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# EFFECTS OF WATER STRESS AND POTASSIUM ON QUANTITY TRAITS OF TWO VARIETIES OF MUNG BEAN (*VIGNA RADIATA* L.)

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**ABSTRACT.** Water stress is known as the major threat to reduced growth and yield of plants in arid and semi-arid regions. Potassium is one of the indicators of plant responses to water stress. To evaluate the impact of water stress and levels of potassium on yield and yield components of two varieties of mung bean (*Vigna radiata)* (promising lines VC6172 and Indian), an experiment in the form of split factorial, based on randomized complete block design with three replicates was conducted in 2011, at the research farm of Safi-Abad Dezfool, Iran (latitude 32$^0$16$^{'}$ N, longitude 48$^0$26$^{'}$ E and altitude 82.9 m above sea level) .Water stress in three levels: irrigation at 120 (no stress), 180 (moderate stress) and 240 (severe stress) mm evaporation from pan, were allocated to the main plots and potassium fertilizer at three levels (0, 90, 180 kg /ha) and two varieties of mung bean (promising line VC6172 and Indian) were allotted to the sub-plots. Results showed that water stress and potassium fertilizer significantly affect all traits. The highest grain yield (2093 kg /ha) was obtained from no stress treatment in the case of 180 kg /ha potassium. Total dry matter, number of pods and grain yield, were significantly different between the two varieties. The interaction between fertilizer and variety, on dry matter and grain yield and the interaction between irrigation and variety, on dry matter were significant. We conclude that use of potassium fertilizer can reduce the adverse effects of water stress.

**Key words:** Potassium fertilizer; Genotypes of mung bean; Yield components.

## INTRODUCTION

Mung bean, with the scientific name of *Vigna radiata*, is a summer short season legume which is grown in tropical and subtropical dry regions. During the growth, plants are exposed in dry stress which leads to important changes in the physiological reactions. Grain legumes are major protein sources in arid and semiarid regions of the world and play a vital role in the economy. Water stress is considered to be one of the major problems in global mung

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bean production which led to decrease in growth and yield, especially in arid and semiarid regions where there is not enough raining (Thomas *et al.,* 2004).Yield loss is depending the time and intensity of the stress, thus in water deficit environments, matching crop development and water demand with the soil water availability will enables plants to utilize the limiting water resource more efficiently (Costa, 2002). In many crops, use of potassium is reported as a preventing or reducing factor in water stress conditions.

Thomas *et al.* (2004) investigate some genotypes of mung bean and stated that water stress accelerate flowering and podding time in many cases. Leaf chlorophyll content is one of the most important indices showing the environmental stress on plants which reduces under stress conditions (Zarco-Tejada, 2000). Wang (2008) stated that by increasing water stress, soybean seed protein was decrease. Liu *et al.* (2004) reported that sever water stress, in the first stage of pod development in soybean, decreased pods growth and led to considerable decrease in number of pod. Sangakkara *et al.* (2001) mentioned the positive effect of potassium consumption on reducing the harmful effects of water stress.

To improve water and fertilizer use efficiency and to obtain a considerable yield in water stress conditions, it is necessary to change management strategies including irregular use of fertilizer. Goal of this research was to study the effect of potassium use in different conditions of water stress on yield and yield component of two varieties of mung bean in dry region of Iran.

## MATERIALS AND METHODS

This experiment was conducted in 2011, at Safi-Abad, Dezfool Agricultural Research Center ($48^0$, 26' E longitude, $32^0$,16' N latitude; elev., 82.9 m), Iran. The experimental design was split factorial in the form of randomized complete block design with three replicates. Treatments were include water stress at three levels: irrigation at 120 (no stress), 180 (moderate stress) and 240 (severe stress) mm evaporation from a standard pan, where devoted to the main plots and potassium levels (0, 90 and 180 kg/ha) and genotypes, including: landrace India (the old variety in Khuzestan) and VC 6172 (promising lines) that allocated to the sub-plots as factorial assigned.

Land preparation was done two weeks before planting. Before planting, the soil was analyzed for soil nutrients, especially potassium, nitrogen and phosphorus were determined. Based on soil test results, the amount of 50 kg N and 150 kg P/ha were used. Seeds were planted in late July, in 3-4 cm depth. Each experimental plot was included four rows with 5 m length, with 50 cm row distance and 10 cm in row spacing. After physiological maturity, samples were taken randomly from 0.5 $m^2$ of each plot, and yield components, including number of pods per plant, 100 grain weight, and number of grains per pod, were measured. The final harvest, takes place when the pods color changes from green to brown and biological and grain yield were determined.

Data were analyzed using SAS (ver. 9.2) and Excel software and mean comparison was done according to Duncan's Multiple Range Test ($p<0.05$).

## RESULTS AND DISCUSSION

**Number of fertile pods per plant**

Results indicate that water stress and use of potassium fertilizer have a significant effect on the number of fertile pods per plant (*Table 1*); severe water stress decrease number of fertile pods/plant by 38% (*Table 2*), our finding was in consistent with Pandey *et al*. (1984).

Use of potassium significantly increased numbers of fertile pods/plant, so that use of 180 kg/ha potassium, in comparison to control (no potassium) increased this trait by 16% (*Table 3*). In the same time, there was no significant difference between two varieties in this trait.

**Number of grains per pod**

The results showed that water stress, potassium sulfate and cultivar had significant impact on the number of grains per pod, but there was no interaction between these factors in this trait (*Table 1*).

Lowest number of grains per pod was observed in severe stress conditions (240 mm evaporation from pan evaporation) to the 8.2, which in comparison to control (120 mm evaporation from pan evaporation) decreased by 30% (*Table 2*).

Usually, length of pod decrease in water stress condition and it can be the reason for decreasing of number of grains per pod. Rahman *et al.* (2000) studied the adaptation of chickpea to drought conditions and stated that all the traits, that they studied, under limited irrigation was reduced.

**Table 1 - Mean square values obtained from analysis of variance**

| S.V. | Biological yield | Grain yield | 100 grain weight | Grains/ pod | No. of pods/plant | Df. |
|---|---|---|---|---|---|---|
| Block | 2101ns | 7011ns | 0.409ns | 1.16ns | 179.65ns | 2 |
| Water stress | 37266366** | 1399544** | 13.884** | 54.55** | 1117.57** | 2 |
| Error (a) | 395824 | 7410 | 0.295 | 0.72 | 27.93 | 4 |
| Potassium | 4787225** | 3310409** | 0.615* | 7.38* | 319.46** | 2 |
| Stress*potassium | 316519ns | 89817ns | 0.304ns | 0.77ns | 30.47ns | 4 |
| Variety | 4072499** | 894748** | 1.342** | 5.35* | 252.91 | 1 |
| Stress x variety | 2117463** | 9206ns | 0.118ns | 0.51ns | 5.73ns | 2 |
| Potassium x variety | 1320124** | 110860** | 0.052ns | 1.79ns | 17.50ns | 2 |
| Stress x potassium x variety | 423997ns | 101211** | 0.081ns | 0.79ns | 10.05ns | 4 |
| Error (bc) | 215534 | 22135 | 0.102 | 1.18 | 32.35 | 30 |
| CV (%) | 7.66 | 5.45 | 3.99 | 9.18 | 11.56 | - |

*, ** and ns indicate a significant difference at 1 and 5% levels and no significant difference, respectively.

**Table 2 - Mean comparison of measured traits at different water stress level**

| Water stress | Biomass (kg/ha) | Grain yield (kg/ha) | 100 grain weight (g) | No. of grains/pod | No. of pods/plant |
|---|---|---|---|---|---|
| slight | 7375.4[a] | 2650[a] | 7.47[a] | 11.65[a] | 57.23[a] |
| moderate | 6163[b] | 2344.6[b] | 6.35[b] | 10.20[b] | 52.39[b] |
| severe | 4506.5[c] | 2093.6[c] | 5.74[c] | 8.2[c] | 41.82[c] |

Means with the same letter, in each column are not significantly different according to Duncan test ($p<0.05$).

The results of this study showed that potassium has a significant effect on number of grains per pod.

Most number of grains per pod was observed at 180 kg potassium per hectare by 10.7, which were 13% greater than control treatment (no fertilizer potassium) (*Table 3*).

Number of grains per pod in the VC 6172 variety was 7% more than India cultivar (*Table 4*). Fanaei *et al.* (2011) mentioned significant differences between canola cultivar in the number of grains per plant and state that genetic differences and adaptation with the environment are good reasons for differences of varieties in the number of seed in the reproductive organs.

**Table 3 - Mean comparison of measured traits at different level of potassium fertilizer**

| Potassium (kg/ha) | Biomass (kg/ha) | Grain yield (kg/ha) | 100 grain weight (g) | No. of grains/pod | No. of pods/plant |
|---|---|---|---|---|---|
| 0 | 5429.9[c] | 1879.1[c] | 6.33[b] | 9.41[b] | 45.62[b] |
| 90 | 6000.7[b] | 2510.3[b] | 6.55[b] | 9.94[b] | 52.74[a] |
| 180 | 6524.3[a] | 2698.4[a] | 6.69[a] | 10.7[a] | 53.07[a] |

Means with the same letter, in each column are not significantly different according to Duncan test ($p<0.05$).

**Table 4 - Mean comparison of measured traits in two varieties**

| Variety | Biological yield (kg/ha) | Grain yield (kg/ha) | 100 seeds weight (g) | Number of grain per pod |
|---|---|---|---|---|
| VC 6172 | 6280.6 a | 2491.6 a | 6.37 b | 10.37 a |
| Indian | 5731.3 b | 2234.1 b | 6.68 a | 9.67 b |

Means with the same letter, in each column are not significantly different according to Duncan test ($p<0.05$).

## 100 seed weight

Water stress, the amount of potassium sulfate and variety had a significant effect on seed weight but there was no interaction between these factors (*Table 1*). The lowest 100 seed weight was observed at severe stress treatment (5.74 g), which decreased by 24%, compared to control (*Table 2*). Nejat *et al.* (2009) stated that under water stress, imposed at flowering stage of corn, the thousands grain weight reduced by 19%. Grain weight is strongly influenced by the maturity condition and the late water stress can reduce this trait significantly.

Potassium consumption (180 kg/ha) increased grain weight by 5% (*Table 3*).The Indian variety had more grain weight, compared with VC 6172 (*Table 4*). Increasing grain weight can be resulted in increasing yield. Grain weight is more influenced by genetic and environmental conditions. High grain weight in Indian variety shows more assimilate translocation to the grain during grain filling period.

**Grain yield**

The results of this study showed that water stress, potassium sulfate, variety, interaction between variety and potassium and interaction between variety *potassium* water stress were significantly different on grain yield (*Table 1*).

The least grain yield was obtained at severe stress and decreased by 22%, compared with control (*Table 2*). Sankar *et al.* (2007) reported that water stress during stem elongation and flowering could cause a significant decrease in grain yield due to decrease of reproductive organs, while stress during grain filling reduce grain yield through grain weight.

Potassium had significant effect on mung bean grain yield. The highest grain yield (2698.4 kg/ha) was observed in the case of 180 kg/ha potassium so that, compared to the control increased by 43% (*Table 3*). Rose *et al.* (2008) reported that for achieving the highest grain yield, in canola, getting enough potassium is important in early flowering stage. Nasri *et al.* (2011) studied the effect of potassium on quantity and quality of bean and found that it has an important role in increasing grain yield through its effect on number of pods and number of grains per pods. The grain yield of VC 6172 variety was more than Indian variety, increased by11% (*Table 4*). Although this variety had less 100 grain weight, it seems that more grain yield observed in this variety, is due to more number of grain per pod.

The interaction between varieties and potassium fertilizer implies that the effect of potassium fertilizer on cultivar VC 6172, at all levels of potassium, was higher than the cultivar of Indian (*Fig. 1*), mentioned that this variety has a greater response to potassium fertilizer.

**Biological yield (Biomass)**

The results showed that water stress had a significant effect on total dry weight of mung bean (*Table 1*). The lowest total dry weight observed at severe stress treatment (4506.5 kg / ha), compared to control, decreased by 22% (*Table 2*).

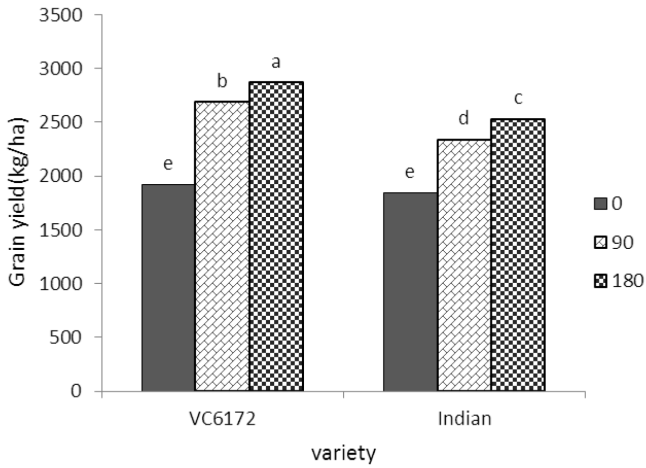


**Figure 1 - Interaction between variety and potassium fertilizer on grain yield**

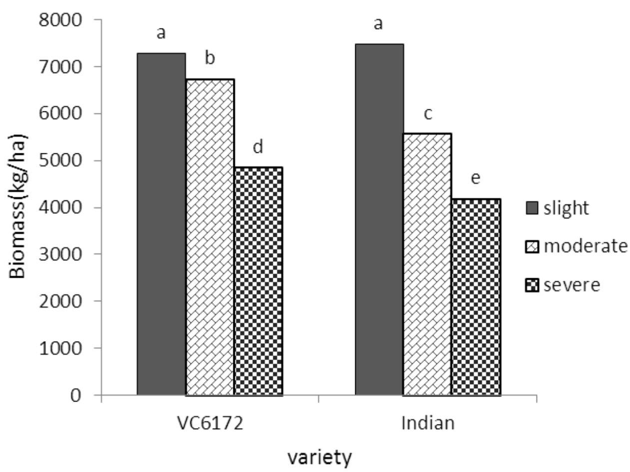


**Figure 2 - Interaction between variety and water stress on biologic yield (Biomass)**

Moradi *et al.* (2008) examine mung bean in conditions of extreme and mild water stress and state that the effect of water stress on total dry matter in vegetative stage was more than reproductive growth.

Potassium fertilizer had a significant effect on biomass of mung bean. The highest total dry weight obtained in the case of 180 kg /ha potassium increased by 18%, in comparison to control (*Table 3*). Hatami *et al.* (2010) studied the effect of 0, 80 and 160 kg/ ha potassium oxide on growth and yield of soybean in North Khorasan, Iran, and stated that potassium fertilizer increased plant dry weight.

VC 6172 variety had more biomass in comparison to Indian variety (8%) (*Table 4*). The interaction between water stress and varieties was significant, so in both varieties, biomass was decreased with increase in stress intensity (*Fig. 2*). Also, the interaction between varieties and potassium fertilizer show that, at all levels of potassium, cultivar of VC 6172 had more biomass (*Fig. 3*).

Generally, the amount of fertilizer, potassium especially at 180 kg per hectare, either in optimum irrigation conditions or intensity stress cause to improves yield and yield components in mung bean. In VC 6172 cultivar is also more resistant to drought stress and to be more responsive to the different amounts of potassium fertilizer.

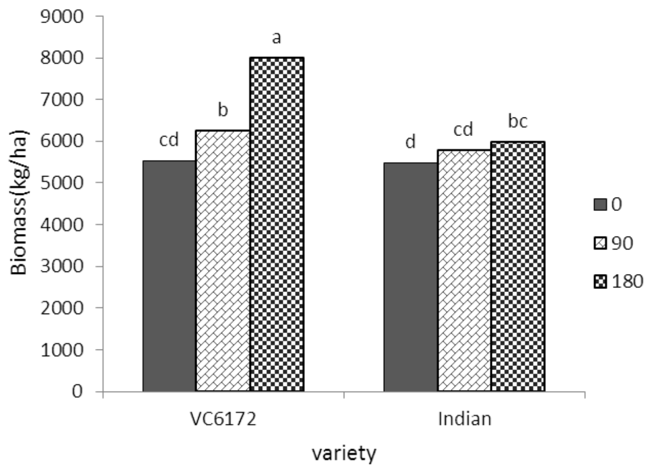


**Figure 3 - Interaction between variety and potassium fertilizer on biologic yield (Biomass)**

## CONCLUSION

Our finding implies that with increase in stress intensity, higher amounts of potassium fertilizer application can reduce the harmful effects of stress on grain yield. Use of 180 kg potassium/ha, even in severe stress condition, can decrease harmful effects of water stress on the number of pods/plant, number of grains/pod, hundred seed weight, grain and biological yield of mung bean. Also the VC 6172 variety was more resistant to water stress, compared with Indian variety, and also it is more responsive to various amounts of potassium fertilizer.

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