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Effects of Drought Stress on Qualitative and Quantitative Traits of Mungbean

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***Abstract*—**In order to investigate the effect of drought stress and row spacing on grain yield and associated traits of Mungbean, an experiment was conducted as a factorial in based on randomized complete block design with three replications in Ilam station, Iran during 2008-2009 growing season. This experiment was conducted in four stages on one kind of Mungbean named Gohar. The experimental factors including (80, 110 and 140mm cumulative evaporation from class A pan) and row spacing (25, 50, and 75cm) were selected. The results of the experiment showed that the varieties affected by the treatment showed significant differences. The highest total yield was obtained in the condition in which evaporation of water was 80mm. Of course some traits such as grain yield did not show a significant difference between the conditions in which evaporation of the irrigation water was 80 and 110mm. The traits under study also showed a significant difference to different raw spacing. Row spacing of 50cm had a higher total yield compared to other raw spaces. It was due to the higher number of pods per plant and grain weight. The interaction of drought stress and row spacing showed that in the condition in which the row space is 50 cm and the evaporation of the irrigation water is 80mm, the highest number of grain is achieved.

***Keywords*—**Stress, Grain yield, Mungbean, Row spacing.

I. INTRODUCTION

MUNGBEAN belongs to *Legominoseae* family; their seed are rich in protein and contains about 25% protein and about 2.1 to 3.1 percent fat. Mungbean is also important due to nitrogen fixation and so increasing soil fertility [1]. Undoubtedly environmental stresses are one of the limiting factors in crop production. Drought is the most important factor limiting crop production in the world [2]. Iran has an arid and semi-arid climate and lack of water is one of the basic problems of agriculture in Iran; therefore, the occurrence of drought stress is inevitable during while plants are in growth process. The reaction of different plants and also different kinds of the same plant is different to drought. Currently, most of beans are produced in dry-land areas. Low performance of types of plants which are used currently, limited use of agricultural institutions, adapting improper production procedures, and occurrence of biological and abiotic stresses are important factors in reducing production and fluctuations in performance of plants [3]. According to the estimates made by Levitt [4], perhaps only ten percent of the arable lands in the world are categorized as lands free of stress. The drought stress is one of the main stresses which assign 26 % of the whole stresses to itself. Lots of stresses affect plants often directly and indirectly through water stress. Generally drought affects all aspects of the growth of plants and also most of its physiological aspects [5]. Gupta et al. [6] reported that drought stress causes decrease in the rate of plans' growth. The number of leaves and branches also decrease and plants flowering stage begins earlier. Loss of chlorophyll content of leaves is reported under drought circumstances, maintaining the concentrations of chlorophyll stable in this situation helps stabilizing photosynthesis. Regulation of leaf surface is taking place by reducing leaf size and leaf number per plant under drought [7]. Yield is the result of the efficiency of the plant in using solar radiation during the growing season, In this regard, the plant needs sufficient leaf surface which should be distributed evenly and should cover the earth surface completely. This aim is possible through varying the density and distribution of plants on the surface of the earth. Trung and Yoshida [8] report the performance of different kinds of Mungbean with varying density. In most cases, with an increase in the amount of density, the number of pods per unit and plant height increases, on the other hand, the number of secondary branches per plant, the number of pods per plant, the number of seeds, and also grain weight decreases which results in reducing yield. This investigation is done in Ilam due to the importance of pulses and also their culturing in the district to show the effect of drought stress on one kind of Mungbean named Gohar.

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II. MATERIALS AND METHODS

In order to investigate the effect of drought stress and row spacing on grain yield and associated traits of Mungbean, an experiment was conducted as a factorial arrangement in based on randomized complete block design with three replications in Ilam station**,** Iran during 2008-2009 growing season. The geographical location of the place was 46 degrees longitude, 28 minutes latitude which was equal to 33 degrees and 37 minutes and height above sea surface was 1174. Chemical properties of soil and the rate of precipitation and Physical are shown in Tables I& II.

TABLE I
PHYSICAL AND CHEMICAL PROPERTIES OF SOIL

Soil texture	Sandy loam
EC (ds.m^{-1})	0.71
pH	7.3
O.C (%)	1.28
N (%)	1.12
P (mg.kg^{-1})	12.4
K(mg.kg^{-1})	280

TABLE II
VARIATION OF TEMPERATURE AND AMOUNT OF PRECIPITATION DURING GROWTH SEASON

Months	April	May	June	July	August
Monthly mean of minimum temperature (ºC)	12	16.3	26.8	24.2	26.1
Monthly mean of maximum temperature (ºC)	23	30	34.4	37.2	41.3
Monthly mean of temperature (ºC)	15.5	23.16	30.1	30.7	32
Monthly mean of precipitation (mm)	10.19	13	0	0	0

In order to determine yield and the performance of the plant in the final harvest, the two lateral lines and a half meters from the beginning and the end of plot were removed, then one square meter of each plot were harvested and transported to the laboratory.

The 1000-grain weight and grain yield was measured by digital scale after placing it in oven. The measurement of the number of grain per pod and number of pods per plant was done by hand. Kjeldahl method was used to measure protein content.

For statistical analysis, data were analyzed using MSTAT-C software. Means were compared by Duncan multiple range test.

III. RESULTS AND DISCUSSION

A. Number of Pods per Plant

The results of the analysis of variance table showed that the effect of irrigation and row spacing treatments at 1% level was significant on number of pods per plant, however their interaction had no significant effect on the number of pods per plant. The results showed that there were significant differences between irrigation levels. Irrigation levels of 80 and 140 mm evaporation had the highest and lowest number of pods (Fig. 1). Based on the results, we can say that whatever drought stress is closer to the pod formation stage, its effect will be higher on the number of pods and on the yield. When irrigation increases, the growth and maturation of pods and leaves will be done in a longer period and aging of leaves will take place slower, so the number of pods per plant will increase.

Reduction in the amount of irrigation and the sudden increase of temperature will causes premature aging in plants.

The next thing is that when the amount of irrigation increases, the plant’s canopy will get more which can provide more food for reservoir by allocating enough dry matter to them. As a result, the number of pods per plant will get higher.

TABLE III
ANALYSIS OF VARIANCE FOR STUDIED TRAITS IN MUNGBEAN

S.O.V	df	pod.plant^{-1}	grains.pod^{-1}	1000 grain weight	Seed yield	Protein content
Replication	2	83.08	0.40	5.25	12830.03	0.79
Irrigation	2	485.82**	0.13ns	27.2*	404876.5**	9.1
Row spacing	2	447.12**	0.48**	472.51*	201389.74**	44.46
I × R	4	13.70ns	0.05ns	4.70 ns	8269 ns	1.60
Error	16	19.51	0.15	9.38	13768.12	4.95
C.V (%)		8.5	9.1	7.1	10.2	6.4

Ns, *and **: non significant, Significant at 5% and 1% probability levels, respectively.

Mouhouche et al. [9] also stated that the number of pods per plant is more sensitive to water stress. The occurrence of drought stress especially at pod formation stage has a determinant role in high yield and can cause a severe reduction in seed yield of Mungbean [10]. As Fig. 2 shows 50cm row spacing, had the highest number of pods per plant. It seems that in this distance, plants rows has been able to increase the number of pods per plant by producing lateral branches with equal distribution of plants and also optimal use of environmental factors such as sunlight. With increasing density and greater competition for limited water and nutrients, the growth and mature of pods will be done in a shorter period, aging of leaves takes place faster, so the number of pods per plants will decrease. On the other hand, the reduction in the amount of irrigation and also increase in the temperature will cause a faster aging of plants.

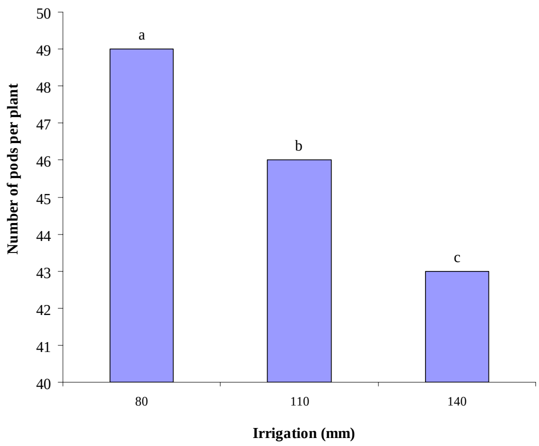

Fig. 1 Effect of drought stress on pods per plant

The next thing is that whatever the amount of water decreases, the plant’s canopy will decrease which cause a limitation in providing food for reservoirs, so enough dry matter will not be allocated to them. So the number of pods per plants will decrease. The appropriate density of plants per unit will cause an increase in the amount of light in the plant community and more space will be available for plant development. In this situation, the dominance effect of the ending buds will decrease and more tributaries branches will start growing in the plant. The possibility of taking advantage of the environmental situation will increase; a greater number of flowers will be produced, so the number of pods per plant will increase. Wanchai et al. [11] reported that by increasing the density, the number of pods per plant will decrease; they also concluded that the density of plant has no effect on the number of seeds per nod, the weight of seeds and also the quality of seeds. They did this by investigating the effect of density on the yield of two varieties of Mungbean.

B. Number of Grains per Pod

The number of grains per pod was affected by row spacing (row spacing was significant at the 1% level). Watering and the interactive effects of Irrigation and row spacing had no significant effect on number of seeds per pod (Table III).

As was shown, there was no significant difference between different levels of drought stress and all of them were placed in the same group regarding their statistically significance (Fig. 3).

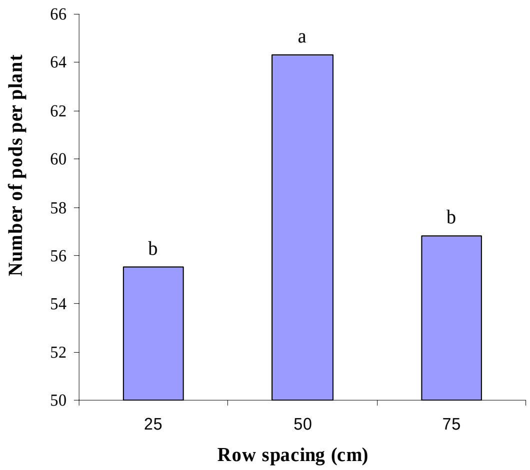

Fig. 2 Effect of row spacing on pods per plant

It seems that the number of seeds per pod is more influenced by genetic factors and is less affected by environmental factors. In this experiment, the drought stress treatments had no significant effect on this trait; all of them were place in the same group.

As was shown, among different types of plants which were investigated, the 25cm row spacing has the maximum number of seeds per pod and 75cm row spacing had the lowest number of pods (Fig. 4). It could be stated that the embryos of some of the fertilized ovaries will be aborted in this stage because of the increase in density due to water restrictions and fewer number of seeds will be produced. In this experiment, the numbers of seeds per pod were influenced by row spacing and it seems that if Mungbean produce a large number of pods, then the 1000-grain weight will decrease. In this experiment, it was observed that the 50cm row spacing has the lowest weight for 1000 seeds.

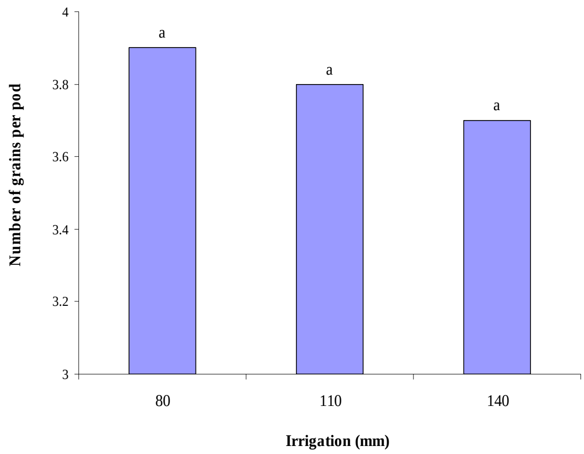

Fig. 3 Effect of drought stress on number of grain per pod

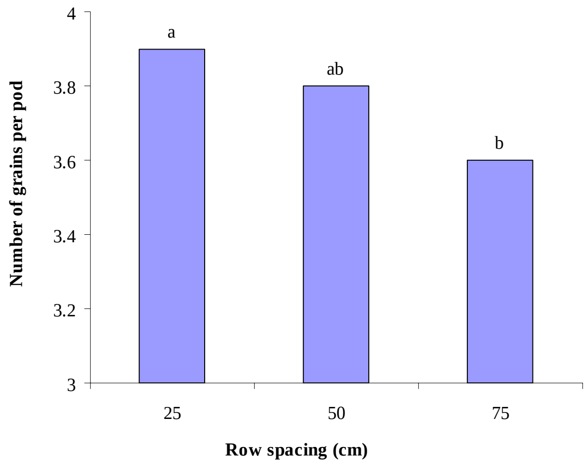

Fig. 4 Effect of row spacing on number of grain per pod

C. Grain Weight (1000-Grain Weight)

The grain weight is one of the important components in increasing yield which the influence of irrigation and row spacing on it was significant at the 1% level. But their interaction does not have a significant effect on grain weight (Table III). As Fig. 5 shows, irrigation at 80 and 140mm evaporation had the highest and lowest grain weight. In this study, simultaneous with the increase in the severity of drought stress, the grain weight will decrease. In general, grain weight is a function of speed and filling period of the plants which is supplied by two sources, named current photosynthesis and remobilization storage of plant material. Lack of soil moisture during the growing season, especially in the reproductive stage will decrease plant photosynthesis, speed, and filling period of the grain and finally it causes a decrease in the weight of the grain.

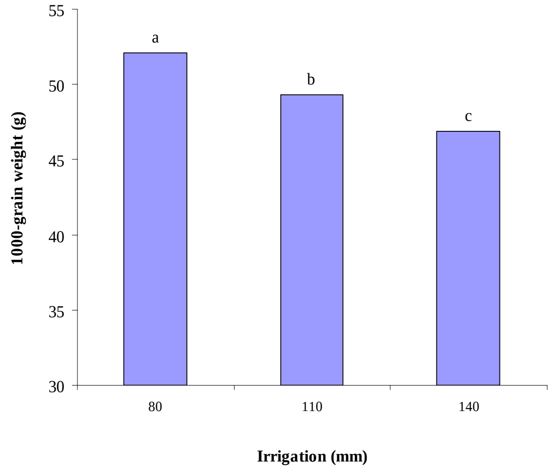

Fig. 5 Effect of drought stress on 1000-grain weight

However, environmental stresses such as drought cause an increase in the remobilization of storage materials from secondary sources to the sink but it cannot compensate the reduction in the amount of current photosynthesis which was created due to the lack of soil moisture. Keating and Cooper [12] stated that the reduction in grain weight under drought stress is due to the adverse effects of drought on biomass production. Drought stress decreases grain weight. Among different row spaces, the weight of 1000 grain of the 25cm row spacing is higher than the other rows and the lowest weight of 1000 grain belongs to 50cm row spacing. According to the results, the increase in the grain weight of the 25cm row spacing is due to the decrease in the two other components of yield.

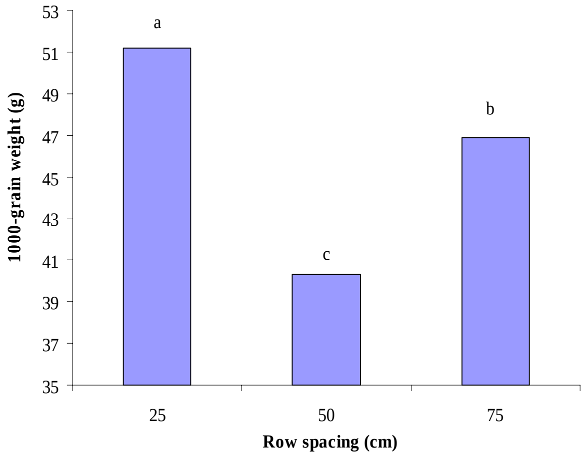

Fig. 6 Effect of row spacing on 1000-grain weight

D. Grain Yield

The results of the analysis of the table of variance of the data showed a significant difference in irrigation and row spacing on grain yield at 1% level but their mutual performance does not have a significant influence on grain yield (Table III). The results of grain yields show that the irrigations with 80mm and 140mm evaporation had the highest and the lowest grain yield respectively (Fig. 7). Agosta [13] by doing an investigation on beans showed that the difference in grain yield under stress is mostly due to the resistance to distribution of dry matters. Those kinds of the plants which had a higher yield under stress had the most number of pods and grains per plant. Gomes-Sanchez et al. [14] in their study concluded that water stress during vegetative growth leads to a reduction in leaf surface and photosynthetic rate, which may lead to reduction in grain yield.

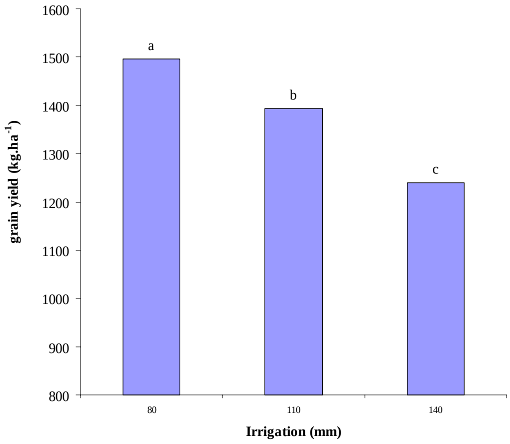

Fig. 7 Effect of drought stress on grain yield

The comparison of means of different rows showed that the 50 cm row spacing has the highest grain number. This may be due to higher number of pods per plant and grains pod (Fig. 8). Results of various studies indicate that the crop yield increases by increase in soil fertility, water availability and plant density per unit area. But if the density of the grains grows more than the desired density, it causes a reduction in yield due to the increase in competition within the bay bottom, plant lodging, etc. even if the soil fertility and available water increase, the yield will reduce. However, the competition between intraspecific completion and interspecific completion for yield is for using more environmental conditions. The maximum yield per unit area is achieved when the competition is minimized. One way to minimize this competition is to distribute plants per unit precisely. Because row spaceing and plant spacing determine the applicable growing space per plant so the grain yield is achievable [15].

E. Protein Content

Based on the results of the analysis of the table of variance of the data, the percentage of the grain protein in different irrigation levels did not show any significant difference. The effect of row spacing on grain protein content was only significant at the 1% level (Table III). As Fig. 9 shows, the row spacing of 50cm had the highest grain protein and 25cm row spacing had the lowest grain protein content. It seems that at a distance of 50cm, because of the fact that the number of the grain per plant and also the weight of 1000 grain decreases, a higher amount of nitrogen is allocated to the grains and the percentage of the protein of grains increase.

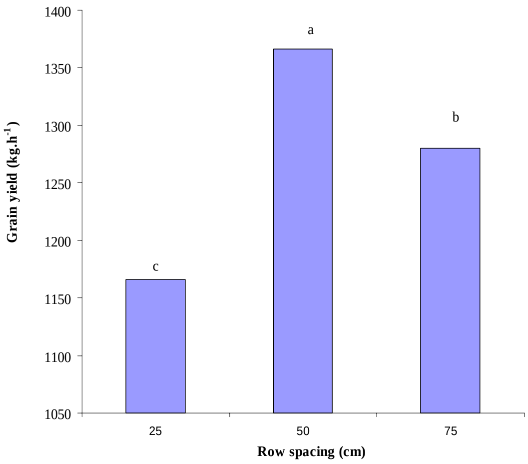

Fig. 8 Effect of row spacing on grain yield

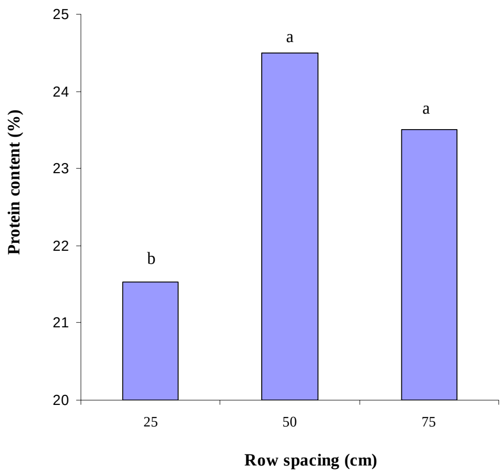

Fig. 9 Effect of row spacing on protein content

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