25	0.91
AS2752	0.49	0.95	1.22	0.89
AS5057	0.38	0.93	1.15	0.91
AS4289	0.21	0.93	1.11	0.95
MS7819	0.62	0.96	1.30	0.86
IS5379	0.70	0.84	1.02	0.84
AS8038	0.58	0.94	1.25	0.87
AS6616	0.66	0.91	1.18	0.85
K3	0.94	0.96	1.43	0.78
MS7837	0.76	0.84	1.04	0.82
Murungapatti local	0.81	0.93	1.29	0.81
Uppam cholam	0.62	0.85	1.01	0.86
VS1564	0.42	0.96	1.22	0.90
VS1560	0.92	0.94	1.37	0.79
CO24	0.78	1.00	1.48	0.82
CO1	0.72	0.82	0.98	0.84