



## Effect of Mulch and Water Stress on Some Physiological Traits, Yield Components and Grain Yield of Red Kidney bean (*Phaseolus vulgaris* L.)

R. Amini<sup>1\*</sup> - A. Dabbagh Mohammadi-Nasab<sup>2</sup> - E. Ghalandarzadeh<sup>3</sup>

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### Introduction

Water use in agricultural production as one of the most important environmental factors affecting plant growth and development, especially in arid and semi-arid climatic conditions of Iran is of special importance (21). One of the ways of alleviating water scarcity is by enhancing its use efficiency or productivity. Improving water use efficiency in arid and semi-arid areas depends on effective conservation of moisture and efficient use of limited water. Mulching is one of the management practices for increasing water use efficiency (WUE). Straw mulch is commonly used as mulch. Straw mulching has potential for increasing soil water storage (16). Mulches modify the microclimate and growing conditions of crops (16), conserve more water and increase water use efficiency (34).

Red kidney bean (*Phaseolus vulgaris* L.) is the most important food legume (25) and is an important source of proteins and minerals (28). The majority of red kidney bean production is under drought conditions, and thus yield reductions due to drought are very common (29). This research was carried out to evaluate the effect of wheat straw mulch and water stress on physiological traits, yield components and grain yield of red kidney bean cultivars.

### Materials and Methods

A field experiment was conducted in 2012 at the Research Farm of the Faculty of Agriculture, University of Tabriz, Iran (latitude 38°05'\_N, longitude 46°17'\_E, altitude 1360 m above sea level). In order to investigate the effect of mulch on grain yield and yield components of red kidney bean (*Phaseolus vulgaris* L.) cultivars at different water stress treatments, a factorial experiment was conducted based on RCB design with three replications. The factors were including water stress treatment (I<sub>1</sub> and I<sub>2</sub>, irrigation after 60 and 120 mm evaporation from class A pan, respectively); mulch application at two levels (M<sub>1</sub>: (no mulch) and M<sub>2</sub>: 2 ton ha<sup>-1</sup> wheat straw mulch) and red kidney bean cultivars including Akhtar and Naz.

### Results and Discussion

The results indicated that the effects of water stress, mulch, cultivar and interaction of water stress × cultivar were significant on nodule number per plant. The results of mean comparison indicated that mulch application increased nodule number per plant by 17%. This result indicates that mulch increased the soil moisture and finally improved the activity of *Rhizobium*. In water stress treatment the nodule number per root of both cultivars reduced but the reduction in cv. Naz was greater than that of cv. Akhtar.

Analysis of variance indicated that the effects of water stress, cultivar and water stress × cultivar was significant on leaf stomata density. At water stress treatment (I<sub>2</sub>) the leaf stomata density increased by 7% but increasing in cv. Akhtar was greater than cv. Naz. One reason for increasing the leaf stomata density at water stress condition could be the reduction in cell size that led to increasing the leaf stomata density.

The effects of water stress, mulch, cultivar and water stress × cultivar was significant on pods per plant. The mulch application increased the pods per plant by 13%. The interaction effect of water stress × cultivar showed that the reduction of pods per plant in cv. Akhtar (27%) was greater than that of cv. Naz (20%). The cv. Naz had an indeterminate growth pattern and was able to compensate the reduction in pods per plant at later growth stages.

The effects of water stress, mulch, cultivar and water stress × cultivar was significant on 100-grains weight.

1- Associate Professor, Department of Plant Ecophysiology, Faculty of Agriculture, University of Tabriz, Tabriz, Iran

2- Professor, Department of Plant Ecophysiology, Faculty of Agriculture, University of Tabriz, Tabriz, Iran

3- Post Graduate Student, Department of Plant Ecophysiology, Faculty of Agriculture, University of Tabriz, Tabriz, Iran

(\*- Corresponding Author Email: r\_amini@tabrizu.ac.ir)

The 100-grain weight of red kidney bean increased in mulch application treatment by 6%. The explanation for increasing of 100-grains weight could be attributed to improving the water availability and photosynthesis rate by mulch application. The interaction effect of water stress  $\times$  cultivar showed that in both water stress treatments the cv. Akhtar had higher 100-grain weight than cv. Naz and the reduction percentage in cv. Naz was greater than that of cv. Akhtar. This result could be related to the longer growth period of cv. Naz than cv. Akhtar.

The effects of water stress, mulch, cultivar and the all interaction effects were significant on red kidney bean grain yield. The mulch application increased the grain yield by 18%. The effect of water stress  $\times$  mulch  $\times$  cultivar indicated that the cv. Akhtar in full irrigation treatment and application of straw mulch had the highest grain yield (3135 kg ha<sup>-1</sup>). Also the cv. Naz in water stress treatment and application of without mulch application had the lowest grain yield (1340 kg ha<sup>-1</sup>). The cv. Akhtar had a bush type growth pattern and a lower green cover than cv. Naz, therefore mulch application on the soil surface could increase the available water for red kidney bean.

## Conclusions

At water limitation conditions by mulch application, the available water, yield components and grain yield of red kidney bean could be increased. Under drought and aridity conditions, field management practices such as selecting high-yielding cultivars and reducing soil evaporation by using of mulch increased the grain yield especially in water limitation condition. Investigating the response of other common bean cultivars to water stress and mulch could be effective for identifying the common bean cultivars with high grain yield at water stress condition with mulch application that is consistent with sustainable agriculture.

**Keywords:** Cultivar, Grain weight, Irrigation level, Pod number, Stomata density