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Effect of Water Regimes on Physiological Parameters of Indian Bean (*Lablab purpureus* L.)

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Abstract: *An experiment involving the effect of water regimes on physiological parameters of Indian bean (Lablab Purpureus L.) variety Katargam, GNIB-21, GP-1, Wal-125-36, Guj. Wal-1 and Guj. Wal-2 was conducted at Navsari Agricultural University, Navsari, during 2014-15. Four treatments viz.,* I_0 *-Control, All irrigation given i.e. 30, 60, 95 DAS,* I_1 *-Two irrigation level given i.e. 30, 60 DAS,* I_2*- One irrigation level 30 DAS and* I_3*- Rainfed was given. The various Physiological parameters like LAI, plant height ,number of branches, days to 50% flowering, number of pod per pant and seed per pod were studied at 30 days intervals after stress i.e. 30, 60 and 90 DAS and at harvest. Studies reported that the application of stress conditions at different growth stages of Indian bean was found to be lowers the different physiological parameters. Among the treatments,* T_1 *treatment i,e., vegetative stage, shows the reduced LAI, Plant height and number of branches per plant.* T_2 *treatment i,e., Flowering stage, shows reduced Days to 50% flowering and decreases the pod setting.* T_3 *treatment i,e., seed formation stage, significant reduced the number of pod/plant and number of seed per pod. Control treatment i.e., irrigation as per recommendation, showed the normal physiological parameter compared to treatment of stress.*

Keywords: *Indian bean, Stress, Physiological parameters.*

INTRODUCTION

Indian bean *i.e.*, *Lablab purpureus* (L.) Sweet (2*n* = 22) with a large biomass and strong capacity for nitrogen fixation is belonging to family *Fabaceae* family and is widely cultivated in India, china and Southeast Asia. Indian bean is the important grain legume for human consumption. Given that most protein consumed by the poor is from plant sources, being protein-rich, beans play an especially significant role in the human diet. Hyacinth bean possesses excellent characteristics for field production, such as tolerance to drought and salinity stress. The responses of plants to drought stress are complex, including the interaction between the environment and various metabolic pathways.

Drought stress occurs when the available water in the soil is reduced and atmospheric conditions cause continuous loss of water by transpiration or evaporation. Drought stress is characterized by reduction of water content, diminished leaf water potential and turgor loss, closure of stomata and decrease in cell enlargement and growth. Severe water stress may result in the arrest of photosynthesis, disturbance of metabolism and finally the death of plant. Water stress inhibits cell enlargement more than cell division. It reduces plant growth by affecting various physiological and biochemical processes, such as photosynthesis, respiration, translocation, ion uptake, carbohydrates, nutrient metabolism and growth promoters (Jaleel *et al*., 2009).

Water deficit and salt stresses are global issues to ensure survival of agricultural crops and sustainable food production. Tolerance to abiotic stresses is very complex, due to the intricate of interactions between stress factors and various molecular, biochemical and physiological phenomena affecting plant growth and development. High yield potential under drought stress is the target of crop breeding. In many cases, high yield potential can contribute to yield in moderate stress environment (Jaleel *et al.*, 2009). Conventional plant breeding attempts have changed over to use physiological selection criteria since they are time consuming and rely on present genetic variability.

MATERIALS AND METHODS

A field experiment was conducted at College Farm, N. M. College of Agriculture, Navsari Agricultural University, Navsari, during rabi season, 2014-2015. There were four treatment consisting of I_0-Control, All irrigation given *i.e.* 30, 60, 95 DAS, I_1-Two irrigation level given *i.e.* 30, 60 DAS, I_2-One irrigation level 30 DAS and I_3-Rainfed. Experiment was laid out in strip plot design with three replications.

Dry sowing of Indian bean variety Katargam, GNIB-21, GP-1, Wal-125-36, Guj. Wal-1 and Guj. Wal-2 was done on raise bed using seed rate of 5-7 kg/ha and maintaining spacing of 60 × 30 cm. The recommended dose of fertilizer was 25 kg Nha^{-1} and 50 kg P_2O_5 ha^{-1}. N and P_2O_5 were applied using urea and single super phosphate, respectively. Plants were harvested after attaining physiological maturity. The data collected from the experiment were subjected to statistical test by following 'Analysis of variance technique' as suggested by Panse and Sukhatme (1985).

RESULT AND DISCUSSION

Plant Height

The data on highest plant height recorded at various growth stages in variety Guj. Wal-1 are presented in (Table 1). The data indicated that the plant height increased progressively till harvest. At all the growth stages, *i.e.* at 30, 60 and 90 DAS the plant height significantly reduced due to stress. The results were similar to the Hassan *et al.*, (2014) recorded plant height for each cultivar during treatment period and at recovery stages. Drought stress has been found to decline the linear growth of shoots in all the cultivars as compared to those of controlled plants. The reduction in plant height is generally associated with a decline in the cell enlargement under water deficit which is greatly hampered due to low moisture.

Number of Branches Per Plant

The data ofbranches per plant of different six Indian bean varieties at 30, 60 and 90 DAS under different four irrigation levels are presented in (Table 1). The difference in the branches per plant was found to be significant in all six varieties and at different irrigation levels. The more number of branch per plant observed in Guj. Wal-1. The results were identical with Uddin *et al.*, (2013). The decrease in the number of branches may be due to lower biomass accumulation and least photosynthesis under water stress condition.

Days to 50% Flowering

The Days to 50 % flowering with the mean data (Table 1) showed that irrigation level significantly affected the days to 50% flowering and I_0 treatment was found to delay flowering as compare to other while stress condition I_3 is responsible for early flowering. The variety and water stress interaction condition was found significant for days to 50 per cent flowering. The results were found homogenous to Deshmukh and Mate (2013) and Sharma *et al.* (2010) Days to 50% flowering are an important phenological stage which determines the plant productivity.

Leaf Area and Leaf Area Index

The mean data indicated that under water stress condition leaf area and leaf area index (Table 1) was significantly decreased compared to irrigated condition. The result is in close arrangement with the findings of D'souza *et al.*, (2014) and Hassan *et al.*, (2014). It is reported that reduction of leaf area is an important adaptive mechanism for drought and is usually the first strategy a plant adopts under water stress. The plant showed reduction in number of leaves and area of leaves as well as curling due to loss of turgidity.

Number of Pods Per Plant and Number of Seed Per Pod

The number of pod per plant and number of seed per pod (Table 2) was significantly reduced under water stress *i.e.* under I_3 and I_4. More number of pod per plant and number of seed per pod were recorded under irrigated condition *i.e.* under I_0 and I_1 and

Table 1
Effect of irrigation intervals on plant height, No. of branches per plant, Days to 50% flowering, Leaf area, LAI andRWCof six Indian bean varieties at different irrigation interval

Genotypes	*plant height (cm)*			*No. of branches per plant*			*Days to 50% flowering*			*Leaf area*			*LAI*			*RWC*		
	30 DAS	*60 DAS*	*90 DAS*	*30 DAS*	*60 DAS*	*90 DAS*				*30 DAS*	*60 DAS*	*90 DAS*	*30 DAS*	*60 DAS*	*90 DAS*	*30 DAS*	*60 DAS*	*90 DAS*
Katargam	25.01	45.85	61.06	1.83	3.94	4.83	65.83			17.51	21.47	22.67	9.79	11.92	12.59	64.33	54.43	35.83
GNIB-21	16.70	26.55	41.41	1.58	2.88	3.44	41.25			10.76	14.05	15.59	5.98	7.80	8.66	66.17	56.77	38.50
GP-1	28.74	47.54	63.13	1.87	2.89	3.94	60.25			14.76	18.31	19.99	8.22	10.17	11.10	65.75	56.06	36.58
Wal- 125-36	28.95	48.66	63.98	1.08	2.03	2.85	57.17			17.26	21.27	22.12	9.59	11.81	12.29	65.67	55.48	36.50
Guj. Wal- 2	29.51	49.03	64.42	1.10	2.16	3.12	56.00			11.06	15.82	17.87	6.14	8.79	9.93	68.67	57.51	40.25
Guj. Wal- 1	31.27	53.23	68.00	1.75	2.38	3.45	57.42			12.83	16.67	18.04	7.13	9.26	10.02	65.75	56.66	38.25
Irrigation																		
I_0	27.74	47.35	63.10	1.66	3.19	4.16	62.67			13.97	20.41	21.62	7.76	11.34	12.01	68.33	59.02	40.06
I1	27.08	46.15	61.52	1.58	2.82	3.79	59.61			14.61	18.86	20.39	8.12	10.48	11.33	66.94	57.07	38.56
I2	26.46	44.72	59.62	1.51	2.58	3.35	54.89			13.44	16.97	18.52	7.46	9.43	10.29	64.72	55.23	36.78
I3	25.51	42.36	57.11	1.39	2.27	3.12	48.11			14.11	15.48	16.99	7.89	8.60	9.44	64.22	53.30	35.22
30 DAS	I	G	I × G	I	G	I × G				I	G	I × G	I	G	I × G	I	G	I × G
S.E.m+	0.48	0.53	1.10	0.04	0.05	0.21	I	G	I × G	2.27	0.31	1.04	0.16	0.18	0.58	0.87	0.77	1.95
C.D.@ 5 %	NS	1.67	NS	0.13	0.17	NS	1.02	1.48	0.35	NS	0.98	NS	NS	0.56	NS	3.01	2.43	NS
C.V. %	7.63	6.90	7.14	10.21	12.44	24.05	3.53	4.65	1.02	8.23	7.73	12.9	8.79	7.87	12.96	5.59	4.05	5.10
60 DAS	I	G	I × G	I	G	I × G	7.69	9.09	1.08	I	G	I × G	I	G	I × G	I	G	I × G
S.E.m+	0.95	0.93	1.73	0.05	0.08	0.31				0.43	0.60	0.94	0.24	0.33	0.52	0.95	0.74	2.07
C.D.@ 5 %	3.28	2.94	NS	0.19	0.26	NS				1.48	1.89	NS	0.82	1.05	NS	3.30	NS	NS
C.V. %	8.9	7.15	6.64	8.44	10.47	19.78				10.12	11.59	9.09	10.11	11.59	9.09	7.22	4.56	6.4
90 DAS	I	G	I × G	I	G	I × G				I	G	I × G	I	G	I × G	I	G	I × G
S.E.m+	1.07	1.79	2.66	0.08	0.13	0.28				0.48	0.67	0.85	0.26	0.37	0.47	0.38	0.78	2.03
C.D.@ 5 %	3.70	5.65	NS	0.29	0.42	NS				1.65	2.10	NS	0.92	1.17	NS	1.32	2.47	NS
C.V. %	7.52	1029	7.65	9.96	12.79	13.35				10.46	11.92	7.59	10.46	11.92	7.59	4.29	7.23	9.34

Table 2
Effect of irrigation intervals on Photosynthetic rate, stomatal conductance, Number of pod per plant, Number of seeds per pod and Tw. 100 seedsof six Indian bean varieties at different irrigation interval

Genotypes	*Photosynthetic rate*			*Stomatal conductance*			*Number of pod*			*Number of seeds per plant*			*Tw. 100 seeds per pod*		
	30 DAS	*60 DAS*	*90 DAS*	*30 DAS*	*60 DAS*	*90 DAS*									
Katargam	8.58	13.83	16.58	0.66	1.26	1.47	39.00			3.84			15.88		
GNIB-21	9.42	16.50	19.33	0.74	1.36	1.57	24.83			3.85			14.95		
GP-1	9.17	14.83	17.67	0.71	1.31	1.52	25.75			3.87			18.95		
Wal- 125-36	8.67	13.92	17.17	0.68	1.29	1.50	24.58			3.85			20.65		
Guj. Wal- 2	10.92	17.58	20.50	0.85	1.47	1.68	33.67			3.91			21.51		
Guj. Wal- 1	9.25	15.67	18.58	0.73	1.36	1.56	29.00			4.00			23.25		
Irrigation															
I_0	9.22	17.00	20.39	0.60	1.61	1.94	36.78			3.98			19.98		
I_1	8.94	16.28	18.89	0.70	1.42	1.64	31.83			3.92			19.71		
I_2	9.56	14.89	17.72	0.78	1.26	1.41	27.28			3.88			19.09		
I_3	9.61	13.39	16.22	0.83	1.09	1.21	22.00			3.78			18.01		
30 DAS	*I*	*G*	*I × G*	*I*	*G*	*I × G*									
S.E.m+	0.14	0.32	1.06	0.016	0.019	0.053	I	G	I × G	I	G	I × G	I	G	I × G
C.D.@ 5 %	0.49	1.01	NS	0.057	0.059	NS	0.51	0.92	0.84	0.03	0.07	0.17	0.40	0.43	0.92
C.V. %	6.48	11.86	19.72	9.58	8.92	12.67	1.77	2.89	NS	0.11	NS	NS	1.37	1.34	NS
60 DAS	*I*	*G*	*I × G*	*I*	*G*	*I × G*	*7.38*	*10.79*	*4.93*	*3.37*	*6.01*	*7.62*	*8.78*	*7.70*	*8.30*
S.E.m+	0.39	0.52	1.22	0.023	0.038	0.026									
C.D.@ 5 %	1.35	1.64	NS	0.080	0.119	NS									
C.V. %	10.77	11.71	13.78	7.27	9.75	3.29									
90 DAS	*I*	*G*	*I × G*	*I*	*G*	*I × G*									
S.E.m+	0.37	0.52	1.26	0.028	0.036	0.026									
C.D.@ 5 %	1.29	1.63	NS	0.098	0.114	NS									
C.V. %	8.66	9.82	11.92	7.71	8.07	2.94									

variety Katargam and Guj. Wal-1 respectively. Result is in close association with the finding of Anitha *et al.*, (2015). It may be due to minimum number of branch per plant which ultimately reduced pod setting and which results in decrease in number of pod per plant under water stress condition compared to irrigated.

Test Weight of 100 Seed

From the result it was observed that maximum test weight of 100 seed (Guj. Wal-1) (Table 2) was recorded under irrigation condition I_0 and I_1. The test weight of 100 seed was significantly reduced under water stress I_2 and I_3. Result is similar to the finding obtained by Ahmad *et al.*, (2015). The reduction in seed weight may occur due decreased transport of photosynthates from source to sink under water stress condition.

Photosynthetic Rate (μ mol CO_2 m^{-2} s^{-1})

Periodical monitoring of photosynthetic rate (Table 2) indicated that, photosynthesis was significantly reduced under water stress condition. At 30 DAS mean photosynthetic rate was observed minimum (Guj. Wal-2) which increases in 60 DAS and 90 DAS in all the six varieties of the indian bean. This result was similar to the findings of Sohrawardy and Hossain (2014) and Krouma (2010). It was reported by Naresh *et al*. (2013) that the rate of net photosynthesis increased with the advancement of crop stage. Improved moisture supply increased the rate of net photosynthesis over I5 "control". At all the stages, I_1 (irrigation at 0.4 bar soil moisture tension) and I_2 (irrigation at 0.6 bar soil moisture tension) were found to be superior to other treatment at various levels of external CO_2 concentrations.

The rate of net photosynthesis decreased in all the varieties and treatments at various stages with the decrease in external CO_2 concentrations in mungbean genotypes. Leaf photosynthesis is an important biological process that directly influences plant growth and productivity. The leaf area is also an important factor which affects the photosynthesis, under moisture stress condition the leaf area is significantly reduced which results in lower rate of photosynthesis.

Stomatal Conductance (mol CO_2 m^{-2} s^{-1})

The mean data of the stomatal conductance indicated that the stomatal conductance significantly decreased at 30 DAS, 60 DAS and 90 DAS (Table 2). Also there was a significant reduction of stomatal conductance in stress condition. Higher stomatal conductance observed in variety Guj. Wal-2. The results obtained were similar to the research findings of Sohrawardy and Hossain (2014). They reported that stomatal conductance was highest in Lublab purpurieus showed 0.0 μmol m^{-2} s^{-1} stomatal conductance in nearly dry watering treatment, but in fully watered treatments stomatal conductance uplift to 0.1μ mol m^{-2} s^{-1}.

During water stress the stomatal pore can be closed to reduce water loss. By closing the stomatal pore the water use efficiency is increased, reducing the amount of water lost per CO_2 molecule assimilated thus reducing the transpiration rate. Plants grown under drought condition have a lower stomatal conductance in order to conserve water. Consequently, CO_2 fixation is reduced and photosynthetic rate decreases, resulting in less assimilate production for growth and yield of plants. Diffusive resistance of the stomata to CO_2 entry probably is the main factor limiting photosynthesis under drought.

Relative Water Content (%)

The data of relative water content at 30 DAS, 60 DAS and 90 DAS are present in (Table 1). Result indicated that variety had non-significant effect on relative water content, while it was significantly affected by water stress level at all growth stages. The results were identical with Suresh *et al*., (2013), D'souza and Devaraj (2011) and Kumar *et al*. (2011). A progressive water stress causes significant physiological and biochemical changes in indian bean and pigeonpea. RWC parameter could be used to select high-yielding genotypes in indian bean and pigeonpea that maintain cell turgor under water deficit environment.

CONCLUSION

The present study on the effect of water stress on physiological, yield and yield component under rabi season revealed that the stress at 60 DAS and 90 DAS leads to severe loss of yield in the indian bean genotypes by reducing the plant height, number of branches, number of pods per plant, number of seeds per pod, seeds yield per plant, test weight of 100 seed, total biomass, photosynthetic rate and stomatal conductance. It can be used as an evaluating parameter for irrigation scheduling and for screening drought resistant varieties. The findings of the present study would help for evaluating genetic variation for drought tolerance in indian bean genotypes. In future, more emphasis may be laid on physiological studies, which result in better understanding of the mechanism of plant survival under water stress condition. Increasing crop tolerance to water limitation would be the most economical approach for enhancing productivity and to reduce agricultural use of fresh water resources purposes.

References

Ahmad, A., Muhammad Selim, M., Alderfasi, A. A. and Afzal, M. (2015), Effect of drought stress on mungbean (*Vignaradiata*L.) under arid climatic conditions ofSaudi Arabia.*WIT Transactions on Ecology and The Environment*, 192: 185-193.

Anitha, Y., Vanaja, M., Sunitha, V., Sowmya, P., Sathish, P. and Kumar, G.V. (2015), Performance of blackgram genotypes under moisture deficit stress-Variability in physiological and yield contributing attributes. *International Journal of Current Science*, 17: 82-89.

Banu, N.R.L. and James, J.E. (2008), Effect of water stress on peroxidase and polyphenol oxidase activity in *lablab purpureus* (L.) sweet. *Plant Archives,* 8(1): 199-201.

D'souza, M.R. and Devaraj, V.R. (2011), Specific and non-specific responses of hyacinth bean (*Dolichos lablab*) to drought stress. *Indian Journal of Biotechnology*, 10: 130-139.

D'souza, M.R., Kokila, S. and Devaraj, V. R. (2014), Polyamine levels in leaves of hyacinth bean (*Lablab purpureus*) and their relation to drought-tolerance. *World Applied Sciences Journal*, 32(12): 2398-2402.

Deshmukh, D.V. and Mate, S.N. (2013), Evaluation of Pigeonpea Genotypes for Morpho-Physiological Traits Related to Drought Tolerance. *World Journal of Agricultural Sciences*, 9(1): 17-23.

Hassan, M.R., Amodu, J.T., Muhammad, I.R., Jokthan, G.E., Abdu, S.B., Abdullahi, B., Adamu, H.Y., Musa, A., Sani, I. and Akpensuen, T.T. (2014), Forage yield and quality of lablab (*Lablab purpureus* L. Sweet) intercropped with maize (*Zea mays* L.) with flooded irrigation system in the semi-arid zone of nigeria. *Journal of Agricultural Science*, 6(11): 196-211.

Jaleel, C.A., Manivannan, P., Wahid, A., Farooq, A., Al-juburi, H.J., Somasundaram, R. and panneerselvam, R. (2009), Drought stress in plants: A review on morphological characteristics and pigments composition. *International Journal of Agriculture & Biology*, 11(1): 100-105.

Krouma, A. (2010), Plant water relations and photosynthetic activity in three Tunisian chickpea (*Cicerarietinum* L.) genotypes subjected to drought. *Turk J. Agric.*, 34: 257-264.

Kumar, R.R., Karajol, K and Naik, G.R. (2011), Effect of polyethylene glycol induced water stress on physiological and biochemical responses in pigeonpea (*Cajanuscajan* L. Millsp.). *Recent Research in Science and Technology*, 3(1): 148-152.

Naresh, R.K., Purushottam, A., Singh, S.P., Dwivedi, A. and Kumar, V. (2013), Effects of water stress on physiological processes and yield attributes of different mungbean (L.) varieties *African J. Biochem Res.*, 7(5): 55-62.

Panse, V. G. and Sukhatme, P. V. (1985), Statistical Methods for Agricultural Workers (Second edition), I. C. A. R., New Delhi.

Sharma, A., Rathod, P.S., and Chavan, M. (2010), Response of pigeonpea (*Cajanuscajan*) to drought management practices under rainfed conditions. *Karnataka J. Agric. Sci.*, 23(5): 693-700.

Sohrawardy, H. and Hossain, M.L. (2014), Response of short duration tropical legumes and maize to water stress: A glasshouse study. *Advances in Agriculture*, pp 1-12.

Suresh, K., Praveen Rao, V., Srinivas, A., Siva Sankar, A., and Govardhan, V. (2013), Relative water content as influenced by varied plant densities and irrigation levels in pigeonpea.*International Journal of Applied Biology and Pharmaceutical Technology*, 4(2): 63-68.

Uddin, S., Parvin, S. and Awal, M.A. (2013), Morpho-physiological aspects of mungbean (*vignaradiata*L.) In response to water stress. *International Journal of Agricultural Science*, 3(2): 137-148.