Journal of AgriSearch 2(3): 162-166
Peer Reviewed Quarterly
ISSN : 2348-8808 (Print), 2348-8867 (Online)

Morpho-Physiological Response of Selected Mungbean (*Vigna radiata* L.) Sri Lankan Genotypes to Drought Stress

DISNA RATNASEKERA* **AND AP THARANGANIE SUBHASHI**

Department of Agricultural Biology, Faculty of Agriculture, University of Ruhuna, Sri Lanka.

ARTICLE INFO

Received on	: 10.04.2015
Accepted on	: 12.06.2015
Published online	: 01.09.2015

ABSTRACT

Mung bean, member of Fabaceae is grown in most tropical and sub-tropical regions of world and have significant role in nutrition in developing countries. Irrigation and water resources are the most critical constrain in most tropics and sub-tropics thus our study aimed to investigate resistance of widely cultivated mung bean genotypes of Sri Lanka ARI, MI -5and MI-6 for its morpho-physiological responses to drought stress during vegetative and reproductive growth stages. A greenhouse pot experiment was carried out under randomized complete block design with five replications and relative water content of leaves, soil moisture content, plant dry matter, leaf area and grain yield and yield components were measured. Results showed that there was no significant difference between control and drought stress during reproductive growth stage on yield and yield components, but drought stress during vegetative growth stage decreased yield and yield components significantly.The genotype and growth stage both had a significant effect on leaf area and plant dry weight at vegetative stage. However, results obtained showed that difference between each three treatments on relative water content (RWC) and soil moisture content (SMC) was significant.

Key words*: Drought Stress, Mungbean, leaf area, Yield and Yield Components, relative water content, crop phenology, water use efficiency.*

INTRODUCTION

Irrigation water resource is the most important and widely operative limiting factor for crop production. Responses of plants to water deficit condition have been employed to make a physiological evaluation of drought resistance. Mung bean (*Vigna radiata* L.) belonging to family Fabaceae is an important pulse crop grown widely in arid and semi-arid regions and it thrives well under drought prone conditions. Mung bean not only augments the soil fertility status but also breaks the soil exhaustion caused by cereal-cereal crop rotations (Singh *et al.*, 2013). Mung bean can be grown under low moisture and fertility conditions; is one of the important grain legumes in the rain fed farming systems in dry and intermediate zones of Sri Lanka. At present Mung bean is one of the most popular short duration grain legumes grown during dry regions and also dry seasons as rice intercrop in Sri Lanka. Mung bean in a rice rotation has increased the yield of paddy and the income of farmers in Punjab (Weinberger, 2003). The effect of water stress is significant at vegetative, flowering and pod development stages of mung bean when grown in upland rice soil (Maqsood *et al.*, 2000). Mung beans respond to water stress resulting in lower yields (Miah and Carangal, 2001). Crop yield of mung bean is more dependent on an adequate supply of water than on any other environmental factor (Kramer and Boyer, 1997). Moisture stress significantly reduced the yield of mung bean variety MI 6 and the reduction was highest when the stress was imposed during the flowering stage and at the vegetative stage (Srikrishnah and Mahendran 2007). However, there is a great variability for drought tolerance among mung bean genotypes under drought condition. Limitation of water source, irregular annual rainfall during growth season and lack of sources management cause severe decrease in crops yield of these regions (Eack, 1996). Therefore, drought stress during crop development period is an important issue that needs to pay attention (Allahmoradi, 2011). Further, the water absorption capacity of mung bean is low during the vegetative period (Chiang and Hubbell, 1978). Hence the yield of mung bean under stress is generally decided by its capacity to grow vigorously and accumulate as much as dry matter before flowering

*Corresponding Author Email: disnaratnasekera@gmail.com

period. Due to short-term growth, nitrogen fixation capability, soil reinforcement and prevention of soil erosion, mung bean is superior to most of other plants. Mung bean is one of the most common crops in most tropical and sub-tropical regions under rice fallow condition. Therefore, this experiment was carried out with aim of understanding the effect of drought stress during vegetative and reproductive stages on some physiological traits, yield and yield components of mung bean to maximize water use efficiency.

MATERIALS AND METHOD

Plant materials and Experimental Layout

The experiment was conducted in a poly tunnel (Temperature 31^0C - 32^0C, Light intensity 112x102-834x102) of a research field, Faculty of Agriculture, University of Ruhuna, Sri Lanka as a pot experiment (24 cm height and 24 cm diameter) using three Sri Lankan mung bean varieties; ARI, MI-5 and MI-6. The experiment was arranged in a randomized complete block design with five replications and three levels as treatments; control (no drought), drought stress during vegetative growth stage and drought stress during reproductive growth stage.

Drought Experiment

Plants were grown under optimum conditions up to 22 days (drought imposition at vegetative stage) and 35 days (drought imposed at reproductive stage) respectively according to the recommendations of Department of Agriculture, Sri Lanka and subjected to drought by complete termination of irrigation. Samples were collected on 4th, 8th, 12th and 16th days after drought imposition. Irrigated plants were analyzed as control.

Grain yield and yield components

Mean number of pods, mean pod weight (g), mean number and weight (g) of grains per pod from different treatments were recorded. The data was analyzed by using SAS 6.12version.

Relative Water Content of Leaf

Relative water content was estimated according to the method of Castillo (1996) for each treatment. Samples (0.5 g) were saturated in 100 ml distilled water for 48 h at 4°C in dark and their turgid weights were recorded. Then they were oven-dried at 65°C for 48 h and their dry weights were recorded. RWC (Eq.1) was calculated as follows:

$$RWC (\%) = [(FW - DW) / (TW - DW)] \times 100 \quad [Eq.1]$$

Where, FW, DW and TW are fresh weight, dry weight and turgid weight, respectively.

Soil Moisture Content

Soil moisture content was determined gravimetrically from a narrow column of 6 inches from randomly distributed pots on 4th, 8th, 12th and 16th days after drought imposition. Fresh weights were taken before the soil samples were dried at 105°C for 48 h. Soil moisture content was calculated as the difference between fresh and dry weights of each soil sample.

Leaf Area

Total leaf area is the cumulative cell expansion and division during leaf growth. Leaf area was measured by using Automatic area meter (model AAM7, Hayashi, Japan) for different treatments.

Plant Dry Weight

After harvest, plants were uprooted and removed of all soil particles adhering to root system. Separated plant parts were air dried for 2-3 days and placed in an oven at 60-70°C for 48 h and weighed.

RESULTS AND DISCUSSION

Grain yield and yield components

The results showed that mean number of pods were affected by drought stress ($p \leq 0.01$) (Table 1). There was no significant difference between control and drought stress during reproductive growth stage on grain yield presented as number of pods per plant. Number of pods decreased significantly under drought stress during vegetative growth stage (table 1). There was no significant difference between control and drought stress during reproductive growth stage on grain yield. Grain yield decreased significantly under drought stress during vegetative growth stage and its average grain yield per plant for all three tested varieties was 3.77g (Table 2). Chaudhary *et al.* (1985), De Costa *et al.* (1999), and Rafiei and Asgharipur (2009) also reported the similar results.

Relative Water Content of Leaf and Moisture Content

There was a significant difference between treatments in terms of relative water content and soil moisture content (Table 2). Control treatment has the highest RWC and SMC and the lowest RWC and SMC observed drought

Table 1: Mean number of pods per treatment in relation to stage of drought imposed

Drought imposed stage	Mean No of pods	Grain yield /plant(g)
Control	5.30 [a]	8.04[a]
Drought at vegetative stage	3.69 [b]	3.77[b]
Drought at reproductive stage	4.14[ab]	7.89[a]

Table 2: Mean comparison of seed weight, relative water content of leaves and soil moisture content of each treatment

Drought imposed stage	100 seed weight (g)	RWC%	**SMC%**
Control	8.32[a]	85.03[a]	91.23[a]
Drought at vegetative stage	6.02[ab]	38.87[c]	52.07[c]
Drought at reproductive stage	6.86[b]	61.53[b]	79.63[b]

imposed at vegetative stage. The results confirmed the earlier findings of Chaudhary *et al.* (1985).

Maximum seed weight with 8.32 grams per plant was observed in control treatment but there was a significant difference in grain yield per plant between drought at vegetative stage and drought at reproductive stage treatments (data not shown). However, with respect to seed weight, there was no significant difference between the drought at vegetative stage and drought at reproductive stage treatments (Table 2). Asaduzzaman *et al.* (2008) also highlighted that moisture stress reduces grain yield of mung bean and maximum negative effects of drought obtained with once irrigation during growth season.

Leaf Area measurements

There were significant differences ($p<0.05$) found in leaf area with genotype in all measured stages after drought imposed at vegetative growth stage (Table 3). In all stages, significantly maximum leaf area was observed in MI-5 compared to that of other two genotypes.

Comparatively maximum leaf area (261cm^2±6.56) was observed on 12th day after inducing drought .At each stage, maximum leaf area was observed in control plants.

There is no effect of genotype at all measured stages after drought imposed in reproductive stage and comparatively highest leaf area was observed in control plants (Table 4).

Table 3: Mean comparison of total leaf area with genotypes and days after drought imposed at vegetative stage

No of days after drought imposed	**Variety**	**Leaf area of drought imposed plants (cm^2)**	**Leaf area of control plants (cm^2)**
4	ARI	170.00 ±2 [b]	192.33 ±3.51[c]
	MI-5	179.33 ±3.05 [a]	202.66 ±2.51[b]
	MI-6	158.33 ±2.08 [c]	210.00 ±2[a]
8	ARI	172.66 ±2.52[b]	233.33 ±3.1[b]
	MI-5	182.66 ±4.04[a]	217.66 ±1.53[c]
	MI-6	160.66 ±1.16[c]	245.66 ±4.93[a]
12	ARI	239.33 ±2.51[b]	345.66 ±2.08[b]
	MI-5	261.00 ±6.56[a]	350.33 ±0.58[a]
	MI-6	235.33 ±5.03[b]	332.00 ±2[c]
16	ARI	153.66 ±3.21[b]	464.66 ±3.06[a]
	MI-5	167.33 ±3.06[a]	453.00 ±3.62[b]
	MI-6	151.66 ±2.52[c]	461.00 ±1[a]

The letters behind the mean values indicate significant differences between leaf area based on Duncan's Multiple Range Test. Mean with the same letters are not significantly different at $P<0.05$.

Table 4: Mean comparison of total leaf area with genotypes and days after drought imposed at reproductive stage

No of days after drought imposed	Variety	**Leaf area of treated plants**	**Leaf area of control plants**
4	ARI	227.90 ± 1.68[a]	249.67 ± 3.51[a]
	MI-5	228.87 ± 6.96[a]	254.37 ± 4.70[a]
	MI-6	228.70 ± 6.91[a]	252.27 ± 5.70[a]
8	ARI	266.47 ± 5.35[a]	337.97 ± 3.49[b]
	MI-5	269.07 ± 9.00[a]	353.90 ± 4.26[a]
	MI-6	262.90 ± 2.59[a]	351.83 ± 2.75[a]
12	ARI	248.60 ± 6.28[a]	414.67 ±7.64[b]
	MI-5	257.67 ± 3.14[a]	428.00 ± 7[a]
	MI-6	251.00 ± 2.62[b]	409.00 ± 5.57[c]
16	ARI	149.60 ± 7.08[a]	565 ± 6.56[a]
	MI-5	157.13 ± 6.80[a]	564 ± 9.64[a]
	MI-6	156.83 ± 2.84[a]	565.73 ± 4.24[a]

The letters behind the mean value indicate significant differences between leaf area based on Duncan's Multiple Range Test. Mean with the same letters are not significantly different at $P<0.05$.

Table 5: Summary of two-way ANOVA for testing the effect of genotype (ARI,MI-5,MI-6) and No of days after drought imposed (4,8,12,16 days) and their interaction on leaf area at different growth stages

Stages	Variety (V)			No of days after drought imposed (D)			V*D		
	df	f	p	df	f	p	df	f	p
Vegetative Stage	2	115.72	***	3	1212.50	***	6	3.20	*
Reproductive stage	2	1.17	ns	3	702.74	***	6	0.63	ns

* $P < 0.05$; ** $P < 0.001$; *** $P < 0.0001$; NS, not significant

There were significant differences in leaf area at vegetative stage among genotype, number of days after drought imposed and the interaction between genotype and number of days after drought imposed (Table 5). At reproductive stage, no significant difference among genotype and the interaction between genotype and days after drought imposed. It was reported that water stress affects crop phenology, leaf area development, number of leaves per plant and finally results in low yield as explained by Abdel *et al.* (2011).

Plant dry weight (Shoot and Root dry weight)

There were significant differences (p<0.05) found in shoot and root dry weight at vegetative stage (Table 6) among the test varieties. The significantly highest shoot and root dry weights were observed in MI-5 compared to that of other genotypes. At reproductive stage no significant differences was found among shoot and root dry weight

Table 6: Mean comparison of plant dry matter with genotype and growth stage

Drought Imposed Stage	Variety	Shoot Dry Weight (g)	Root Dry Weight (g)
22 days (Vegetative)	ARI	0.762 ± 0.0079[b]	0.254 ± 0.0049[b]
	MI-5	0.941 ± 0.0286[a]	0.335 ± 0.012[a]
	MI-6	0.768 ± 0.037[b]	0.241 ± 0.052[b]
35 days (Reproductive)	ARI	1.53 ± 0.01[a]	0.843 ± 0.118[a]
	MI-5	1.82 ± 0.29[a]	0.847 ± 0.1069[a]
	MI-6	1.83 ± 0.15[a]	0.877 ± 0.10598[a]

The letters behind the mean value indicate significant differences between populations based on Duncan's Multiple Range Test. Mean with the same letters are not significantly different at P<0.05

The genotype and drought imposed stage both had a significant effect on shoot dry weight and root dry weight (Table 7). Further, a significant interaction between genotype and drought imposed stage was observed on shoot dry weight except root dry weight. Sangakkaran *et al.* (2000) reported that drought tolerant Mung bean diverted more carbon to roots under moisture stress. When Mung bean is grown under rain fed condition, greater rooting depth helps to acquire stored water from various depths to improve stability in grain yield. Drought stressed plants diverted significantly higher dry matter to roots and stems, while well watered plants diverted to pods and grains (Kumar and Sharma, 2009). It has also been shown that Mung bean genotypes having higher root biomass produced higher pod and seed yield at low level of phosphorous (Boutraa *et al.*, 1999). The formation of more roots for improved water use efficiency could compete for assimilates that could be remobilized to the grain. Being a short duration crop, it is possible that mung bean, when stressed a week before flowering would rather utilize current assimilates for reproductive purposes.

Table 7: Summary of two-way ANOVA for testing the effect of genotype (ARI,MI-5,MI-6) and growth stages(Vegetative and Reproductive stage) and their interaction on plant dry weight.

Character	Variety(V)			Drought imposed stage (S)			V*S		
	df	f	p	df	f	p	df	f	p
Shoot dry weight	2	43.17	***	1	1123.68	***	2	10.41	**
Root dry weight	2	4.80	*	1	389.07	***	2	0.25	ns

* $P < 0.05$; ** $P < 0.001$; *** $P < 0.0001$; NS, not significant

CONCLUSION

Water scarcity drastically shortened all morphological and physiological parameters of mung bean. According to the results of our experiment, a negative effect of drought stress during vegetative stage is significantly high and less effects was observed during reproductive growth stage. Therefore, removal of irrigation at beginning of pod development can be cost effective under irrigated systems. Genotype, MI-5 would be the best-performed variety among three varieties tested.

REFERENCES

Abdel CG, Thahir and Al-Rawi IM. 2011. Response of mungbean (*Vigna radiata* L.,) to gibberellic acid (GA3) rates and varying irrigation frequencies. *International Journal of Bio sciences* **3**:85-92.

Allahmoradi P, Ghobadi M, Taherabadi S and Aherabadi S. 2011. Physiological aspects of mungbean (*Vigna radiata* L.) in response to drought stress. *Intl Conf Food Engg Biotechnol*, IPCBEE 9, IACSIT Press, Singapore.

Asaduzzaman FK, Ullah J and Hasanuzzaman M. 2008. Response of mung bean (*Vigna radiate* L.) to nitrogen and irrigation management. *American-Eurasian Journal of Scientific Research* **3**:40-43.

Boutraa T, Iqbal MJ and Sanders FE. 1999. Can we improve the tolerance of *Phaseolus vulgaris* cultivars to low soil phosphorus by selecting for greater root biomass. *J. Experimental Bot.* **4:**4-39.

Castillo FJ. 1996. Anti-oxidative protection in the inducible CAM plant *Sedum album* L. following the imposition of severe water stress and recovery. *Oecologia* **107**: 469–477.

Chaudhary TN, Chopra UK and Sinha AK. 1985. Root growth, leaf water potential and yield of irrigated summer mung bean (*Phaseolus aureus* ROXB.) in relation to soil water status and soil temperature under various mulches. *Field Crops Research* **11**:325-333.

Chiang MY and Hubbel JN.1978. Effect of irrigation on mung bean yield. In: *Proc First Intl Mung bean Symp*, AVRDC, Shanhua, Taiwan pp 93-96.

De Costa WA, Shanmugathasa KN and Joseph KD. 1999. Physiology of yield determination of mungbean (*Vigna radiata* L.) under various irrigation regimes in the dry and intermediate zones of Sri Lanka. *Field Crop Res.* **61**: 1-12.

Eack HV. 1996. Effect of water deficit on yield and yield components and water use efficiency of irrigated corn. *Agronomy Journal* **78**: 1083-1089

Kramer PJ and Boyer JS. 1997. Water relations of Plants and Soils, Academic Press, San DiagoArrese, I., Gonzalez, E.M., Mariano, D.,Landera, R.,Larraiza, E., Gil-Quintana, E.,(2009), Physiological response oflegume nodules to drought, Plant stress, Global Science book, vol. 5, pp.24-31.

Kumar A and Sharma KD.2009. Physiological response and dry matter partitioning of summer mung bean (*Vigna radiate* L.) genotypes subjected to drought conditions. *J Agron Crop Sci*. **95**:270-277

Maqsood M, Rahman S and Islam A 2000. Effect of soil moisture stress on growth and yield of summer mung bean. *Asian J. Plant Sci.* **33**(8): 250-258.

Miah MZI, and Carangal VR 2001. Yield of 10 mung bean cultivars evaluated in intensive rice based cropping system. *Intl. Rice Res. Newsl*. **6**(4): 27.

Rafiei SM and Asgharipur MR 2009. Yield reaction and morphological characteristics of some mung bean genotypes to drought stress. *J Modern Agr Knowledge* **5**(15): 67-76.

Sangakkaran UR, Frehner M and Nosberger J 2000. Effect of soil moisture and potassium fertilizer on shoot water potential, photosynthesis and partitioning of carbon in mung bean and cowpea. *J Agron Crop Sci*. **185**: 201-207.

Singh AK, Kumar P and N Chandra**.** 2013. Studies on yield production of mung bean (*Vigna radiate*) sown at different dates. J. *Environ. Biol*. **34:** 1007-1011.

Srikrishnah S and Mahendran S. 2007. The effects of soil moisture stress on the leaf water potential and yield of mung bean var. MI-6 at different growth stages. Sri Lanka *Assoc Adv Sci Proc 63rd Annu Session*.

Weinberger K. 2003. Impact analysis of mung bean research in South and Southeast Asia. *Final report of GTZ Project*. The World Vegetable Center (AVRDC), Shanhua, Taiwan.

Citation:

Ratnasekera D and Subhashi APT.2015. Morpho-Physiological Response of Selected Mungbean (*Vigna radiata* L.) Sri Lankan Genotypes to Drought Stress. *Journal of AgriSearch* **2** (3): 162-166