P-ISSN: 2305-6622; E-ISSN: 2306-3599
International Journal of Agriculture and Biosciences
www.ijagbio.com; editor@ijagbio.com

Research Article

Influence of Water Stress and Potassium Fertilizer on Some Characteristics of Rapeseed

Sara Abkhesht[1], Hamid Reza Mobasser[1] and Hamid Reza Fanaei[2]

[1]Department of Agronomy, Islamic Azad University, Zahedan Branch, Zahedan, Iran
[2]Agriculture and Natural Resources Research Center of Sistan, Iran
***Corresponding author:** hamidrezamobasser@gmail.com

Article History: Received: October 12, 2015 Revised: November 24, 2015 Accepted: December 18, 2015

ABSTRACT

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. Environmental stress such as water limitation during growth and development of plants can affect seed quality and quantity. 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. Field experiment was laid out split plot with randomized complete block design with three replications. 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, 150, 200 and 250 kg). Analysis of variance showed that the effect of water stress and potassium on all characteristics was significant (except biological yield).

Key words: Plant height, Biological yield, Grain yield

INTRODUCTION

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). 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. 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 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

Cite This Article as: Abkhesht S, HR Mobasser and HR Fanaei, 2015. Influence of water stress and potassium fertilizer on some characteristics of rapeseed. Inter J Agri Biosci, 4(6): 218-221. www.ijagbio.com

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 significant correlation 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).

MATERIALS AND METHODS

Location of experiment

The experiment was conducted at the zahak which is situated between 31° North latitude and 61° East longitude.

Composite soil sampling

Composite soil sampling was made in the experimental area before the imposition of treatments and was analyzed for physical and chemical characteristics.

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, 150, 200 and 250 kg).

Data collect

Data collected were subjected to statistical analysis by using a computer program MSTATC. Least Significant Difference test (LSD) at 5 % probability level was applied to compare the differences among treatments` means.

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 250(kg/ha) was obtained (Table 2). The minimum of Plant height of treatments control was obtained (Table 2). 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 plant height reduction, which is an important agricultural research subject (Zhang *et al*., 2008).

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 250(kg/ha) was obtained (Table 2). The minimum of harvest index of treatments control was obtained (Table 2). 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).

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

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

S.O.V	df	Plant height	HI	Biological yield	Grain yield
R	2	26.88^{ns}	0.852^{ns}	251661.06^{ns}	11010.56^{*}
Irrigation	3	196.58^{**}	62.586^{**}	9643331.78^{**}	1782397.19^{**}
Error a	6	9.01	1.312	173920.42	10299.31
Potassium	3	47.89^{*}	23.738^{**}	147244.56^{ns}	187192.19^{**}
Irrigation * Potassium	9	2.29^{ns}	3.632^{*}	250294.30^{ns}	12179.17^{*}
Error b	24	2.46	0.99	42138.19	3909.99
CV (%)	-	2.35	3.69	2.433260	2.74

*, **, 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	120.72a	29.63a	9378.6a	2780.42a
Irrigation from planting to flowering	117.49b	26.34c	9018.6b	2366.17b
Irrigation from planting to rosette	113.96c	27.82b	7570.4c	2105.25c
Irrigation from flowering- pod	111.47d	24.24d	7777.4c	1883.42d
Potassium (kg/ha)				
Control	113.48c	25.76c	8317.5a	2141.75d
150	115.28b	26.27bc	8508.2a	2239.08c
200	116.71ab	27.03b	8550.3a	2317.33b
250	118.15a	28.97a	8369.0a	2437.08a

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

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 200(kg/ha) was obtained (Table 2). The minimum of biological yield of treatments control was obtained (Table 2). 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).

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 250(kg/ha) was obtained (Table 2). The minimum of grain yield of treatments control was obtained (Table 2). A balanced supply of mineral nutrients is crucial for quantity of the grain yield, 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).

REFERENCES

Abbasian A and AH Shirani Rad, 2011. Investigation of the response of rapeseed cultivars to moisture regimes in different growth stages. J Cent Eur Agr 12: 353-366.

Abebe AS and MA Brick, 2003. Traits associated with dry edible bean (Phaseolus vulgaris L.) productivity under diverse soil moisture environments. Euphytica 133: 339-347.

Amtmann A, JP Hammond, P Armengaud and PJ White, 2006. Nutrient sensing and signaling in plants: Potassium and phosphorus. Adv Bot Res 43: 210-257.

Cakmak I, 1994. Activity of ascorbate-dependent H2O2-scavenging leaves, but not in phosphorus-deficient leaves. J Exp Bot 45: 1259-1266

Cakmak I, 2005. The role of potassium in alleviating detrimental effects of abiotic stress in plants. J Plant Nutr Soil Sci 168: 521-530.

Cakmak I, 2010. Potassium for better crop production and quality. Plant Soil 335: 1-2.

Chango G and PBE McVetty, 2001. Relationship of physiological characters to yield parameters in oilseed rape. Can J Plant Sci, 81: 1-6.

Ding Y-C, C-R Chang, W Luo, Y-S Wu, X-L Ren, P Wang and G-H Xu, 2008. High potassium aggravates the oxidative stress induced by magnesium deficiency in rice leaves. Pedosphere 18: 316-334.

Frahm MA, JC Rosas, N Mayek-Perez, E Lopez- Salinas, JA Acosta-Gallegos and JD Nelly 2004. Breeding beans for resistance to terminal drought in the lowland tropics. Euphytica 136: 223-232.

Jensen CR, VO Mogensen, G Mortensen, JK Fieldsend, GFJ Milford, MN Anderson and JH Thage, 1996. Seed glucosinolate, oil and protein content of field-grown rape (Brassica napus L.) affected by soil drying and evaporative demand. Field Crop Res. 47: 93-105.

Larcher W, 2003. Physiological plant ecology. – Berlin, Germany, 513 p.

Marschner H, 1995. Mineral Nutrition of Higher Plants. Academic, San Diego, 2: 11-29.

Mengel H and M Viro, 1974. Effect of potassium supply on the transport of photosynthates to the fruits of tomatoes (Lycopersicon esculentum). Physiol Plant 30: 295-300.

Micheletto S, L Rodriguez-Uribe, R Hernandez, RD Richins, V Curryv and MA Connell. 2007. Comparative transcript profiling in roots of

(Phaseolus acutifolius) and (Phaseolus vulgaris) under water deficit stress. Plant Sci, 173: 510-520.

Mir Mousavi A., H Zeynali, and A. Hoseinzadeh, 2006. Evaluation of genetic correlation of oil seed content with some important quality and quantity traits in Canola using multivariate statistical methods. J Iranian Agric Sci, 1: 176-186. (in Persian).

Moradshahi A, B Salehi Eskandari, B Kholdebarin, 2004. Some physiological responses of canola (Brassica napus L.). Iran J Sci Technol Trans A-Science, 28: 43-50 (in Persian).

Ohashi Y, N Nakayama, H Saneoka, K Fujita, 2006. Effects of drought stress on photosynthetic gas exchange, chlorophyll fluorescence and stem diameter of soybean plants. Biologia Plantarum, 50: 138–141.

Padilla-Ramirez JS, JA Acosta-Gallegos, E Acosta- Diaz, N Mayek-Perez and JD Nelly, 2005. Partitioning and partitioning rate to seed yield in drought-stressed and non-stressed dry bean genotypes. Ann. Rep. Bean Improv. Coop. 48: 152-153.

Pandey RK, JW Maranville, and A Admou, 2001. Tropical wheat response to irrigation and nitrogen in a Sahelian environment. I. Grain yield, yield components and water use efficiency. Eur J Agro, 15: 93-105.

Pazouki AR, 2000. Investigation and measurement of water stress on Physiologic characteristics and drought tolerance indices in two rapeseed cultivars. Ph.D. Dissertation, Science and Research Unit, Islamic Azad University, Ahvaz, Iran. (in Persian).

Peoples TT and DW Koch, 1979. Role of potassium in carbon dioxide assimilation in Medicago sativa L. Plant Physiol 63: 878–881327.

Robertson MJ and JF Holland, 2004. Production risk of canola in the semi-arid subtropics of Australia. Aust J Agric Res, 55: 525-538.

Tohidi-Moghadam HR, AH Shirani-Rad, G Nour-Mohammadi, D Habibi, SAM Modarres-Sanavy, M Mashhadi-Akbar-Boojar, and A. Dolatabadian, 2009. Response of six oilseed rape genotypes to water stress and hydrogel application. Pesq Agropec Trop, 39: 243-250.

Wright PR, JM Morgan, RS Jossop and A Cass, 1995. Comparative adaptation of canola(Brassica napus L.) and Indian mustard (B. juncea L.) to soil water deficit: yield and yield components. Field Crops Res, 42: 1-13.

Younesi O and A Moradi, 2009. The effect of water limitation in the field on sorghum seed germination and vigor. Aust. J Basic Appl Sci, 3: 1156-1159.

Zhang WX, Z Zhao, GX Bai and FJ Fu, 2008. Study and evaluation of drought resistance of different genotype maize inbred lines. Frontiers Agric China, 2: 428-434.