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THE EFFECT OF WATER DEFICIT ON THEPHYSIOLOGICAL CHARACTERISTICS OF MUNG BEAN CULTIVARS (VIGNARADIATA L.)IN THE GROWTH AND DEVELOPMENT STAGES

ABSTRACT

The aim of this study was to compare local Iranian cultivar with cultivars took from ICARDA centre to identify its efficiency and possibility of its cultivation in semiarid and arid conditions of Iran. This study was conducted in 2009-2011 in Varamin agriculture research station. The experiments were conducted as split plot design in completely random block in 3 replications. In each replication there were 30 experiment plots and every plot (10 m^2 each one) has 5 cultivation lines with 2 m length and the seeds were randomly cultivated with 20 cm distance from each other (10 bushes in m^2) and in 5 cm depth.The plots include 4 levels of irrigation cutting which include:in the flowering, podding and seed formation stage, and normal irrigation. The subplots include 5 cultivars of Mung Beaninclude:Gohar(local cultivar as a control), Partoo, NM-94, C-1-6-16 and C-1973A.In 2010 the obtained dates were lower than in 2009, which could be explained by climatic conditions. Proline accumulation in Partoo cultivar (equal 7.34 mg/g) was considered as a resistant cultivar to irrigation cutting rather than other cultivars. The mean density of Proline in leaf in all cultivars changes remarkably.The result of research shows that Partoo cultivar with high density of chlorophyll(0.39 mg/g)is more resistant to irrigation cutting.The relative density of water of leaf in Partoo and NM-94 cultivars (with 83.37 and 73.41 mg/g)is more. Also, among Mung bean cultivars the most Protein density of seed is related to Partoo cultivar (about 29.17 mg/g) that shows more resistance to the irrigation cutting.

KEYWORDS: Mung Bean, Physiological characteristics,Water deficit stress.

INTRODUCTION

Drought stress is one of the most important factors which are the central problem in the agriculture of the countries with irrigation sources deficit and very low annul precipitations (Thomas *et al*., 2003). Drought stress influences morphological, physiological and biological characteristics of the plant in every stage of plant growth (Majnoun Hosseini,2008).Van Den Boogaard *et al*. (1997) reported that this damage caused the vegetative products, to be reduced and this reduction of products was due to the delay or the plant non-establishment, weakening or impairing established plants, susceptibility of plant to pests and disease attack, biological and biochemical changes in the metabolism of plant, the change in the seed quality, forages oil, and other economical crops.

There are a lot of studies in the world conducted on the investigation of the influence of drought stress on the plants. However there are still open questions depend on this problem. It is important to say that in the drought regions of Iran such as Varamin, Khuzestan etc. with height temperature the irrigation is one of the important points in the agriculture.In these regions it is necessary to introduce the Legume cultivars (Mung Bean) tolerant to dry conditions. However better understanding of the influence of drought stress on the Mung Bean cultivars (such as finding out the most sensitive stages of Mung Bean growth depend on drought influence, investigation physiological parameters) will give us opportunity to improve agriculture politics of this plants cultivation in the hot and drought regions of Iran.

One of important plant`s task is to maintain turgor by osmosis regulation. That is done by an active accumulation of soluble substances process (such as Proline, Chlorophyll, RWC and Protein of seed) during the plant`s growth and development (Ouvrard *et al*., 1996). Proline, Chlorophyll, RWC and Protein of seed can be accumulated in the cell under the irrigation cutting condition without any delaying in cellular metabolism.

Proline as a soluble material regulates or osmosis pressure decreases the water loss from the cell, cell swelling maintains decreases ions retarding effect on the enzyme activity prevent Protein break down, increases the persistence of some cytoplasm and mitochondria enzymes the persistence of Proteins natural shape and protects the membrane (Barker *et al*., 1993).Pesarkli *et al*. (1999) reported that Chlorophyll combinations decrease under irrigation cutting conditionandare some physiological traits that are resistant to

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irrigation cutting. Mohsen Zadeh *et al*. (2006) reported that in grains decrease in Chlorophyll A, B and total Chlorophyll causes chloroplast destruction under the irrigation cutting condition.The effect of drought stress decreases Chlorophyll content in the leave of sensitive cultivars and increases in tolerable cultivars (Shahrayari, 2001).The drought stress in higher relative of leaf water (RWC) means the greater ability of leaf to maintain the water in stress conditions. Higher RWC may be obtained by osmosis regulation ability or the root ability in the water absorption (Johnson *et al*., 1984).Protein synthesis is very sensitive in rapid growing tissues relative to the humidity stress which causes the difference among different species of cereals (Berey *et al*., 1998). They reported the total Protein level and free amine acids are increased in drought stress condition in tolerable and sensitive cultivars of pea, so the Protein level of plant is greater in humidity stress stage than the cultivars sensitive to the drought stress.Barker *et al*. (1993), by doing some research figured out that when Mung Bean plant is exposed to the irrigation cutting the processes such as Protein analysis; amino acid increase (Proline) and amides increase get faster.

According to this fact that the agriculture researches and experiments have been conducted on Mung bean in Iran country and in the world lesser than other plants, this study was conducted to understand more this plant in different dimensions especially in the tolerance dimension to the irrigation water deficit and cultivation in arid and mid arid regions. Our study was performed in 2009-2010 aimed to investigate growth and development of Mung Bean cultivars with cutting irrigation during the different stages of plant vegetation (Iran origin cultivar: Gohar and some takes from ICARDA: Partoo, NM-94, C-1-6-16, C-1973A) to identify the effect of its planting in semiarid and arid regions of Iran, to choose the best dry tolerant cultivars to be introduced into agricultural production of mentioned regions.The results obtained from this experiment influenced the farmer's life.

MATERIALS AND METHODS

The aim of this study was to compare local Iranian cultivar with cultivars took from ICARDA centre (world collection of Mung Bean) located in Syria to identify its yield, efficiency and possibility of its cultivation in semiarid and arid conditions of Iran. This study was conducted in 2009-2011 in a field with area of 1000 m^2 in Varamin agriculture research station which was located on 1000 m from sea level. The experiments were conducted as split plot design in completely random block in 3 replications for 2 years (2009-2010). In each replication there were 30 experiment plots and every plot (10 m^2 each one) has 5 cultivation lines with 2 m length and the seeds were randomly cultivated with 20 cm distance from each other (10 bushes in m^2) and in 5 cm depth (the map of design).The plots include 4 levels of irrigation cutting which include:$\mathbf{I_1}$: in the flowering stage; $\mathbf{I_2}$: in the podding stage; $\mathbf{I_3}$:in the seed formation stage; $\mathbf{I_4}$: normal irrigation (without stress of irrigation cutting). The subplots include 5 cultivars of Mung Bean, which include:$\mathbf{V_1}$**:**Gohar; $\mathbf{V_2}$:Partoo; $\mathbf{V_3}$: NM-94; $\mathbf{V_4}$: C-1-6-16; $\mathbf{V_5}$: C-1973A.Partoo and Gohar cultivars are commercial varieties in dry and temperate regions whichare used in the research programs. Also, other variability as import cultivars is used. Goharwas one local cultivar as a control and other cultivars taken from ICARDA.

The filed preparation was began in the fall of the year before experiment execution by one deep plowing and was completed in the spring of next year by one superficial plowing, one disk, discharge straw and leveling the field soil. Then ridges with 50 cm distance were created and 2 ridges were placed to prevent the irrigation interference between every major plot and are fertilizer (starter–urea $CO(NH_2)_2$) was added to the field in proportion of 20 kg/ha one week before seeding. Nitrogen fertilizer used to provide normal growth and development of plant in a first period of vegetation until development of root system, which could fix nitrogen from atmosphere and use it by nodule bacteria. In the 2009 year the seeding was made on 5 May and harvesting in the beginning of August. In 2010 seeding was made on 29 of April and harvesting in the end of July. And in 2011 seeding was made on 23 of April and seeding in the last decade of July. After finishing seed cultivation, the field was immediately irrigated and irrigation operations were done equally for all treatments. The irrigation was performed 4 times in a quantity of 4000 m^3(1000 m^3 per 1 irrigation procedure). After irrigation operations cultivation operations were done which included 2 times hand–weeding (several days after cultivation) and thinning action to obtain desirable density.

The soil of research place was sampled by standard method before beginning the design execution operation to determine physical and chemical characteristics of soil from different points and from 0-30 and 0-60 cm and was analyzed after preparation of composed

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sample. Soil analyze was made by the standard method (Table 1). Soil consist 0.72 % humus in 30 cm in the depth. In a case of there is not enough nitrogen in soil the nitrogen fertilizer was used.

Table 1.Physical and chemical characteristics of Experiment execution place soil

Soil tissue	Depth (cm)	pH	Clay (%)	Cilt (%)	Sand (%)	Available phosphor(ppm)	Available potassium(ppm)	Electric conductivity (mm hos/cm)	Carbon (%)
Loam	0-30	7.6	34	54	12	10.6	324	3	0.72
clay	30-60	7.8	26	48	26	9.5	300	3.5	0.50

Investigations were performed in the laboratory of Karaj Agriculture University. 10 Mung bean bushes were selected and were sent to the laboratory to measure physiological characteristics. Physiological characteristics were evaluated and calculated as follows:

A)**Proline:**At first 200 mg fresh leave were prepared from Mung Bean plant samples (in every stage of flowering, growth stage, podding, seed formation and were powdered then were added to 10 ml sulphosalisic acid and were homogenized by mortar and resultant extract was purified. 2000 ml nainhydrin acid (1.25 gnainhydrin acid, 30 ml acetic acid, 20 ml acid ortofosforic).Solution was added to 2 ml purified extract and 2 ml acetic acid was added then the resultant solution was placed for 1 hour in 100 cg. Finally the tubes containing the solution were placed immediately in 0 cg water and after isotherm solution with the environment; 4 mm toluene was added to the solution. The density of toluene was calculated in the wave length 500 nanometer using spectrophotometer (Shimodzu UV180) and finally the level of Proline samples were calculatedin terms of mg/g wet weight of plant according to the standard deviation resulting from the different densities (Gayton method, 1975).

B) **Chlorophyll:**Measurement method of leave Chlorophyll is done by Arnon *et al*. (1990) changed method. To measure Chlorophyll level at first the solution was poured in the experiment tube then 0.5 g from every sample of Mung Bean plant leaf was homogenized in 5ml acetone of 80 percentage and then obtained extract was purified and its volume was reached to 10 ml by adding eston then the absorbed light level was measured by the extract using spectrophotometer in the length or waves 645 and 663 nanometer.The density of Chlorophyll A, B and their total was calculated to the following relationship:

A= [12.7(the light absorption in 663 nanometer) – 2.69 (the light absorption in 645 nanometer)] × V / (W × 1000)

B = [22.9(the light absorption in 645 nanometer) - 4.69 (the light absorption in 663 nanometer)] × V / (W × 1000)

A and B = [20.2 (light absorption in 645 nanometer) + 8.02 (light absorption in 662 nanometer)] × V / (W × 1000),

V= final extractedvolume, mg; *W*= sample weight, g.

Finally the leaf Chlorophyll level was calculated according to proportion of dry weight to wet weight of leaf as the viscosity in terms of mg/g dry weight.

C) **Relative water content (RWC):**Five parts was prepared in every experimental unit from middle part 2 of Mung Bean plant leave samples (in every flowering growth stages, podding, and seed formation) and their wet weight was measured 0.001 g by sensitive scale then these parts were placed inside experiment tube containing distilled water for 4 hours exposed low light then their level was dried by paper dryer and tourgence weight was calculated. The leaf samples were dried after weighing in 75 cg for 48 hours in autoclave and their dry weight was determined finally relative content of leaf water (RWC) was calculated according to the following equation (Noudor, 1979).

RWC= (wet weight - dry weight)/ (tourgence weight - dry weight) × 100.

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D) **The seed protein**: To measure Protein percentage of Mung Bean plant seed 100 g seed was prepared from every experimental plot and after grinding, the seed were placed in autoclave with heat grade 70 cg for 48 hours then 1 gr ground seeds was weighted and was determined as percentage during different stages of experiment by obtaining samples nitrogen level, then the percentage of seed Protein was calculated from the following equation (method of Kejeldar) (Imam, Niknejad, 1994).

$$\text{Protein percentages} = \text{nitrogen } \% \times 6.25$$

$$\text{Yield of Protein (mg/g)} = \text{Protein } (\%) \times \text{seed yield (t/ha)}.$$

Data statistical analysis was done by using MSTAT-C, SASand SPSS software. Means comparisons was conducted by Duncan multi-range trial method in the level 1 and 5%.

RESULTS

In the first year of experiment (2008-9), analysis of variance in irrigation cutting execution stage in the present research has got significance difference between RWC($P<0.05$) and Protein of seed ($P<0.01$) while no significance difference was for Proline and Chlorophyll among different growth stages (table 2).In different stages of irrigation cutting execution the most and the least rate of physiological characters (Proline, Chlorophyll, RWC and Protein of seed) was respectively related to seed formation and flowering stages (table 5). Also Partoo cultivar had got the most rates of physiological characters. Gohar cultivar for Proline and Chlorophyll characters and C-1973A cultivar for RWC and Protein of seed characters allocated the least rate to themselves (table 5).
In the second year of experiment (2009-10), analysis of variance in Mung Bean cultivars indicated a significance difference ($P<0.01$)for all of the Physiological characters (table 2).In different stages of irrigation cutting execution the most and the least rate of physiological characters (Proline, Chlorophyll, RWC and Protein of seed) respectively was related to se seed formation stage and flowering stage (table 5). Also Partoo cultivar had got the most rates for all physiological characters. Gohar cultivar for RWC and Chlorophyll characters and C-1973A for Proline characters allocated the least rate to themselves. The least amount of seed`s protein character was equal in two cultivars of Gohar and C-1973A (table 5).

In the first and second year of experiment (2008-10), The combined analysis of variance in the first and second year of experiment indicated that irrigation cutting execution had got a significance difference for Proline and Chlorophyll characters ($P<0.05$) and RWC, Protein of seed characters ($P<0.01$) (table 3).Also analysis of variance in Mung Bean cultivars indicated a significance difference ($P<0.01$)in whole physiological characters except Protein of seed.In different stages of irrigation cutting execution the most and the least rate of physiological characters (Proline, Chlorophyll, RWC and Protein of seed) respectively were related to seed formation stage and flowering stage, also Partoo cultivar had got the most rate of whole physiological characters.Gohar cultivar for Chlorophyll character and C-1973A cultivar for Proline, RWC and Protein of seed characters allocated the least rate to themselves (table 5).
As have shown the dates of physiological characters of Mung Bean at irrigation cutting on the different phenological stages of growth and development of plants are presented in table 4and figures 1-8.As have shown the results of the first year of experiment for all investigated parameters (physiological - Chlorophyll and RWC, and quality – Proline and Protein of seed) the most sensitive phase of drought influence was irrigation cutting on the flowering stage (0.32, 69.79, and 6.26, 23.08) which was quite different from normal irrigation conditions (0.37, 80.48, and 8.01, 26.84), second year of experiment (0.23, 58.97, and 3.05, 20.75) which was quite different from normal irrigation conditions (0.30, 73.07, and 5.33, 26.23). Second most sensitive stage of irrigation cutting is podding, it was shown that in the condition of irrigation cutting on this stage we'll obtain a bit better results in 2009 (0.34, 72.81 and 6.27, 24.14) and in 2010 (0.26, 67.00, and 4.35, 23.93), compare with flowering stage. And at least cutting of irrigation on the seed formation phase indicated that the most tolerant to drought influence in this (2009 - 0.35, 78.96, and 7.85, 26.06) (2010 - 0.30, 71.96 and 5.08, 25.78) compare with flowering and podding stages(table4) (Lalinia, 2011).

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The physiological characters of investigated cultivars: Proline, Chlorophyll, RWC and Protein seed are presented in table 5 and figures 5-8.As have shown the results of our study in 2009 as well as in 2010 the physiological characters of all investigated cultivars of Mung Bean at irrigation cutting condition decreased compare to normal irrigated plants. So in control cultivar (Gohar), irrigation cutting compare with normal irrigation decreased content of Proline in 2009on 6.23and 6.17mg/gand in 2010 on 3.82 and 3.79 mg/g, Chlorophyll in 2009 on 0.31 and 0.29 mg/g and in 2010 on 0.29 and 0.24 mg/g, RWC in 2009 on 73.82 and 72.05 mg/g and in 2010 on 66.09 and 61.60 mg/g, and Protein of seed in 2009 on 23.19 and 23.15 mg/g and in 2010 on 22.99 and 21.88 mg/g; while in Partoo cultivar the investigated parameters decreased on 8.90 and 8.69 mg/g (2009) and on 6.65 and 5.99 mg/g (2010), 0.45 and 0.43 mg/g (2009) and 0.39 and 0.34 mg/g (2010), 85.05and 84.98 mg/g (2009) and 83.80 and 81.76 mg/g (2010), 29.45 and 29.37 mg/g (2009) and 29.09 and 29.00 mg/g (2010), respectively.As we see water deficit has its negative influence on physiological characters of Mung Bean, lead to decrease of its content in leaf, as well as in seed, because there is a positive correlation between investigated physiological characters (Lalinia *et al*., 2010, 2011).In 2 years of study Partoo, NM-94 and C-1-6-16 cultivars compare with control demonstrated height concentration of Proline, leaf Chlorophyll and Protein of seed. By containing of RWC in Partoo and NM-94 demonstrated the best result compare with control.

The physiological data in 2010 was low. So, compare with 2009 concentration of Proline in Partoo decreased on 6.65 (normal irrigation) and 5.99 mg/g (irrigation cutting), Chlorophyll on 0.39(normal irrigation) and 0.34 mg/g (irrigation cutting), RWC on 83.80 (normal irrigation) and 81.76 mg/g (irrigation cutting), Protein of seed on 29.09(normal irrigation) and 29.00 mg/g (irrigation cutting). In 2009 all investigated cultivars compare with control demonstrated height concentration of mentioned above characters, except C-1073A cultivar by RWC and seed's Protein. During 2 years of study significantly height dates of physiological characters were indicated in Partoo and the lowest in C-1973A cultivars.So, by the physiological dates obtained during 2 years study the best results were demonstrated Partoo, NM-94 and C-1-6-16 cultivars, which indicate about its better tolerance to dry condition.
Partoo cultivar had got the most rates for all physiological characters. Gohar cultivar for RWC and Chlorophyll characters and C-1973A for Proline characters allocated the least rate to themselves. The least amount of seed`s Proteincharacter was equal in two cultivars of Gohar and C-1973A.Gohar cultivar for Chlorophyll character and C-1973A cultivar for Proline, RWC and seed'sProtein characters allocated the least rate to themselves (table5).Compare two years result we see the positive tendency to increase of all investigated characters.

Results of two years study indicated that Proline accumulation in Partoo cultivar (equal 7.34 mg in one gram of the wet weight of Mung Bean`s leaf) is considered as a resistant cultivar to irrigation cutting rather than other cultivars (figure 5).The mean density of Chlorophyll in leaf in all cultivars changes remarkably. Partoo and Gohar cultivars respectively with density of 0.39 and 0.27 mg in gram of the wet weight of Mung Bean`s leaf are resistant and sensitive to irrigation cutting (figure6). The relative density of water of leaf in Partoo and NM-94 cultivars respectively with 83.37 and 73.41 mg in gram of the wet weight of Mung Bean`s leaf is more, in comparison with other cultivars that are indicator of more resistance in Mung Bean cultivars to the irrigation cutting (figure7).Among Mung Bean cultivars the most Protein density of seed is related to Partoo cultivar (about 29.17 mg in gram dry weight of Mung Bean`s seed) that shows more resistance to the irrigation cutting (figure8).

The results of research confirm that irrigation cutting causes Protein density reduction in a seed of plant, also those cultivars that have got more Protein are more resistance to irrigation cutting, in whole they gained results by physiological characters evaluation shows that physiological indexes had got the least damage in seed formation stage and the most significance difference in flowering stage.
It is clear that Partoo and NM-94 cultivars demonstrated the best yield in the irrigation cutting conditions, so we recommended it's for planting in the regions of Iran with dry climate.As we see in semiarid territories of Iran, Partoo and NM-94 cultivars have normal growth and development, and show height physiological traits, which indicate about its tolerance to arid conditions, and it is recommended to plant them in the territories with dry climate.

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DISCUSSION

Proline accumulation in Partoo cultivar (equal 7.34 mg in one gram of the wet weight of leaf) is considered as a resistant cultivar to irrigation cutting rather than other cultivars (tables 5 and figure 5). The results of research shows that Proline accumulation in the plant can highly help in plant`s growth and survival until the end of its life time and under irrigation condition.The mean density of Proline in leaf in all cultivars changes remarkably.

Partoo and Gohar cultivars respectively with density of 0.39 and 0.27 chlorophyll mg in gram of the wet weight of leaf are resistant and sensitive to irrigation cutting (table 5 and figure 6).MohsenZadeh, *etal.* (2006) reported that in grains decrease in chlorophyll A, B and total chlorophyll causes chloroplast destruction under the irrigation cutting condition.Pessarkli*etal.* (1999) by doing some research figured out that photo synthesis survival and maintaining chlorophyll in the leaf under the irrigation cutting are some physiological traits that are resistant to irrigation cutting.The result of research shows that those cultivars with high density of chlorophyll are more resistant to irrigation cutting.

The relative density of water of leaf in Partoo and NM-94 cultivars respectively with 83.37 and 73.41 mg in gram of the wet weight of leaf is more, in comparison with other cultivars that are indicator of more resistance in Mung Bean cultivars to the irrigation cutting (table 5 and figure 7). Moradi Ahmadi and Hossein Zadeh (2008) by studying concluded that water relative content in the leaf is an important indicator for determining of Mung Bean plant resistance to irrigation cutting and as much as the density of relative water in leaf is more the resistance of that plant to the irrigation cutting will increase.

Among Mung Bean cultivars the most Protein density of seed is related to Partoo cultivar (about 29.17 mg in gram dry weight of seed) that shows more resistance to the irrigation cutting (table 5 and figures 8).There are lots of controls about protein accumulation that irrigation cutting is the main, cause and also they have relation with physiological adaptation to water deficiency (Berey*etal.*, 1998).The results of research confirm that irrigation cutting causes protein density reduction in a seed of plant, also those cultivars that have got more protein are more resistance to irrigation cutting, in whole they gained results by physiological characters evaluation shows that physiological indexes had got the least damage in seed formation stage and the most significance difference in flowering stage.

In the current study we were aimed to investigate physiological characters of Mung Bean under the influence of water deficit. This study helped us to recognize the best cultivars to be recommended to Iranian farmers as well as to indicate the most sensitive drought influence stage. The dates in the table indicate that during investigated years the physiological characters of Mung Bean cultivars are affected by dry at irrigation cutting conditions at the flowering and podding stages. In 2010 the obtained dates were lower than in 2009, which could be explained by climatic conditions. Because of the fact that in 2010 there was a low quantity of precipitation and the weather was hot (29°C), then from atmosphere dry condition the physiological characters of Mung Bean decreased resulted in disorders in synthetic features of plant, denaturizing of Protein and changing in colloid-chemical conditions of cytoplasm, as well as by decreasing of organic mature accumulated by plant because of leaf growth late and decrease its surface.

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Source of change	df	Mean squares							
		Proline mg.g thewet weight of leaf		Chlorophyll mg.g the wet weight of leaf		RWC mg.g thewet weight of leaf		Protein of seed mg.g the dry weight of seed	
		2009	2010	2009	2010	2009	2010	2009	2010
Block	2	16.792	0.834	0.002	0.024	16.939	182.363	1.792	11.815
Irrigation cutting stage	3	13.871	15.746	0.007	0.019	383.046*	1855.604	44.588**	93.183
Error of main plot	6	7.173	4.440	0.004	0.006	58.179	1487.993	2.501	35.372
Mung Bean cultivars	4	13.43**	11.176**	0.040**	0.022**	399.294**	3641.397**	73.229**	125.543**
Cultivar x stress	12	1.119	1.294	0.004	0.002	35.188	275.919	4.889	3.227
Error of sub plot	32	0.678	1.016	0.003	0.002	38.113	1458.587	4.212	6.230
Coefficient variation (%)	-	11.67	22.41	15.23	15.49	8.18	9.97	8.20	10.33

Table 3. Analysis of combined variance of physiological characters in Mung Bean cultivars under the influence of irrigation cutting (2009-2010).

Source of changes	df	Mean square			
		Proline mg.g thewet weight of leaf	Chlorophyll mg.g thewet weight of leaf	RWC mg.g thewet weight of leaf	Protein of seed mg.g the dry weight of seed
Year	1	203.143**	0.148**	1808.445**	22.080
Block	4	8.83	0.013	54.151	27.214
Irrigation cutting stages	3	28.728*	0.023*	966.970**	390.752**
Block × stress	3	2.889	0.003	34.680	22.563
The error plot	12	5.807	0.005	153.0186	227.242
Mung Bean cultivars	4	24.117**	0.060**	1235.303**	777.122**
Block × cultivar	4	0.102	0.002	74.388	17.967
Stress × cultivar	12	1.437	0.003	21.060	41.194
Block × stress × cultivar	12	0.975**	0.003	37.046	56.199
Error of subplot	64	0.852	0.002	41.850	334.140
Coefficient of variation (cv %)	-	15.91	15.43	9.03	9.28

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Table 4. The physiological characters of Mung Bean cultivars in irrigation cutting conditions during investigated phenological stages of growth and development of plant

Plant growth and development stage		Proline mg.g thewet weight of leaf			Chlorophyll mg.g the wet weight of leaf			RWC mg.g thewet weight of leaf			Protein of seed mg.g the dry weight of seed		
		2009	2010	Mean of 2009-2010	2009	2010	Mean of 2009-2010	2009	2010	Mean of 2009-2010	2009	2010	Mean of 2009-2010
Irrigation cutting	flowering	6.26c	3.05c	4.66c	0.32c	0.23ab	0.28c	69.79c	58.97c	64.38c	23.08c	20.75c	21.92c
	podding	6.27ab	4.53ab	5.40ab	0.34ab	0.26b	0.30ab	72.81ab	67.00ab	69.91ab	24.14ab	23.93ab	24.04ab
	seed formation	7.85b	5.08b	6.47b	0.35b	0.30a	0.33b	78.96b	71.96b	75.46b	26.06b	25.78b	25.92b
Control – normal irrigation		8.01a	5.33a	6.67a	0.37a	0.30a	0.34a	80.48a	73.07a	76.78a	26.84a	26.23a	26.54a

Note. With probability level of 1 % by Duncan, different letters presented in columns indicate about significant difference occurrence.

Table 5.The mean comparison of physiological characters in Mung Bean cultivars at the irrigation cutting conditions

Cultivar	2009								2010							
	Proline		Chlorophyll		RWC		Protein of seed		Proline		Chlorophyll		RWC		Protein of seed	
	normal irrigation	irrigation cutting	normal irrigation	irrigation cutting	normal irrigation	irrigation cutting	normal irrigation	irrigation cutting	normal irrigation	irrigation cutting	normal irrigation	irrigation cutting	normal irrigation	irrigation cutting	normal irrigation	irrigation cutting
«Gohar» control	6.23c	6.17c	0.31c	0.29c	73.82c	72.05c	23.19c	23.15c	3.82c	3.79c	0.29c	0.24c	66.09c	61.60a	22.99c	21.88c
Partoo	8.90a	8.69a	0.45a	0.43a	85.05a	84.98a	29.45a	29.37a	6.65a	5.99a	0.39a	0.34a	83.80a	81.76a	29.09a	29.00a
NM-94	7.65a	7.49a	0.40a	0.37a	77.80a	76.02a	26.00a	25.70a	5.00a	4.88a	0.36a	0.28a	72.08a	70.79a	25.80a	25.31a
C-1-6-16	7.09b	6.92b	0.39b	0.32b	76.80b	74.48b	25.80b	24.31b	6.00b	4.21b	0.44b	0.25b	66.90b	62.83a	23.02b	22.43b
C-1973A	6.90ab	6.23ab	0.38ab	0.31ab	73.60ab	70.02ab	24.00ab	23.00ab	4.40ab	3.62ab	0.32ab	0.25ab	65.80ab	61.76a	22.65ab	21.88ab

Table 5.Continue

Cultivar	Mean for 2 years							
	Proline		Chlorophyll		RWC		Protein of seed	
	normal irrigation	irrigation cutting	normal irrigation	irrigation cutting	normal irrigation	irrigation cutting	normal irrigation	irrigation cutting
«Gohar» Control	6.66a	4.98c	0.30c	0.27c	69.96ab	66.83c	23.09c	22.52a
«Partoo»	7.78a	7.34a	0.42a	0.39a	84.43a	83.37a	29.27a	29.17a
«NM-94»	6.33ab	6.19b	0.38b	0.33b	74.94a	73.41b	25.90a	25.51a
«C-1-6-16»	6.55b	5.57bc	0.42a	0.29c	71.85b	68.66bc	24.41b	23.37a
«C-1973A»	5.65c	4.93c	0.35ab	0.28c	69.70c	65.89c	23.33ab	22.44a

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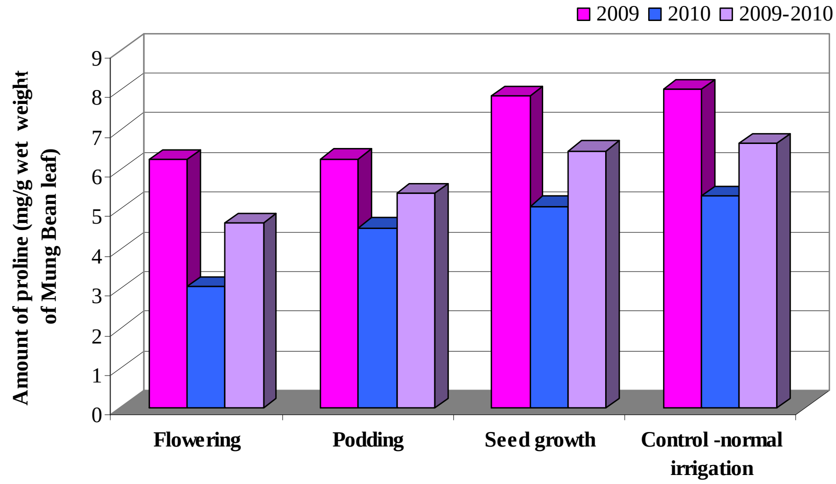

Figure 1. Comparison of average of irrigation cutting stress on amount of Proline in different stages of growth of Mung bean Cultivars

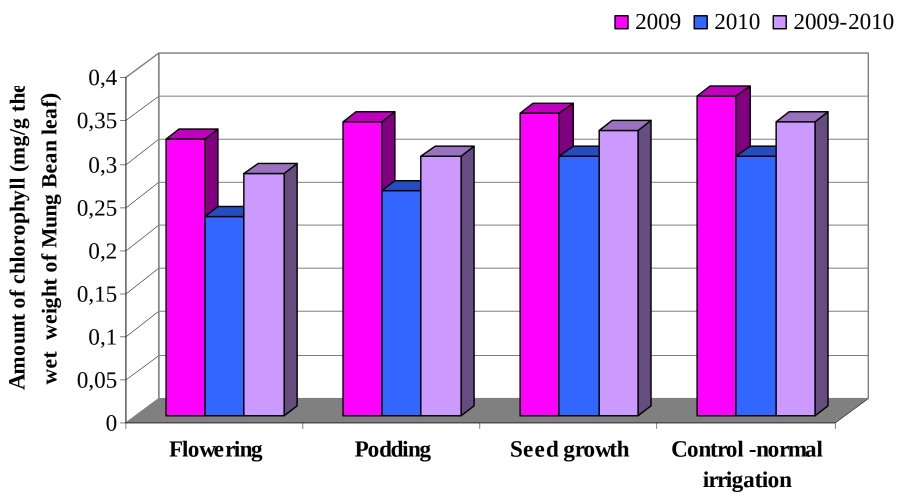

Figure 2. Comparison of average of irrigation cutting stress on amount of leaf Chlorophyll in different stages of Mung Bean cultivars

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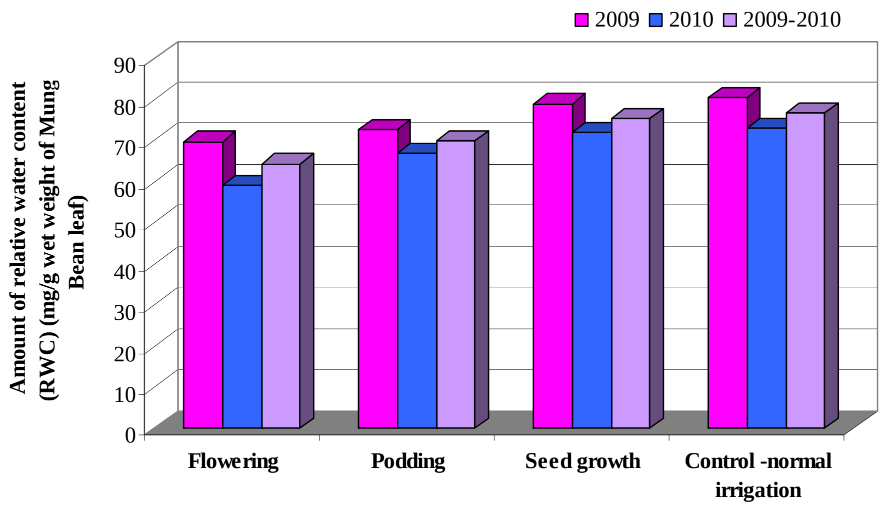

Figure 3. Comparison of average of irrigation cutting stress on RWC in different stages of growth of Mung bean Cultivars

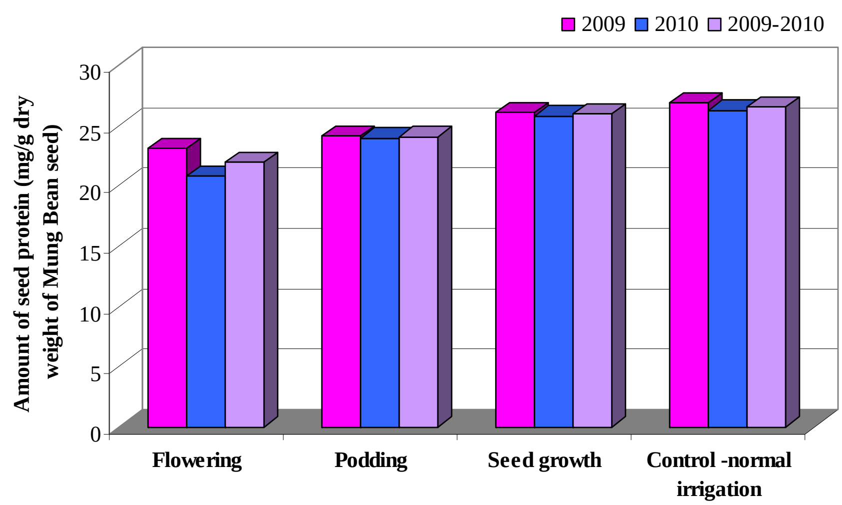

Figure 4. Comparison of average of irrigation cutting stress on the amount of seed Protein in different stages of growth of Mung Bean cultivars

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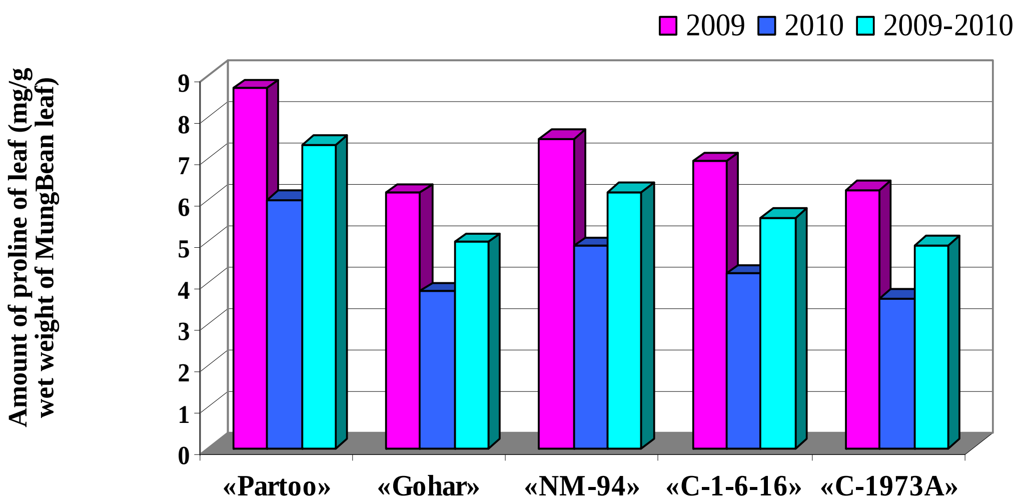

Figure 5.Comparison of average of Mung Bean cultivars regardingamount of leaf Proline

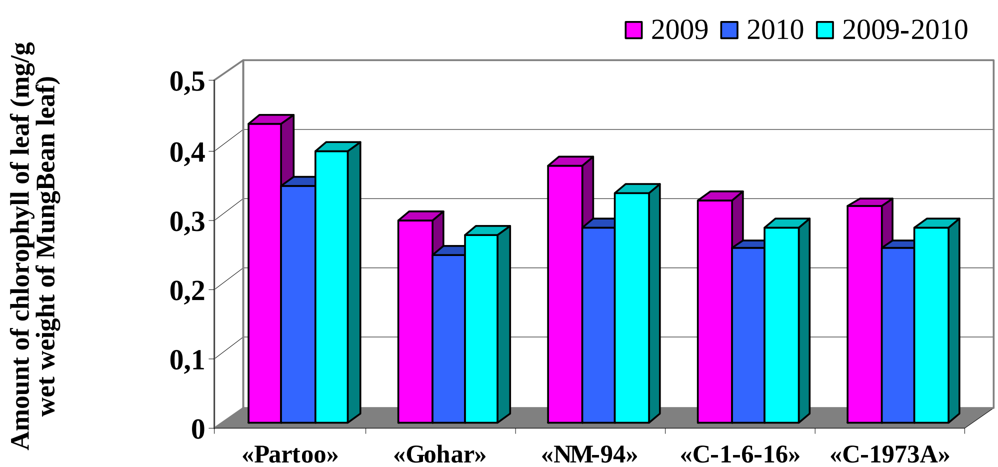

Figure 6.Comparison of average of Mung Bean cultivars regarding amount of leaf Chlorophyll

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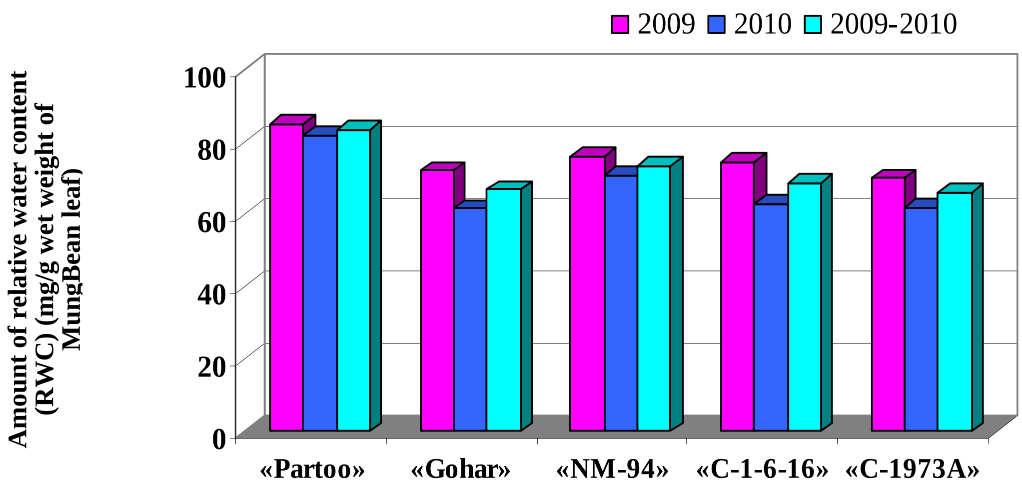

Figure 7.Comparison of average of Mung Bean cultivars regarding relative continent of leaf water (RWC)

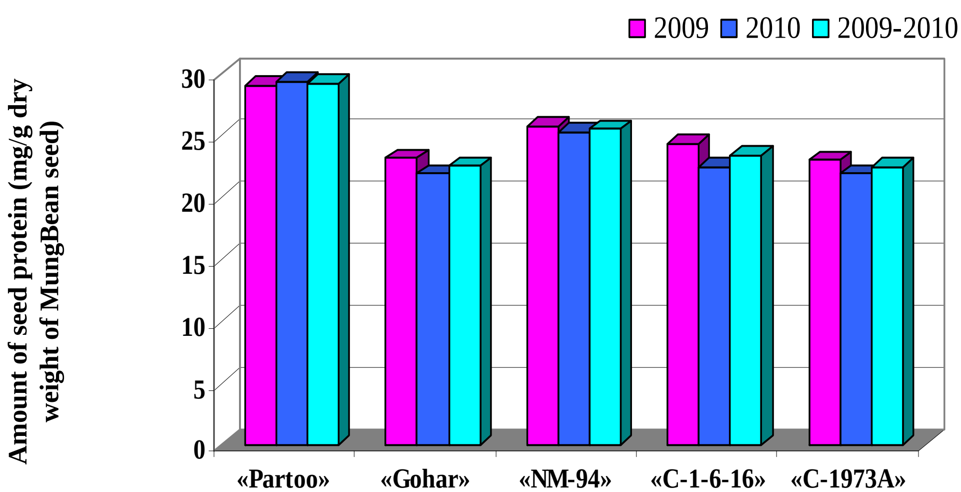

Figure 8.Comparison of average of Mung Bean cultivars regarding seed Protein

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17. *Table 2.*Analysis of variance of physiological characters in Mung Bean cultivars under the influence of irrigation cutting (2009 and 2010).

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