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Studies on Drought Resistance in Sorghum-Root Characters

by

S. THANGAVELU[1], K. MEENAKSHI[2] and C K. RAJAGOPAL[3]

The yield of the rainfed crop of *sorghum* is very often significant reduced due to inadequate and ill-distributed rainfall and the frequent prevalence of long periods of drought. It has been noticed that some of the varieties are able to withstand the vagaries of the season better than others. These differences are attributed to various causes; but sufficient attention has not been paid to the root system in this regard. The results of preliminary studies made on the association of different root characters with drought resistance are presented in this paper.

Review of literature: Exact determinations by Rotmisrov (1910) and Modestov (1915) (quoted by Maximov, 1929) and Weaver (1926) have shown that crop plants such as wheat and oats have root systems reaching a depth of one to two metres with an equal spread. Miller (1916) found that corn and *sorghum* could mature when the upper two feet of soil was below wilting co-efficient and water was being absorbed from as great a depth as six feet. Sankaran (1933) reported that the drought resistant *herbaceum* cotton possessed a much longer and thicker root system than the *indicum* type. Ostermeyer (1934) states that the root system of drought resistant oat varieties penetrated deeper into the soil while Aadmodt and Johnson (1936) found that drought resistant wheat varieties possessed a more highly branched primary root system than the non-resistant varieties.

Rajagopalan (1958) states that the root number, total length of root system, dry weight and thickness of roots are greater in drought resistant varieties. Charles Ratnaswamy (1960) has observed that *Sorghum durra* has thick and long root with greater penetration.

Material and Methods: Two wild *sorghums* 20- and 40-chromosome forms of *S. halepense* and five dryland strains belonging to *S. durra* (Co. 1 & Co. 11), *S. roxburghii* (Co. 3), *S. dochna* (K 3), and *S. cernuum* (M-47-3; Maldandi *Jowar*) are chosen for study. These two wild *sorghums* are reputed for their drought resistant capacity. Co. 1 and Co. 3 are drought resistant dry land strains with high yield potential even during adverse seasons. The plants were raised in the black soil of the Regional Research Station, Kovilpatti under rainfed conditions during the main season 1963.

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1. Assistant in Millets and 2. Assistant Millets Specialist, Agrl. College & Research Institute, Coimbatore. 3. Assistant Pulses Specialist, Jayamkondan.

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Data on number, length and thickness of roots were recorded on two plants in each variety at the time of maturity while the root-shoot ratio was based on 5 plants in each type at the time of flowering. As a result of preliminary studies made on the root system of *sorghum*, the spread and penetration of the roots were found to be 2' diameter and 1½' depth respectively. Hence the soil beyond 2' from the central root on all the four sides was first removed and the roots were lifted along with the soil to a depth of 2' without causing any damage. The root system was carefully washed free of soil. The fibrous roots from the entire root system were cut and the total number was counted. The length and the thickness of the individual fibrous roots were recorded at 1 cm from the base of the root. The roots were classified into two groups based on the mean length of *S. halepense* (2n : 40) namely longer roots and shorter roots, those roots which attain a length of 24.5 cm and over being classified as long roots, while the others are classified as short roots.

The whole plant with the entire root system was completely removed at the time of flowering for estimation of root-shoot ratio. The root system was washed free of soil, and the root and shoot portion were dried to constant weight and the dry weights were recorded. The drought resistant plants were studied for the possession of rhizomes, if any.

Results and Discussion : The data collected in respect of length of root, number of roots and thickness of roots are presented in Table 1. The total root length is the greatest in diploid form of *S. halepense* followed by Co. 1, Co. 3 and *S halepense* (sn : 40) while *S. halepense* (2n : 40) possessed the longest root followed by Co. 1, diploid from of *S. halepense* and Co. 3. This greater root length would help the plant to absorb the sub-soil moisture thereby enabling it to endure the drought without permanent injury. Further, the possession of longer roots increases the absorbing surface of the root, which in turn helps the plant to absorb more moisture from the soil. It is observed that the drought resistant wild *sorghum* and Co. 1 have higher ratio of number of long roots to the number of short roots than the rest.

The drought resistant types are characterised by the possession of a greater percentage of thin roots and with a greater total root length and greater mean length.

Another distinct feature that was inferred from the studies is that *S. halepense* (sn : 40) which was found to withstand extreme droughty conditions were strongly rhizomatous while diploid *S. halepense* was found to possess only weak rhizomes. The degree of drought resistant capacity of *S. halepense* sn : 20 is also found to be less as compared to *S. halepense* sn : 40 when observed under field conditions. However, the tillering is profuse in both the wild *sorghums*. So rhizomes may also play a prominent role in conferring

drought resistance to the plant. It is also observed that tetraploid *S. halepense*, which is highly drought resistant, has the highest root-shoot ratio indicating the presence of a comparatively better development of the root system (*vide* Table 1). The well developed root system helps the plant to tide over prolonged periods of drought without suffering any permanent adverse effects.

TABLE 1

Particulars	Duration in days	Total root length in cm	Mean length of a root in cm.	Length of longest root in cm.	Number of long roots	Number of short roots	Long root/short root ratio	Mean thickness of a root in cm.	Rhizome expression	Root shoot ratio on dry basis	Depth of penetration in cm
Co. 1	115	1141	21.5	49.5	17	36	0.47	0.37	Nil	0.163	35
Co. 3	115	944	15.9	44.0	8	52	0.15	0.32	Nil	0.153	31
Co 11	100	862	15.2	38.5	5	52	0.10	0.33	Nil	0.149	27
K. 3	105	517	14.7	40.5	5	34	0.15	0.30	Nil	0.124	29
M. 47-3	105	517	14.6	32.0	5	31	0.16	0.27	Nil	0.114	26
S.h.2n:20	105	1265	24.6	44.0	24	27	0 89	0·16	Weak	—*	41
S.h.2n:40	105	852	18 5	55.0	13	33	0.40	0.25	Strong	0.222	32

* The root shoot ratio for S.h.2n:20 could not be assessed due to subsequent damage of the shoot portion.

The data presented in Table 1 indicate that *S. halepense* 2n:20 and 2n:40 have got the maximum root penetration as compared to the cultivated strains where the penetration is less. Hence it may be stated that a deeper root system is associated with drought resistant types which is in conformity with findings made in paddy by Rajagopalan (1958).

From the discussions so far made, it appears that diploid *S. halepense* is more resistant to drought than Co. 1, which is followed by tetraploid *S. halepense* and Co. 3. However, it is not actually so when observed under field conditions. Tetraploid *S. halepense* is found to be the most drought resistant type of all the *sorghums* studied. This phenomenon may propably be attributed to the strong rhizomatous characteristic of tetraploid *S. halepense*, which plays a prominent role in conferring drought resistance to the plant.

However, diploid *S. halepense*, Co. 1 and Co. 3, which possess greater total root length and mean root length, more number of thin roots, deeper root penetration and higher root-shoot ratio are found to withstand the droughty conditions very well and regenerate under favourable conditions inspite of their weak or non-rhizomatous conditions. The present studies have shown indications of the part played by the other characters of the root system like greater root length, mean length, deeper penetration *etc*.

Due to the very complex nature of drought resistance and the characters associated with it, it becomes necessary to take a complex of characters into consideration for assessing the drought resistant capacity of the plant. From the studies made so far, it appears that in *sorghum* the root system also plays a very important role in conferring drought resistance to the plant.

Summary: The possible correlation of different root characters of the plant with drought resistance was studied with the two reputed drought resistant wild *sorghums* and five cultivated strains of *sorghum*. The root-shoot ratio, number of roots per plant, number of thick roots, number of thin roots, total length of the entire root system, mean root length and thickness of individual roots and presence of rhizomes were studied in a detailed manner in two wild sorghums and five cultivated strains.

Eventhough the studies indicated the possibilities of the minor roles played by the different components of root system like possession of greater root length, mean root length, longest root, higher percentage of thin roots, higher root-shoot ratio and deeper root penetration, the rhizomatous conditions probably seem to play a major role in conferring drought resistance to the wild *sorghums*.

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