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Research Article

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Effect of Water Logging Condition on Growth, Physiology and Yield Characteristics of Soybean Genotypes (*Glycine max* L.) Merrill)

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ABSTRACT

Water logging is one of the environmental stresses that affect the growth, physiology and yield attributes injured due to the anaerobic environment. The objective of above investigation was to study the variation in Growth, physiological and yield characteristics in soybean genotypes/varieties. The genotypes were grown under excess moisture condition and recommended cultivation (control). The experiment was carried out at the research of Plant Breeding & Genetics, RAK College of Agriculture, Sehore (M.P.) during 2014 seasons. A total of 25 soybean genotypes/varieties were grown in complete randomized block design with three replications having 5 rows 40cm apart with 3meter row length of every genotype. Water logging was created at 20 DAS, 40 DAS and 60 DAS in event of no rains after planting by applying water level about 5 cm above the soil surface. The mean data of the all characters viz. plant height, number of branches/plant, number of nodules/plant , dry weight of nodules/plant, ascent of sap in (%), transpiration rate in (mmol H_2O m^{-2} s^{-1}*), harvest index (%) and yield (q/ha.) were computed for statistical analysis as per the standard procedure given by (Panse & Sukhatme 1989). The results revealed that soybean could grow and produce grains even under water logging condition. The significant differences were observed among the genotypes for major growth physiological and yield attributes except number of branches, number of nodules and ascent of sap in the year. Further the result revealed that high magnitude of characters like plant height, dry weight of nodules, transpiration rate harvest index and yield per hectare were found in genotypes/varieties RVS2007-7, JS2069, RVS2007-1, RVS2001-4 and JS 2059 in the year as compare to control. Hence these genotypes/varieties were found suitable under waterlogged condition.*

Keywords: *Excess moisture Stress, Genotype, Ascent of sap, Transpiration rate, Yield traits*

INTRODUCTION

Soybean (*Glycine max* (L.) Merrill.) with its 40-42 percentage protein and 20-22 percentage oil has emerged as one of the major oil seed crop in India it has now been established as one of the most important oil seed crop in the world.

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Accounting for more than 50 percent of oil seeds production and 30 percent of the total supply of all vegetables oil. Among the various growth stages of soybean, vegetative and flowering period have been found to be most sensitive to excess moisture. The Kharif season of soybean cropping in M.P. is characterized as a monsoon season with gradual increase of soil water content to an excess extent, after a long-term dry season known as Rabi. In the Kharif season, soybean seeds germinate in an optimum soil moisture condition, but suffer in later growth stages from excess moisture conditions due to continuous raining, consequently developing poor root systems by the time of flowering. The end of monsoon corresponds to flowering and maturity stages, thereafter soybean plants further suffer from water deficit due to the poor root system developed in the excess soil moisture. Thus, soybean plants during Kharif season in M.P. face excess moisture stress till flowering as well as water deficit during the maturity. Identification and use of soybean genotypes that develop good root systems in excess soil moisture conditions during the monsoon to tolerate water deficit during maturity is an important approach to increase or stabilize soybean yields in M.P. The field conditions soybean is very sensitive to excess water compared to other crops. The response to excess water in soybeans is associated with a number of biochemical, morphological and anatomical changes in both the root and the shoot (Richard et al. 1994; Bacanamwo and Harper 1997). Bacanamwo and Purcell (1999) reported that morphological mechanisms of acclimation to flooding stress in soybean appear to involve an avoidance of water loss by transpiration and a facilitated transport of atmospheric O_2 to the submerged roots through the flood-induced formation of adventitious roots and aerenchyma. The effects of water logging on soyabean root development are substantial and generally negative (Sallam and Scott 1987). However, short-term acclimation to flooding through biochemical mechanisms may limit the impacts of injurious factors (Vartapetian & Jackson 1997). Long-term flood tolerance may require morphological adaptations in the plant to sustain adequate aeration and functioning of the root system (Bacanamwo & Purcell 1999). Extensive adventitious root development has been reported to enhance oxygen transport from the stem to the roots (Visser et al., 1996). Flooding increased adventitious root fresh weight as a percentage of total root weight (Bacanamwo & Purcell 1999). While yield and seed qualities are typically selection criteria (Van Toai et al., 1994). Therefore the present investigation was undertaken to physiological evaluation of soybean cultivars under excess moisture stress.

MATERIALS AND METHODS

The field experiment was carried at research farm of RAK College of Agriculture, Sehore (M.P.) during 2014 season. Twenty five genotypes/ varieties were grown under three conditions *viz.* excess moisture condition and recommended cultivation (Control). All the treatments were replicated thrice in a complete randomized block design and each genotypes was grown 5 rows 40cm apart with 5meter row length. The recommended dose of fertilizer for soybean was 20, 60, and 20 kg N, P and kg/ha, respectively. The seeds were treated with thirum and bevestin, PSB and rhyzobium culture before sowing. The observations on five competitive plants from every genotype and each replication were recorded as per schedule of the action plan during 2013 and 2014. The root system measure was carried out by cutting of plant from six inches of ground level at blooming stages then wrapped with cotton & immediate tight with rubber bend then removed cotton & recorded weight after 24 hours and finally recorded ascent of sap in mg. Similarly the transpiration rate was measured in mmol H_2O m^{-2} s^{-1} at flowering stage by using automatic Li-cor 6400 photosynthesis system. The plant growth and yield attributes were recorded at flowering and harvesting stages on five randomly selected plants from every genotypes and replication *viz.* plant height, number of branches/plant, number of nodules/plant , dry weight of nodules/plant, harvest index (%) and yield (q/ha.) were computed for statistical

analysis as per the standard procedure given by (Panse & Sukhatme 1989).

RESULTS AND DISCUSSIONS

Growth, Physiological and Yield Characteristics -

The interaction between genotypes and environment *viz*., excess moisture exerted significant impact on plant height per plant , dry weight of nodules, transpiration rate (mmol H_2O m^{-2} $s^{-1)}$ at flowering, harvest index (%) and yield (q/ha) at harvesting during 2014 while most of the genotypes did not show significant differences among them (Table -1). Different characters under present investigation revealed that the plant height per plant was found significant differences among the varieties. However variety RVS2007-7 recorded maximum plant height per plant (56.00 and 52.40) both the environment at flowering stage and it was at par with all other genotypes under excess moisture and normal condition followed by genotypes JS2069 (54.60,51.90), RVS2007-3 (53.62, 51.80) and RVS2001-4 (53.58, 51.30) while minimum plant height found was genotype RVS2007-6 (46.80, 37.90) respectively. Water logging occurring in early vegetative phase (V_2) and early reproductive phase (R_1, R_2 and R_3) are the major sensitive phases reported by (Linkemer et al., 1998). However variety RVS 2007-7 exhibited the maximum number of branches per plant (5.56, 4.89) both the environment at flowering and it was at par with all other genotypes under excess moisture and normal condition followed by genotypes JS2069 (5.36, 4.80), RVS2007-3 (5.35,4.76) and RVS2001-4 (5.33, 4.67) while minimum number of branches per plant found was genotype JS20-87 (4.11,3.44) respectively. It is because waterlogging suppressed branches formation causing less number of branches per plant reported by (Linkemer et al., 1998) also reported a significant decline in branch number after 7 days of flooding at various vegetative and reproductive growth stages. The maximum number of nodules per plant found was genotype RVS 2007-7 (83.70, 69.80) both the environments and it was at par with all other genotypes under excess moisture and normal condition followed by JS20-69 (79.89,55.92) while minimum number of nodules per plant noticed genotype JS20-79 (47.67, 35.00) However varieties RVS 2007-7 exhibited the maximum dry weight of nodules per plant at flowering (0.64, 0.60) both the environment at flowering and it was at par with all other genotypes under excess moisture and normal condition followed by genotypes JS2069 (0.63, 0.50) and RVS2007-3 (0.62, 0.45) while minimum dry weight of nodules per plant found was genotype JS20-71 (0.30,0.19) respectively. They conditions lead the plants experiencing water excess stress that occur if the water availability in the soil is more than plant's requirement. In this condition a plant will experience root organ damage and it can be toxic to the plant because of anaerobic condition reported by (Ariffin, 2002). The maximum ascent of sap was obtained higher in varieties RVS 2007-7 (41.62,36.29) at flowering stages both the environments followed by JS20-69 (38.91, 35.59), and RVS2007-3 (38.02,35.29). However minimum ascent of sap was noticed by genotype JS20-71 (27.73, 21.63) respectively. The transpiration rate was obtained higher in varieties RVS 2007-7 (5.45,3.92) at flowering stages both the environments followed by JS20-69 (4.96,3.75), RVS2007-3 (4.85,3.50) and RVS2001-4 (4.59,3.30). However minimum transpiration rate was noticed by genotype RVS2007-2 (2.54, 1.58) respectively. The maximum harvest index varieties RVS 2007-7 (69.35, 45.83) and seed yield (18.2, 11.98) was found both the environments followed by varieties JS2069 (65.70, 40.80) and seed yield (16.4,11.75). However minimum harvest index obtain by varieties RVS2007-6 (28.12, 23.53) and seed yield NRC 7 (7.1,5.17) respectively. It also reported by (Kuswantoro, 2011) yield loss can reach up to more than 60% in soybean applied with periodically water logging.

Table 1: Growth, physiological and yield characteristics of Soybean genotypes/varieties under waterlogging condition

Genotypes	Plant height (cm) at flowering		No. of Branches/plant at flowering		No. of Nodules/plant at flowering		Dry weight of Nodules (g) at flowering		Ascent of sap (%) at flowering		Transpiration rate (mmol H_2O m^{-2} s^{-1}) at flowering		Harvest index (%)		Yield (q/ha.)	
	Control	E. M.	Control	E. M.	Control	E. M.	Control	E. M.	Control	E. M.	Control	E. M.	Control	E. M.	Control	E. M.
RVS 2007-1	52.40	51.10	5.11	4.44	59.00	48.70	0.50	0.31	32.80	26.04	4.12	1.86	50.27	32.41	13.6	10.23
RVS2007-2	53.62	47.20	5.35	3.67	67.56	49.90	0.50	0.37	38.02	31.92	2.54	1.58	41.97	33.59	11.9	10.38
RVS 2007-3	53.30	51.80	5.35	4.76	74.70	55.86	0.62	0.45	36.56	35.29	4.85	3.56	57.03	39.67	15.60	11.00
RVS 2007-4	53.60	46.00	4.18	3.89	59.80	39.60	0.53	0.44	35.34	33.30	3.12	2.31	30.77	39.13	11.7	9.41
RVS 2007-5	49.10	44.40	4.44	4.67	50.60	44.40	0.36	0.28	29.64	35.29	3.66	2.71	38.95	34.22	10.1	8.00
RVS 2007-6	46.80	37.90	4.56	4.33	72.20	42.90	0.50	0.20	28.43	28.90	3.74	2.77	28.12	23.53	14.1	7.66
RVS 2007-7	56.00	52.40	5.56	4.89	83.70	69.80	0.64	0.60	41.62	36.29	5.45	3.92	69.35	45.83	18.2	11.98
JS 95-60	51.80	48.70	4.40	4.09	56.90	43.20	0.50	0.24	32.87	28.34	2.85	3.17	38.69	37.02	14.2	8.62
JS 9305	54.40	45.30	4.56	4.44	70.89	53.33	0.42	0.33	31.25	27.56	4.12	2.69	45.87	37.22	13.8	8.69
JS 335	47.00	49.30	4.78	4.65	59.40	41.30	0.41	0.27	36.56	33.92	3.84	3.56	34.72	28.77	14.2	8.90
JS 97-52	55.10	49.30	4.22	4.11	66.10	51.78	0.59	0.30	33.55	30.38	4.57	2.69	37.72	31.10	12.8	10.94
BREGG	53.30	41.80	4.22	3.83	54.70	48.11	0.56	0.38	34.02	32.62	3.55	2.80	32.39	34.57	13.8	10.56
NRC 37	46.20	48.00	4.78	4.46	65.90	51.10	0.43	0.36	28.97	25.08	3.05	2.41	46.79	33.00	12.9	9.20
NRC 7	53.40	40.70	4.78	3.78	70.00	51.00	0.40	0.32	35.66	30.49	2.96	2.34	37.60	38.43	7.1	5.17
RVS 2001-4	53.58	51.30	5.33	4.69	74.33	55.00	0.61	0.45	37.34	35.20	4.59	3.30	56.30	39.13	15.2	10.95
JS 20-50	52.90	42.80	4.33	4.20	55.44	39.30	0.36	0.25	38.91	30.92	3.65	2.88	52.44	38.65	16.4	10.77
JS 20-53	54.60	52.90	4.67	4.22	58.10	48.00	0.40	0.30	36.98	29.43	3.41	2.39	36.30	30.91	10.9	9.76
JS 20-59	53.40	51.20	5.31	4.67	74.68	52.30	0.58	0.42	36.70	34.19	5.75	3.21	53.24	39.03	14.1	10.78
JS 20-69	54.60	51.90	5.36	4.80	79.89	55.92	0.63	0.50	38.91	35.59	4.96	3.75	65.70	40.80	16.4	11.75
JS 20-71	50.30	47.00	4.56	3.78	70.70	49.40	0.30	0.19	27.73	21.63	3.01	2.11	30.75	28.72	14.1	9.44
JS 20-73	50.60	45.80	4.78	4.22	68.78	42.30	0.48	0.30	35.64	34.19	2.95	2.07	46.19	34.66	11.3	7.51
JS 20-79	48.70	44.70	4.67	3.67	47.67	35.00	0.30	0.28	32.65	28.65	2.88	2.61	53.49	33.69	14.1	10.77
JS 20-80	50.20	40.00	4.33	3.89	63.67	45.70	0.40	0.31	36.08	26.60	3.47	1.91	45.59	39.03	10.6	9.81
JS 20-86	53.40	49.00	4.33	4.17	69.40	43.80	0.53	0.35	36.70	30.02	3.75	2.06	48.16	38.49	12.3	9.69
JS 20-87	52.10	48.00	4.11	3.44	66.40	42.70	0.30	0.31	36.43	35.29	3.78	2.08	42.65	29.54	13.6	9.52
Mean	**49.40**	**47.50**	**4.28**	**4.27**	**55.89**	**54.49**	**0.46**	**0.34**	**33.26**	**29.48**	**3.71**	**2.61**	**44.84**	**34.74**	**13.17**	**9.55**
CD 5%	**7.40**	**9.41**	**NS**	**NS**	**NS**	**NS**	**NS**	**0.24**	**NS**	**NS**	**0.60**	**0.65**	**14.22**	**12.99**	**155.3**	**114.8**
CV	**8.94**	**11.09**	**25.9**	**20.9**	**37.39**	**36.75**	**34.50**	**31.20**	**31.03**	**30.88**	**11.4**	**10.80**	**18.90**	**22.28**	**19.3**	**19.9**

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CONCLUSION

Soybean was still able to grow and produce grains even in a waterlogging condition almost throughout its life cycle. Genotype RVS2007-7 had the highest seed yield (q/ha) under both the environments followed by JS20-69 and RVS2007-3 varieties. Genotypes had the highest seed yield was supported by a many number of pods per plant. The nutrient content in surface water need to be analyzed due to adventitious roots cannot absorb nutrients from the soil that have rich nutrients.

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