Paper ID: 1169
Theme 4. Biodiversity, conservation and genetic improvement of range and forage species
Sub-theme: 4.1. Plant genetic resources and crop improvement

Biochemical evaluation of forage sorghum for stress tolerance

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Keywords: Forage sorghum, Proline, Stress

Introduction

Abiotic stresses are the major limiting factors in plant growth. With continuous increment in scarcity of water and increased salinization of soil and water, it is estimated that more than 50% of all arable lands will be affected by salinity and drought by 2050. Plants are often exposed to both, soil and atmospheric water deficit during their life cycle. The frequency and intensity of droughts is increasing as a result of global climate change. Understanding how plants respond to water stress is thus crucial for the estimation of impacts of climate change on crop productivity and ecosystem functioning. The knowledge about the mechanism adapted by plant to respond to drought, salt and co-occurring stresses can play an important role in stabilizing crop performance under drought and saline conditions. Sorghum (*Sorghum bicolor* L.) is an important crop in many parts of the world. It is utilized as food, fodder and several industrial purposes. In general, sorghum is known to be more tolerant to any stresses including heat, drought, salinity and flooding.

Materials and Methods

Nine selected lines with two checks were sown in glass house and field for the evaluation of drought tolerance at morphological and biochemical levels. Fresh weight, dry weight, water content, and levels of various photosynthetic pigments were measured in leaves. Proline was measured by the acid- ninhydrin method of Bates *et al*. (1973). 0.5 g leaf tissue was homogenized in 5.0 ml sulphosalicylic acid (3%). The homogenate was centrifuged at 11,000 x g for 15 min at 4 ºC. The clear supernatant was used for estimation of proline.

Results and Discussion

Water content and specific leaf weight of sorghum leaves in control and water stressed conditions indicated that some of the sorghum lines have higher water retention capacity than others (Tables 1 and 2). These lines may be better performing under drought conditions. Line IG-03-285 was early flowering line identified both in green house and field conditions. This line may be used as early maturing short duration crop. This may also be utilized to develop short duration hybrid lines. Proline content in these lines was estimated to evaluate their capacity to tolerate the stress. The data is presented in Table 3. In general, the SGS lines have more proline as compared to non SGS lines.

Proline accumulation has been correlated with improved plant performance under stress. It was suggested that proline might confer a protective role by inducing biosynthesis of stress protective proteins. Exogenous application of proline induces the expression of ubiquitin, antioxidative enzymes and dehydrins. Glycine betaine is an osmoprotectant which accumulates under osmotic stress. Choline dehydrogenase catalyzes the oxidation of choline to glycine betaine *via* betaine aldehyde as intermediate. When flowering time was measured, it was found that flowering was delayed in all stay green lines. Furthermore, the stay green lines having delayed flowering showed a better performance and resistance to drought. Flowering was delayed in some SGS lines, which may be good candidates to be used as fodder in drought prone areas.

Table 1: Leaf morphological parameters of different lines of sorghum

S. No.	Line	Leaf length (cm)	Leaf width (cm)	Plant height (cm)
1	Control 1	40.00 ± 8.89	1.67 ± 0.35	56.33± 1.53
2	Control 2	51.00 ± 2.65	1.57 ± 0.25	55.00 ± 1.00
3	IG-03-285	42.67 ± 8.39	1.23 ± 0.06	56.33 ± 1.53
4	EC-507882	45.67 ± 5.13	2.23 ± 0.31	66.00 ± 2.00
5	SGS-96	54.67 ± 7.57	2.67 ± 0.15	72.00 ± 2.00
6	SGS-154	62.33 ± 4.04	2.67 ± 0.21	69.33 ± 3.06
7	SGS-89	49.67 ± 7.09	2.53 ± 0.55	66.33 ± 1.53
8	SGS-168	48.67 ± 1.53	1.90 ± 0.20	60.67 ± 0.58

9	SGS-33	42.33 ± 0.58	2.93 ± 0.06	51.00 ± 1.00
10	SGS-45	76.67 ± 4.16	2.43 ± 0.38	91.67 ± 1.53
11	SGS-118	73.67 ± 1.53	3.23 ± 0.47	114.33 ± 4.04

Table 2: Dry matter and water percentage in leaves of different lines of sorghum

S. No.	Line	Dry Matter %	Water %
1	Control 1	29.58 ± 2.09	70.42 ± 2.09
2	Control 2	46.85 ± 7.94	53.15 ± 7.94
3	IG-03-285	29.66 ± 6.23	70.34 ± 6.23
4	EC-507882	28.55 ± 3.77	71.45 ± 3.77
5	SGS-96	29.93 ± 2.29	70.07 ± 2.29
6	SGS-154	25.48 ± 2.10	74.52 ± 2.10
7	SGS-89	30.72 ± 1.33	69.28 ± 1.33
8	SGS-168	32.82 ± 2.80	67.18 ± 2.80
9	SGS-33	26.55 ± 0.79	73.45 ± 0.79
10	SGS-45	18.68 ± 2.98	81.32 ± 2.98
11	SGS-118	29.55 ± 1.34	70.45 ± 1.34

Table 3: Proline content in leaves of different lines of sorghum

S. No.	Line	Proline (μmoles/g Fr. Wt.)
1	Control 1	0.226
2	Control 2	0.488
3	IG-03-285	0.448
4	EC-507882	0.988
5	SGS-96	0.485
6	SGS-154	1.330
7	SGS-89	0.572
8	SGS-168	0.514
9	SGS-33	0.157
10	SGS-45	1.618
11	SGS-118	0.496

Conclusion

The three SGS lines, SGS 33, SGS 45 and SGS 118 showed delayed flowering and higher growth among all the lines tested. These are being used to develop as stay green drought tolerant sorghum using breeding techniques.

References

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Acknowledgement

The authors acknowledge the support and encouragement of Head-CI Division, Head-ST Division and Director IGFRI for present work.