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Research Article

Influence of Drought Stress on Plant Height, Biological Yield and Grain Yield of Rapeseed in Khash Region

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ABSTRACT

The deficit of feed oil in Iran has been observed by imports that have entailed considerable costs. For making up the deficit of feed oil in Iran, oil seed production can be increased by planting oil plants in dry land areas with deficit water. According to annual precipitation, many regions in Iran suffer from water deficit. Under water deficit it is important the time of irrigation to maintain and /or improve soil water availability for crops. Drought, salinity, heat and freezing are environmental conditions that cause adverse effects on the growth of plants. Water deficit more than other stresses limits the growth and the productivity of crops. Field experiment was laid out split plot with randomized complete block design with three replications. Treatments included drought stress (control, complete irrigation, Irrigation from planting to flowering, Water cut in the pod and grain filling, Irrigation from planting to rosette, Water cut in the flowering) and potassium fertilizer (control, 175, 225 and 275 kg). Analysis of variance showed that the effect of water stress and potassium on all characteristics was significant (except biological yield).

Key words: Brassica napus, Components yield, Harvest index

INTRODUCTION

The deficit of feed oil in Iran has been observed by imports that have entailed considerable costs. For making up the deficit of feed oil in Iran, oil seed production can be increased by planting oil plants in dry land areas with deficit water. According to annual precipitation, many regions in Iran suffer from water deficit. Under water deficit it is important the time of irrigation to maintain and /or improve soil water availability for crops. Oilseed canola plant (*Brassica napus* L.) is an important agricultural crop grown primarily for its edible oil and the meal that remains after oil extraction has value as a source of protein for the livestock feed industry (Jensen *et al*., 1996). Canola container valuable fatty acids and amino acid required by the human body, with 40-49 percent and 35-39 percent protein (after oil extraction) and oil respectively. Rapeseed (*Brassica napus* L.) is one of the most important oilseeds both in Iran and throughout the world with drought stress being one of the main limiting factors of its growth and production in Iran (Moradshahi *et al*., 2004). Water deficit is one of the most significant stresses of agriculturally important crops, affecting growth, development and yield (Micheletto *et al*., 2007). Environmental stress such as water limitation during growth and development of plants can affect seed quality and quantity (Younesi and Moradi, 2009). Usually, water deficit stress has detrimental effects on many processes in plants, which include reducing photosynthesis, accumulation of dry matter, stomatal exchanges, and protein synthesis that affect their growth stages (Larcher, 2003; Ohashi *et al*., 2006). Generally, plants respond to water deficit stress through developmental, biochemical and physiological changes and the type of the observed response depends on several factors such as stress intensity (SI), stress duration and genotype (Moradshahi *et al*., 2004). Drought stress often causes yield reduction, which is an important agricultural research subject (Zhang *et al*., 2008). Robertson and Holland (2004) reported that the effect of drought stress is a function of genotype, intensity and duration of stress, weather, growth and developmental stages of rapeseed (*Brassica napus* L.). The effects of water stress depend on timing, duration, and magnitude of water deficiency (Pandey *et al*., 2001). The occurrence time is more important than the water stress intensity (Abbasian and Shirani Rad, 2011). Most oilseed rape crops grown in Iran are established in autumn and usually drought is an important limiting factor. In certain tolerant-adaptable crop plants such as rapeseed, morphological and metabolic changes occur in response to

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drought, which contribute towards adaptation (Tohidi-Moghadam *et al*., 2009). Drought reduces biomass and seed yield, harvest index, number of silique and seeds, seed weight, and days to maturity (Abebe and Brick, 2003; Munoz- Perea *et al*., 2006; Padilla-Ramirez *et al*., 2005). Besides, drought increases cooking time and seed protein content (Frahm *et al*., 2004). According to Mir Mousavi *et al*. (2006), seed yield has a larger positive direct effect on oil yield and content. Harvest index has a large positive correlation with oil yield; Great positive correlation was due to its indirect effect via seed yield in each plant (Abbasian and Shirani Rad, 2011). Pazouki (2000) showed that shortening irrigation interval increased 1000- seed weight and vice versa. In an experiment with nine summer rapeseed, Chango and McVetty (2001) observed that total dry matter and harvest index had a significantcorrelation with grain yield. Under field conditions, early drought (occurring at green bud stage) could lead to a decrease in oil content of seeds, implying that allocation of assimilates to the ovule at the early stage of the megaspore could be related to the final oil concentration (Wright *et al*., 1995; Abbasian and Shirani Rad, 2011). In agricultural systems, high-density monoculture crops deplete soil minerals quickly and therefore rely on external supplies for most of their nutrients, particularly nitrogen, potassium (K) and phosphorus (Amtmann *et al*., 2006). A balanced supply of mineral nutrients is crucial for both quantity and quality of the crop, but rarely achieved in the field. Of the mineral nutrients, imbalanced nutrition with K is well known and becoming an important constraint to crop production in many areas (Cakmak, 2010). Potassium (K) is an essential macronutrient and plays an important role in metabolism as it functions as a cofactor of many enzymes and is required for charge balance and transport of metabolites (Marschner, 1995). It has been shown that the rate of net photosynthesis and the activity of ribulose-1, 5-bisphosphate carboxylase decrease in plants under conditions of K deficiency (Peoples and Koch 1979; Zhao *et al*., 2001; Cakmak, 2005; Weng *et al*., 2007). Several lines of evidence have also shown that K deficiencycauses a decrease in sucrose export from source leaves (Mengel and Viro, 1974; Cakmak, 2005). Thus, the impairment in photosynthetic CO2 fixation and decrease in sucrose export in K-deficient leaves could lead to enhanced oxygen photoreduction in the chloroplast via the Mehler reaction resulting in the production of ROS. In order to detoxify ROS, increases in the activities/contents of antioxidants are expected in leaves of K-deficient plants. Indeed, enhancement in the activities of antioxidant enzymes has been demonstrated in K-deficient bean leaves (Cakmak, 1994, 2005). Ding et al. (2008) also reported that the activities of SOD, CAT and peroxidase in the leaves of rice plants supplied with low K (0.5 mM) were higher than those supplied with high K (6mM). This article is research article and the aims are influence of drought stress on plant height, biological yield and grain yield of rapeseed in Khash Region.

MATERIALS AND METHODS

Location of experiment

The experiment was conducted at the khash which is situated between 60° North latitude and 27° East longitude.

Composite soil sampling

The soil was sandy-loam texture.

Measurement of plant height

Distance from the ground level to the plant apex was recorded at the maturity from 18 plants in every individual plot

Field experiment

The field experiment was laid out split plot with randomized complete block design with three replications.

Treatments

Treatments included water stress (control, complete irrigation, Irrigation from planting to flowering, Water cut in the pod and grain filling, Irrigation from planting to rosette, Water cut in the flowering) and potassium fertilizer (control, 175, 225 and 275 kg).

Data collect

The experimental data were statistically analyzed for variance using the SAS software. When analysis of variance showed significant treatments effects, Duncan multiple range test was applied to compare the means (at the 5% probability level).

RESULTS AND DISCUSSION

Plant height

Analysis of variance showed that the effect of water stress on Plant height was significant (Table 1). The maximum of Plant height of treatments control was obtained (Table 2). The minimum of Plant height of treatments irrigation from flowering- pod was obtained (Table 2). Analysis of variance showed that the effect of Potassium on Plant height was significant (Table 1). The maximum of Plant height of treatments 275(kg/ha) was obtained (Table 2). The minimum of Plant height of treatments control was obtained (Table 2).

Table 1: Anova analysis of the mung bean affected by water stress and potassium

S.O.V	df	Plant height	Harvest Index	Biological yield	Grain yield
R	2	29.73^{ns}	0.723^{ns}	221552.07^{ns}	12510.56^{*}
Irrigation	3	182.42^{**}	53.453^{**}	9443331.78^{**}	1872397.19^{**}
Error a	6	8.69	1.113	174920.42	11399.31
Potassium	3	52.23^{*}	21.728^{**}	133244.56^{ns}	154192.19^{**}
Irrigation * Potassium	9	2.79^{ns}	2.523^{*}	242294.30^{ns}	11979.17^{*}
Error b	24	2.53	0.87	41738.19	3759.99
CV (%)	-	2.24	2.43	2.243260	1.63

*, **, ns: significant at P<0.05 and P<0.01 and non-significant, respectively.

Table 2: Comparison of different traits affected by water stress and potassium

Treatment	Plant height	HI	Biological yield	Grain yield
Water stress				
control	123.72a	32.43a	9178.6a	2770.42a
Irrigation from planting to flowering	119.23b	29.64c	8718.6b	2376.87b
Irrigation from planting to rosette	116.42c	30.72b	7230.4c	2198.85c
Irrigation from flowering- pod	110.23d	27.23d	7583.1c	1876.12d
Potassium (kg/ha)				
control	110.28c	23.56c	8432.5a	2365.75d
175	114.23b	24.23bc	8643.2a	2231.06c
225	115.31ab	25.30b	8640.3a	2312.93b
275	117.24a	26.77a	8470.0a	2457.08a

Any two means not sharing a common letter differ significantly from each other at 5% probability.

Harvest index

Analysis of variance showed that the effect of water stress on harvest index was significant (Table 1). The maximum of harvest index of treatments control was obtained (Table 2). The minimum of harvest index of treatments irrigation from flowering- pod was obtained (Table 2). Analysis of variance showed that the effect of Potassium on harvest index was significant (Table 1). The maximum of harvest index of treatments 275 (kg/ha) was obtained (Table 2). The minimum of harvest index of treatments control was obtained (Table 2).

Biological yield

Analysis of variance showed that the effect of water stress on biological yield was significant (Table 1). The maximum of biological yield of treatments control was obtained (Table 2). The minimum of biological yield of treatments irrigation from planting to rosette was obtained (Table 2). Analysis of variance showed that the effect of Potassium on biological yield was not significant (Table 1). The maximum of biological yield of treatments 225 (kg/ha) was obtained (Table 2). The minimum of biological yield of treatments control was obtained (Table 2).

Grain yield

Analysis of variance showed that the effect of water stress on grain yield was significant (Table 1). The maximum of grain yield of treatments control was obtained (Table 2). The minimum of grain yield of treatments irrigation from flowering- pod was obtained (Table 2). Analysis of variance showed that the effect of Potassium on grain yield was significant (Table 1). The maximum of grain yield of treatments 275(kg/ha) was obtained (Table 2). The minimum of grain yield of treatments control was obtained (Table 2).

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