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RESEARCH PAPER

Physiological studies on evolution of soybean genotypes for drought tolerance

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Abstract **:** Studies were undertaken during 1998-99 in the Department of Crop Physiology, Agricultural College and Research Institute, Madurai to screen soybean genotypes for drought tolerance. The extent of drought tolerance was tested by photosynthetic rate, leaf water potential, leaf temperature, transpiration rate, stomatal diffusive resistance. The genotypes culture 425, UGM 34 and EC 2541 showed tolerance to drought due to higher photosynthetic rate, higher pod number per plant, higher yield among the genotypes tested.

Key Words **:** Drought, Genotypes, Soybean, Photosynthetic rate, Yield, Tolerance

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INTRODUCTION

The area under soybean cultivation in India has grown from 300 hectares in1967 to seven lakhs hectares as on today. But the average productivity per unit area is low due to several factors (Trikha, 1985). Raising soybean crop offers a number of advantages *viz.*, ability to fix nitrogen, low phosphorus requirement (Tadano and Tanaka, 1980), tolerance to low pH and high soil moisture content (Tadano *et al*., 1979). Many scientists have reported the adverse effects of water stress on soybean (Wein *et al*., 1979). Drought stress has been observed to be one of the factors causing low yields since soybean cultivation is confirmed mostly to drought prone areas.

The main objective of this study which was undertaken during the year 1998-99 was to evaluate different soybean genotypes and identify suitable cultivars for adoption in drought prone areas.

MATERIALS AND METHODS

The experiment was conducted to evaluate different soybean genotypes under rainfed condition with a view to select the drought tolerant types. A total of 30 genotypes of soybean were taken up for the study. The experiment was carried out during dry season of 1998-99 at Agricultural College and Research Institute, Madurai. The experiment was laid out in a Randomized Block Design replicated thrice with a spacing of 30 x 10 cm. The plot size was 5.0 x 8.0 m. Observations were recorded at the reproductive stage of the crop for the following physiological parameters. The water potential was measured using Pressure bomb Apparatus.

Leaf temperature, transpiration rate and stomatal diffusive resistance were determined by means of "Steady State Porometer" of make Licor, Lincoin, Nebraska, U.S.A. Photosynthetic rate was recorded in the top fully expanded leaf with the help of "Infra Red Gas Analyser" of model 225-2B-SS. At harvest date, yield components such as pod number/ plant and pod yield / plant were collected in randomly selected ten plants in each replication and in each genotype.

RESULTS AND DISCUSSION

During summer, the period of drought is common under dry land conditions. Crop plants modify their physiological activities in response to the water deficit conditions. The

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degree of adaptation of the crops varies with the genotypes. Some types exhibit higher ability to survive the unfavourable dry environment by modifying the physiological mechanism. In the present study as well, it was noticed that wide variations existed among the thirty genotypes of soybean in respect of the various physiological attributes studied.

Table 1 : Observations on photosynthesis and yield components

Sr. No.	Cultivars	Photosynthetic rate (mg CO_2 dm^{-2} h^{-1})	Pod No. $plant^{-1}$	Dry pod weight (g $plant^{-1}$)
1.	Culture 70	19.45	45	9.5
2.	EC 100776	20.63	40	7.4
3.	AM 5549	18.31	34	6.8
4.	Culture 189	19.07	29	5.7
5.	Culture 101879	26.36	56	15.5
6.	EC 109548	22.41	37	13.0
7.	EC 50084	16.75	38	8.4
8.	EC 15086	19.43	36	10.0
9.	MACS 125	23.61	28	8.8
10.	ACC No.2004	19.01	36	12.9
11.	EC 18733	19.09	54	11.4
12.	Culture 15590	18.63	43	9.0
13	SDDC	23.01	33	12.0
14.	PLSO-1	20.70	22	4.8
15.	UGM 34	26.41	57	16.8
16.	EC 62384	28.01	41	9.6
17.	DS 295	19.36	81	14.9
18.	EC109545	22.61	38	10.5
19.	PLSO-1	20.63	49	11.0
20.	EC 2541	24.10	58	15.8
21.	Culture 425	20.71	52	18.3
22.	UGM 30	28.69	43	13.6
23.	EC 95287	26.61	16	2.8
24.	EC 50082	24.31	23	5.0
25.	EC 109548	21.02	42	9.5
26.	EC 18226	19.41	37	13.5
27.	EC 141390	18.61	33	9.5
28.	EC 95258	22.01	41	13.0
29.	DC 13007	24.63	31	8.8
30.	EC 24058	23.07	41	13.3
	S.E. (d)±	1.410	1.112	1.323
	C.D. (P=0.05)	3.969	3.762	3.996

The observations recorded on leaf water potential, leaf temperature, transpiration rate and stomatal diffusive resistance are furnished in Table 2. The leaf water potential which ranged from -10.75 bars (culture 1018790) to -24 bars (EC 109548) showed wide variations in response to water deficit conditions. The fact that some of the genotypes maintained leaf water status at a higher level in spite of drought indicated their ability to survive under dry environment. Other parameters such as leaf temperature and transpiration rate also indicated wider genotypic variations. From the observations on these two parameters *viz.*, leaf temperature and transpiration rate, it could be observed that those genotypes which had higher rate of transpiration showed reduced leaf temperature. The stomatal diffusive resistance of leaf showed lower values in genotypes with higher transpiration rate. The existence of such an interrelationship among these physiological characters was already established in many field crops in previous studies (Roark and Quinseberry, 1977). In the study also, the negative relationship existing among these leaf parameters was brought out in the correlation studies (Transpiration rate Vs leaf temperature r = -0.69741**. Stomatal diffusive resistance Vs transpiration rate r = -0.6049*. Leaf water potential Vs leaf temperature r = -0.5617).

It has been stated that because of lower stomatal resistance which means higher leaf conductance, transpiration rate increases with concomitant reduction in leaf temperature brought about by evapotranspiration process.

Rate of photosynthesis varied significantly among the soybean genotypes. Among the cultivars studied cultures *viz.*, UGM 30 (28.69), EC 62384 (28.01, EC 95287) (26.61) and UGM 34 (26.41) recorded higher photosynthetic rate. Photosynthesis is the major physiological process that determines the yield in crop plants. In soybean, photosynthesis may influence yield through N_2 fixation because the root nodules consume a considerable amount of carbohydrates. It was further observed that the genotypes which possessed higher stomatal resistance exhibited decreased photosynthesis, the reason being lower diffusion rate of CO_2.

It was seen that the genotypes exhibited wide variability in respect of pod number per plant. The high yielder identified in this study *viz.*, culture 425, UGM 34 and EC 254 possessed greater number of pods. Previous studies in soybean also indicated that yield variation was mainly due to variation in pod number. Thus, it could be seen that the pod number was an important factor contributing for increased yield in soybean.

Even though some of the genotypes such as UGM 30, EC 62384 and EC 95287 had shown higher rate of photosynthesis, their yield was not greater. Although photosynthetic efficiency is the primary component of drymatter productivity, it has however, been found to be inconsistently related to economic yield (Gaskel and Pearce, 1981) because of several factors like photorespiration, dark respiration, translocation of assimilated and partitioning efficiency, sink size, etc. It was evident that both higher

Table 2 : Observations on physiological parameters in soybean genotypes

Sr. No.	Cultivars	Leaf water potential (bars)	Leaf temperature (°C)	Transpiration rate (m.moles m^{-2} s^{-1})	Stomatal diffusive resistance (dcm^{-1})
1.	Culture 70	-16.25	33.00	8.28	2.13
2.	EC 100776	-15.75	32.45	7.72	2.01
3.	AM 5549	-17.25	32.70	7.57	3.66
4.	Culture 189	-17.25	33.40	6.36	2.71
5.	Culture 101879	-10.75	32.45	10.03	2.19
6.	EC 109548	-11.25	31.85	11.47	1.24
7.	EC 50084	-13.25	31.60	12.03	2.45
8.	EC 15086	-14.75	31.65	11.11	1.27
9.	MACS 125	14.25	31.90	14.03	1.25
10.	ACC No.2004	-14.75	32.55	10.57	3.45
11.	EC 18733	-14.00	32.20	10.56	3.33
12.	Culture 15590	-21.75	32.55	15.20	3.19
13	SDDC	-20.75	32.10	11.43	1.11
14.	PLSO-1	-12.75	32.35	7.83	5.91
15.	UGM 34	-11.25	32.05	6.64	2.51
16.	EC 62384	-15.50	32.10	5.23	2.77
17.	DS 295	-19.75	38.10	8.24	2.07
18.	EC109545	-16.75	31.55	15.02	1.89
19.	PLSO-1	-17.75	32.90	8.71	3.01
20.	EC 2541	-14.75	33.10	3.84	2.58
21.	Culture 425	-12.25	33.50	4.59	3.95
22.	UGM 30	-15.75	32.35	7.31	2.46
23.	EC 95287	-16.25	32.20	5.29	2.30
24.	EC 50082	-21.40	33.25	6.41	3.07
25.	EC 109548	-24.00	33.20	7.16	3.14
26.	EC 18226	-15.25	32.55	7.75	3.32
27.	EC 141390	-20.25	32.35	10.20	1.54
28.	EC 95258	-15.75	32.50	8.61	2.85
29.	DC 13007	-15.75	32.80	8.36	2.63
30.	EC 24058	-11.75	31.60	14.23	1.95
	S.E.(d)±	1.430	1.730	1.267	0.281
	C.D. (P=0.05)	3.792	3.962	3.393	1.064

photosynthetic rate and pod number should be essential for achieving higher pod yield in soybean. It could be said that the high yielders, culture 425, UGM 34 and EC 2541 produced greater pod yields by virtue of their high rate of photosynthesis and pod number per plant.

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