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Research Article

Physiological Basis of Screening Samai Varieties for Drought Tolerance under Rainfed Conditions

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Abstract

A field experiment was conducted at the Regional Research Station, Paiyur main farm with the varieties *viz.*, Paiyur 2, PM 29, KRI-11-05, MS- 110, MS- 509, MS-1211, MS-1236, MS-4700, MS-4784 and CO 4. The experiment was designed for screening the samai cultivars under rainfed conditions through the physiological and biochemical responses. Morphological characters, plant water relations, proline accumulation and soluble protein were taken in to consideration to assess the response of the various samai cultivars to rainfed condition from this experiment. Significant differences were observed for most of the morphological characters like plant height, number of leaves per plant and dry matter production per plant. Significant differences were observed for the bio chemical attributes. Leaf proline content was high in the variety MS 1236 (0.81 mgg^{-1}) .The variety MS 110 recorded the maximum protein content of 10.88 mg/g. Relative water content of the leaf was high in the variety MS 1236 (71.87 %) and also recorded the maximum crop growth rate (g m^2day^{-1}) of 0.607 and 1.074 at 0- 30 DAS and 30-60 DAS respectively. Similar trend was observed in the relative growth rate also.Significant difference was observed for grain yield among the 10 varieties tested for drought tolerance. MS -1236 recorded the maximum yield of 1.73 tonnes ha^{-1} and was on par with all the varieties except MS - 509, which recorded the lowest yield of 1.48 tonnes ha^{-1}. The culture KRI -11-05 closely followed MS 1236 with the mean grain yield of 1.71 tonnes ha^{-1}.

Keywords: *Samai, Drought, Rainfed, Morphological, Physiological and yield.*

Introduction

Little millet (Samai) is predominantly cultivated as a rain fed crop in 2,000 hectares in Krishnagiri district and 12,000 hectares in Dharmapuri district. In recent years, cultivation of samai has gained importance as it fetches higher market price due to promotional activities by the government in providing nutritional security for the burgeoning population. Moreover this crop has high nutritive value and tremendous scope for value addition. However, the area under samai is declining due to the low productivity of existing varieties under prolonged drought situation. Evolving a drought tolerant variety suitable for cultivation in the North Western Zone of Tamil Nadu will check the declining area and improve the productivity of the crop.

Drought is a worldwide problem, constraining global crop production seriously and recent global climate change has made this situation more serious. Currently, drought study has been one of the main directions in global plant biology and biological breeding. The impacts of drought condition on grain development and yield of crops depend on their severity and the stage of plant growth during which they occur. Drought adversely affects some of the

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important physiological, biophysical and biochemical processes of the plants. The major challenges in drought prone areas are to establish ways and means by which reduction in crop yields can be minimized. Genetic improvement for drought tolerance is a long term strategy and hence the selection for drought resistance has to be either drought escape or drought avoidance or drought tolerance assumes greater importance (Tuinstra, *et al*., 1992). It has been documented that root growth, leaf area development, and osmatic adjustment under stress are some of the guidelines in characterizing the genotypes for stress tolerance in ragi (Blum and Sullivan, 1987). Screening varieties for relative drought tolerance has been attempted by various workers using different physiological and biochemical mechanism in various crops but not much in samai crop. Barrs and Weatherly, (1962) developed the concept of relative water content and the reduction in relative water content under stress has been used as a measure of drought tolerance by several workers. The production of Reactive Oxygen Species (ROS) is one of the major responses of drought.

Damage to cellular membranes and Chlorophyll can be used as reliable indicators to determine the extent of damage suffered by plants due to the AOS. Maintaining the integrity and stability of cell membranes under stress conditions is a major component of drought tolerance in plants. Removal of water from the membrane disrupts the normal bilayer structure and displaces membrane proteins, leading to loss of membrane integrity, disruption of cellular compartmentalization and loss of enzymes activity, which are primarily membrane based (Bajji, *et al*., 2001). Chloroplast membranes are in particular sensitive to oxidation stress damage caused by the generation of excessive amount of AOS in these membranes (Asada, 1999).

Thus, this experiment was designed for screening the samai cultivars under rainfed conditions through the physiological and biochemical responses. Plant water relations, disintegration of cellular membranes, response of photosynthetic pigments, proline accumulation and soluble protein will be taken in to consideration to assess the response of the various samai cultivars to rainfed condition from this experiment.

Materials and Methods

A field experiment was carried out at the Regional Research Station, Paiyur main farm during 2014-2016. The experiment consists of ten varieties *viz*.,Paiyur 2, PM 29, KRI-11-05, MS- 110, MS- 509, MS-1211, MS-1236, MS-4700, MS-4784 and CO 4 with three replications were laid out in Randomized Block Design. The seeds were sown in the field as line sowing after receiving sufficient rainfall. After thinning 22.5cm x 10cm spacing was maintained with the plot size of 3 x 2.5m. The experiment was designed for screening the samai cultivars under rainfed conditions through the physiological and biochemical responses. Morphological characterslike., plant height, root length and number of leaves were recorded at 30 and 60 DAS (Days After Sowing). The physiological and biochemical parameters viz., Relative Water Content (RWC), proline accumulation and soluble protein were analyzed at 60 DAS. The growth attributes characters viz., Crop Growth Rate (CGR) and Relative Growth Rate (RGR) were measured at 30-60 DAS. The yield $ha^{-1}$was assessed at the time of harvesting.

Result and Discussion

Plant Height

Plant height is an imperative morphological factorcorrelated to growth and development of the crop. Growth comprises both cell growth and development. Cell growth and development is a process is made up of cell division, cell enlargement and cell differentiation (Wareing and Phillips, 1970). These processes are very sensitive to water deficit because of their requirement upon turgor. Morphologically, plant growth is perceived as an increase in plant size in terms of plant height and growth rate, while development involves tissue and organ formation. In this present study, the influence of water deficit on the growth

ofmorphological observation was recorded 30 DAS and 60 DAS. Significant difference between the varieties was observed for the characters studied. Maximum plant height and number of leaves was observed in KRI 11-05 (44.5cm and 53.0cm) at 30 and 60 DAS. The variety MS -1211 recorded the minimum plant height (29.5cm and 38.3cm) at 30 and 60 DAS.The most evident effect of water deficit to the plant growth of samai was growth inhibition. Cell expansion and enlargement is one of the most sensitive processes affected by a change in plant water status (Begg and Turner, 1976).

Root Length

The data on root length was more in PM 29 (7.7cm and 12.0cm) and was closely followed by KRI 11-05 (7.0cm and 8.3cm). The variety MS -1211 recorded the minimum root length of 2.5cm and 7.3cm at 30 and 60 DAS.In this present study, the root length was increased under rainfed conditions. The study of Eghball and Maranville, (1993) revealed that increasing water deficit is associated with increasing root length and root weight i.e. intensive root length increased with increasing water deficit. This is mainly because of the fact that when the crops experience water stress, their roots penetrate deep in the soil to withdraw water and nutrients (Rhoads and Bennett, 1990).

Number of leaves

The leaf production in terms of number of leaves revealed that, Paiyur 2 recorded maximum number of leaves (7.0 and 8.8) at 30 and 60 DAS. The lowest number of 3.3 and 5.7 leaves was, however produced by variety MS -1211 recorded the minimum number of leaves (3.3 and 5.7) at 30 and 60 DAS. Leaf is considered as an important functional unit of plant, it is the most effective weapons in the crop economy and eventually their yield under the drought stress. In this present study, a significant increase in number of leaves in the entries of Paiyur 2 at 30 and 60 DAS. Drought reduced leaf area, dry matter accumulation, seed weight, radiation use efficiency and yield of finger millet. Drought significantly reduced the number of leaves per plant, leaf area per plant at vegetative and reproductive stage in finger millets. The reduction in leaf number under water stress may have been due to reduction in leaf formation and increased abscission of lower leaves eventually leading to wilting of the whole plant (Tezara, *et al.*, 2002).

Physiological and Biochemical parameters

Significant differences were observed for the bio chemical attributes. Leaf proline content was high in the variety MS 1236 (0.81 mg g^{-1}) and was par with all the varieties except MS 4700 and MS 4784. The variety MS 110 recorded the maximum protein content of 10.88 mg g^{-1} and was followed by KRI - 11-05, CO- 4 and MS-1236. Relative water content of the leaf was high in the variety MS 1236 (71.87 %) and was on par with KRI -11-05, MS 4700 and MS -110. The variety MS- 1236 recorded the maximum crop growth rate (g m^2day^{-1}) of 0.607 and 1.074 at 0- 30 DAS and 30-60 DAS respectively. Similar trend was observed in the relative growth rate also. Significant difference was observed for grain yield among the 10 varieties tested for drought tolerance. MS -1236 recorded the maximum yield of 1.73 tonnes per hectare and was on par with all the varieties except MS - 509, which recorded the lowest yield of 1.48 $tonnesha^{-1}$. The culture KRI -11-05 closely followed MS 1236 with the mean grain yield of 1.71 $tonnesha^{-1}$.

Table 1: Effect of drought on plant height, root length, number of leaves and yield of samai entries under rainfed conditions

Variety	30 DAS			60 DAS			Yield per hectare (t/ha)
	Plant height (cm)	Root length (cm)	No. of leaves	Plant height (cm)	Root length (cm)	No. of leaves	
Paiyur 2	38.7	4.3	7.0	64.0	8.3	8.8	1.57
PM 29	34.2	7.7	4.0	53.0	12.0	8.1	1.53
KRI -11-05	44.5	7.0	5.3	65.3	13.5	8.3	1.71
MS - 110	44.0	5.3	5.0	59.0	10.8	6.7	1.65
MS - 509	33.5	4.7	5.0	38.7	9.3	6.0	1.48
MS - 1211	29.5	2.5	3.3	38.3	7.3	5.7	1.54
MS - 1236	34.7	3.7	5.0	48.0	8.2	6.7	1.73
MS - 4700	39.8	5.0	5.0	55.0	10.2	7.1	1.57
MS - 4784	31.3	4.0	4.3	40.7	8.8	6.7	1.52
CO - 4	34.8	4.7	3.3	66.3	8.2	7.3	1.57
SE(d)	2.74	0.28	0.15	4.31	0.46	0.45	0.11
CD 0.05	5.78	0.58	0.32	9.06	0.96	0.95	0.22

Table 2: Effect of drought on plant height, root length, number of leaves and yield of samai entries under rainfed conditions

At 60 DAS				0-30 DAS		31-60 DAS	
Variety	RWC (%)	Proline (mg/g)	Protein (mg/g)	CGR ($g/m^2/day$)	RGR (g/g/day)	CGR ($g/m^2/day$)	RGR (g/g/day)
Paiyur 2	67.10	0.74	9.09	0.506	0.084	0.755	0.013
PM 29	67.67	0.67	9.18	0.599	0.087	0.898	0.013
KRI -11-05	71.25	0.77	10.67	0.508	0.084	0.872	0.014
MS - 110	70.52	0.76	10.88	0.320	0.077	1.040	0.018
MS - 509	67.29	0.67	9.32	0.398	0.081	0.243	0.007
MS - 1211	69.13	0.68	9.29	0.335	0.078	0.793	0.018
MS - 1236	71.87	0.81	10.35	0.607	0.087	1.074	0.021
MS - 4700	70.55	0.54	10.02	0.428	0.082	0.466	0.011
MS - 4784	68.28	0.44	8.55	0.256	0.074	0.314	0.012
CO - 4	67.15	0.78	10.35	0.321	0.078	0.861	0.019
SE (d)	1.94	0.04	0.46	0.02	0.003	0.045	0.001
CD 0.05	4.06	0.09	0.97	0.041	0.006	0.094	0.003

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