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Studies on Drought Resistance in *Sorghum*—Leaf and Panicle Characters

by

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Introduction: Various investigators have been attempting to find out relatively simple and practical indices for assessing the drought resistance in various crop plants by means of morphological, anatomical and physiological studies. Even though consisderable work on this aspect has been done especially in roots and leaves in cereals like wheat, oats and paddy, much work has not been done in *Sorghum*. In this paper, the results of preliminary studies obtained on the association between morphological characters and drought resistance are presented.

Review of Literature: Miller (1916) believed that a smaller leaf surface together with a larger root system are instrumental in keeping the water supply of the leaf sufficient to retard incipient wilting. Martin (1930) observed that *Sorghum* leaves have a waxy and cutinised epidermis which reduces evaporation. Clements and Kulota (1942) in trying to find out the moisture index in sugarcane observed that drought resistance is characterised by reduced leaf area. Dutt and Rao (1948) (quoted by Argikar 1955)

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reported that drought resistance is generally associated with a smaller leaf area. Rajagopalan (1958) believed that total leaf area in rice does not seem to play any part in drought resistance.

Material and methods: Two wild *Sorghums* (*S. halepense* 2n = 20 & 40), four dry land strains (Co. 1, Co. 3, M. 47-3 and K. 3) blonging to *S. durra var. Coimbatoricum*, *S. roxburghii.* var. *hians*, *S. cernuum* and *S. dochna* var. *irungu* and one fodder strain (Co. 11, *S. durra* var. *mediocre*) and three synthetic tetraploid progenies of [*S. halepense* (2n : 40) x *S. durra* (2n : 20) x asynaptic *S. durra*] that were found to be drought resistant were chosen for study. The plants for study were raised in the black soil of the Regional Research Station, Kovilpatti under rainfed conditions during the main season. Observations were recorded in five plants in each type based on the standards prescribed by Aiyangar (1942). The observations on leaf characters were made at the time of flowering irrespective of the duration of different types.

Leaf characters: The number of distinguishable nodes above the ground level was taken as the number of leaves per plant. The length (L) and breadth (B) of the fourth leaf were measured and the area worked out as 2L x B. The intensity of the waxy deposit on the leaf sheath was graded into three groups as sparse, medium and dense.

Moisture content: The fourth leaf from top was cut at the leaf junction at 9 a. m. and the weight was immediately recorded in grams. The leaves were carefully labelled and dried in the shade to constant weight and the final dry weight was taken. The percentage of moisture content to dry weight of leaf was then worked out.

Panicle characters: The thickness of peduncle was recorded with calipers at 5 cm. below the base of the earhead. The length was measured from the basal whorl of branches to the tip of panicles with errect branches. In Co. 3 (*S. roxburghii*), the length was measured from the basal whorl to the tip of the longest rachis. The data in respect of all the characters were statistically analysed.

Observations: In general, the two wild *Sorghums* and the three synthetic tetraploid derivatives followed by the dry land strains, M47-3 and K. 3 were found to withstand the droughty condition very well as adjudged by visual observation both in the seedling stage and in the flowering phase as compared to other cultivated strains of *Sorghum*.

Leaf characters: The data obtained in respect of the number of leaves (Table I) showed significant differences between the wild *Sorghums* and the cultivated strains. Also the wild *Sorghums* and tetraploid derivatives

had less number of leaves than the cultivated *Sorghums* and exhibited significantly narrow leaves as compared to the cultivated strains characterised by broader leaves. The total leaf surface of the 4th leaf was also correlated with drought resistance. The wild *Sorghums* and the cultivated strains showed significant differences in the fourth leaf area and the wild *Sorghums* and tetraploid progenies showed lesser leaf area as compared to the greater leaf area of the cultivated strains (Table I).

TABLE I

Mean values of number of leaves per plant, breadth and area of fourth leaf, thickness of peduncle and length of panicle

S. No.	*Sorghum* types	Number of leaves	Breadth of fourth leaf (cm)	Fourth leaf area (sq. cm)	Thickness of peduncle (cm)	Length of panicle (cm)
1.	Co. 1	11·6	9·0	1453	1·00	24·3
2.	Co. 3	10·6	7·9	1295	0·84	34·2
3.	Co. 11	8·0	6·3	760	0·74	14·8
4.	K. 3	9·8	6·7	957	0·84	21·8
5.	M47–3	9·8	7·9	1157	0·60	14·8
6.	*S. halepense* (2n:40)	9·6	4·2	686	0·54	48·4
7.	*S. halepense* (2n:20)	9·4	1·7	198	0·24	34·0
8.	0292 (tetraploid derivative)	8·4	5·2	769	0·68	23·6
9.	0295 (do)	8·6	4·5	601	0·64	45·6
10.	0297 (do)	7·4	4·7	393	0·70	24·8
	S. E.	0·3	0·4	153	0·04	1·2
	C. D. (P = 0·05)	1·0	1·1	412	0·11	3·3

Conclusion :

Number of leaves: 1 2 4 5 6 7 9 8 3 10

Breadth of Fourth leaf: 1 2 5 4 3 8 10 9 6 7

Fourth leaf area: 1 2 5 4 8 3 6 9 10 7

Thickness of peduncle: 1 2 4 3 10 8 9 5 6 7

Length of panicle: 6 9 2 7 10 1 8 4 5 3

Waxy deposit : All the cultivated strains taken for the study showed all the three grades namely sparse, medium and dense waxy deposit while the progenies exhibited medium and dense waxy deposit. (vide Table II) The wild sorghums showed sparse waxy deposit. There was practically no visual difference between the plants with dense waxy deposit and those with sparse or medium waxy deposit in their drought resistant capacity and no definite relationships could be established between drought resistance and the occurrence of waxy deposit. The percentage of moisture content ranged from 395 to 540 in the non-resistant types while the resistant types recorded more than 549 (Table II).

TABLE II

Percentage of moisture content in fourth leaf and intensity of waxy deposit

S. No.	*Sorghum* types	Percentage of moisture content to dry weight of leaf	Grade of waxy deposit
1.	Co. 1	395	Medium
2.	Co. 3	358	Medium
3.	Co. 11	540	Medium
4.	K. 3	549	Sparse
5.	M47–3	566	Medium
6.	*S. helepense* (2n : 40)	615	Sparse
7.	*S. helepense* (2n : 20)	616	Sparse
8.	0292	550	Dense
9.	0295	...	Medium
10.	0297	...	Dense

Note : Data for the culture 0295 and 0297 are not furnished as the leaves were damaged during drying.

Panicle characters : The peduncle thickness was significantly less in wild *Sorghums* and synthetic tetraploid progenies as compared to the cultivated strains. The data collected on length of panicle indicated significant differences among the different *Sorghums* studied. *S. halepense* (2n : 40), Co. 3 and *S. halepense* (2n : 20) had the longest panicle.

Discussion : Wild *Sorghums* and grasses, which withstand extreme droughty conditions possess narrow leaves, which is one of the factors responsible for reducing the total leaf surface. Hence studies were made not only on the number and breadth of leaves, but also on the leaf area. It is also found that long open panicles with thin peduncles go with

S. halepense, which is reputed for its resistance to drought. So the possibility of any of these characters being associated with drought resistance was also considered and data collected accordingly.

Leaf characters: It is seen from the results that there were significant differences in respect of number of leaves, breadth and total leaf surface of fourth leaf between drought resistant varieties namely the wild *Sorghums* and the synthetic tetraploids and cultivated strains. Distinct variation also existed in respect of the leaf characters. The two wild *Sorghums* and the three synthetic tetraploids which were found to withstand the droughty conditions had reduced number of leaves, lesser breadth in fourth leaf and consequently reduced leaf surface minimising the water loss. Similar observations have been recorded by Miller (1916) in the case of corn and *Sorghum*. The intensity of waxy deposit ranged from sparse to dense in the sorghums studied. But there was no perceptible difference in their resistance to drought. Hence no definite indications to prove that the presence of waxy deposit confers resistance to drought, could be obtained.

Moisture content: The percentage of moisture content to dry weight of leaf was high in the drought resistant wild *Sorghums* which recorded more than 600 followed by the reputed dry land strains M47–3 and K. 3 and the tetraploid derivatives while the other cultivated strains recorded less than 400 (*vide* Table II).

Panicle characters: The peduncle thickness was very much less in both the wild *Sorghums* followed by M47–3 which is eminently suited for dry farming conditions and the synthetic tetraploid progenies. The other cultivated strains studied had thicker peduncles. The thickness is thus seen to be associated with drought resistance, the types with thinner peduncle being more drought resistant. The wild *Sorghum* had longer panicles than the rest showing significant difference over less resistant *Sorghums* which had shorter panicle length.

Conclusion: The very complex nature of drought resistance and the characters associated with it necessitates to take a complex of characters into consideration for assessing the drought resistant capacity of the plant. From the studies now made, it appears that in *Sorghum*, lesser leaf area with less number of leaves and lesser breadth and thin peduncle with long panicle confer drought resistance. Considering these characters, the wild *Sorghums* stand first followed by the synthetic tetraploid progenies in drought resistance. M47–3 and K. 3, the two cultivated strains, take the next order of preference in their capacity to resist drought. These two strains are adapted for cultivation in the dry farming tracts with limited rainfall in Andhra and Maharastra, and Madras States respectively.

Summary: The possible association of different characters of the plant with drought resistance was studied using the two reputed drought resistant wild *Sorghums*, three synthetic tetraploid progenies of wild and cultivated *Sorghums* and five cultivated strains of *Sorghum*. The various leaf characters *viz.*, the number of leaves, breadth, total leaf surface, moisture content of fourth leaf, waxy deposit, thickness of peduncle and length of panicle were studied in detail and the following conclusions were drawn.

1. Less number of leaves, narrow leaf character and reduced fourth leaf area appear to help the plant to withstand the drought by minimising the water loss by transpiration.

2. No definite association between intensity of waxy deposit and drought resistance could be estimated.

3. High moisture content seems to be associated with drought resistance.

4. The peduncle thickness is inversely propotional to drought resistant capacity.

5. The greater the length of the panicle, the more is the drought resistant capacity.

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