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Full Length Research Paper

Study of drought stress on agronomic traits of winter canola (*Brassica napus* L.)

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Drought and opportune water use is too important for water saving and high yield product. In order to investigate drought stress on agronomic traits of winter canola, experiment was carried out in 2005 to 2006 crop season. Using two treatments and three replicates, in which irrigation remained as the main factor in seven levels and the two secondary factors consisting of Zarfam and Opera varieties. The results showed that the effect of variety on the seed yield, seed-oil yield, seed-oil percent (1%) and 1000-seed weight (5%) was significant (P<0.05). Interaction between irrigation and cultivars were determined in comparison with the highest grain yield in the normal water conditions of Zarfam variety, the average is 4800 kg/ha. Among the studied parameters, the correlation between the seed-oil yield and seed-oil percent was found positive and significant (P<0.01) as compared to the number of seeds in forming pods and the maximum correlation was found between seed yield and oil yield to be (r = 0.99).

Key words: Drought stress, rapeseed, varieties, yield and yield component.

INTRODUCTION

The amount and velocity transfer of assimilates including plant photosynthesis is dependent on plant reverse action, absorption of environmental stimulus, enzyme-hormone and Avanti system operation. Respective effects of these factors appeared in the form of grain filling and velocity which has key role in grain resistance operation (DuDaka and Gayianas, 1991). It is apparent that water stress has no considerable effect on grain quality but during flowering, it causes a decrease in grain oil contents (Wilcox and Frankenberyer, 1987).

One third of the world lands are classified as arid and semi-arid region and the remains are faced with water seasonal or local fluctuations (Beweley and Krochko, 1982). Aridity is the most common environmental stress and approximately includes 25% of the world lands (Christianse, 1982). Among the most important criteria for genotypes assessment in environmental conditions is the study of respective effects of genotype and resistant study of grain operation through non-considerable changes in different environmental conditions. The fact that water stress effects on growth and yield are genotype-dependent is well known (Bannayan et al., 2008). Identification of the critical irrigation timing and scheduling of irrigation, based on time and accuracy to the crop, is the key for conserving water and improving irrigation performance and sustainability of irrigated agriculture (Ngouajio et al., 2007). In arid and semi-arid environments, both efficient use of available water and a higher yield and quality of safflower are in demand (Lovelli et al., 2007; Dordas and Sioulas, 2008; Koutroubas et al., 2008).

Major part of Canola production in the world is under dry farming conditions and as a result, plant reaction to stress is an important topic (Mayers et al., 1997). Canola may be treated by dry farming in those regions which have autumn and spring training. The plant has no need for extra water, but during the germination stage, rosette period, stem elongation, flowering, seed formation and its growth; there is the sense of water requirements (Singh et al., 1977). Canola is sensitive to drought in times of germination and pod growth. The case being most important when sufficient water is available for commencement of germination and new planted seedling are faced with insufficiency of water. In Canola

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cultivation, water irrigation may not be used (Mayers et al., 1997).

Brassica napus has considerable resistance against aridity which is due to different features including: Root/shoot position; more distribution of plant in comparison with grains and pods after pollination between and inside Canola, especially *B. napus* which has a considerable variance with regards to resistance against aridity such as: Proline accumulation; chlorophyll resistance, and more germination in water stress conditions (Mendham and Scot, 1975). Irrigation performance after 50 mm evaporation of Class A in Canola produced the most grain operation and with increase irrigation period to 100 and 150 mm evaporation of class A, grain operation show meaningful decrease (Shirani-e-Rad, 2002). After Irrigation with 50 mm evaporation in control Class A in Canola, the most production of grain operation is attained and with an increase of irrigation to 80 mm evaporation of Class A, grain operation did not receive meaningful decrease but in irrigation of 110 mm of class A; there was meaningful decrease of grain operation regarding control sample (Shirani-e-Rad, 2002). Although, most part of consumable oil of the company are import from foreign countries due to limitations of water resources, the necessity of planting oil seeds have an important feature. The aims of this research were to study the effects of late season drought stress on seed and oil yields and their components, and to evaluate their relationships among Autumn Rapeseed Cultivars.

MATERIALS AND METHODS

For finding the resistance to drought stress, two varieties of autumnal rapeseed were used and the component of their function was surveyed in conditions of treatment for examination of their drought stress and regular irrigation (control group). Examination in the case of split plot was done in the form of a complete block design with three repetitions, and it was observed that the irrigation was the main factor in seven levels, which consist of: regular irrigation (control group), cutting irrigation in stage of jointing, cutting irrigation in stage of flowering, cutting irrigation in stage of forming pods, cutting irrigation in stage of jointing and flowering, cutting irrigation in stage of jointing and forming pods, and cutting irrigation in stages of flowering and forming pods (Table 1). Also, the accessory factor in two levels consists of Zarfam and Opera varieties. The experiment was carried out at the Seed and Plant Improvement Institute (SPII) (35°59´N, 50°75´E, and altitude of 151m above the sea level), in Karaj and Iran from 2005 to 2006. This region has a semi-arid climate (230 mm annual rainfall).

In this survey, all the stages of plant's phonology and various attributes such as length of the bush, number of the secondary branches in the bush, the thickness of the stem, the length of pod's main stem, secondary branch, the length of the pod, the number of the pod in the main stem and the secondary stem, number of the pod in the bush, the number of seeds in the pod in main stem and secondary stem, the number of seeds in the pod, the weight of thousands of seeds, function of the seed, biologic function of harvest's coefficient and the percentage of oil of the seed and the function of the seed's oil were measured. The experiment was organized in a randomized complete block design, with split plot arrangement, employing three replications. Data matching statistical models split plot design in randomized complete block design was simple variance analysis and comparison of means using multiple ranges Duncan test 5% level was performed. The simple correlation between test characteristics was measured. Weather conditions of the area have been in the crop season experiment in Ombrotermic curve (Figure 1).

RESULTS AND DISCUSSION

Variance on the results of this experiment was the variety of traits, such as grain yield, grain oil yield, grain oil percent ($P \leq 0.01$) and 1000-seed weight ($P \leq 0.05$) were significant. The interaction between irrigation and cultivars on the adjective has a significant effect on the number of seeds per pod. The results of this study showed that, is significant due to a variety ($P<0.01$) of grain yield. Interaction between irrigation and cultivars were determined in comparison with the highest grain yield in the normal water conditions of Zarfam variety, with the average being 4800 kg/ha. And the lowest grain yield in the water phase (7), water stress was about 2100 kg/ha as compared with the average of Opera been tested in field conditions (Table 2). Adverse effect of water stress can affect the performance of canola, but these effects depend on the genotype, stage of plant development and adaptation to drought (if previously exposed land is located). Khoshnazar et al. (2000), Reddy and Rudy (1998) observed between the different varieties of *Brassica,* significant difference in grain yield. Poma et al. (1999) stated one advantage among canola varieties, the ability to absorb water from the depths of the earth and that there is need for rain in dry areas (Poma et al., 1999). Simple interaction effects of irrigation and variety was not significant on 1000-seed weight, while the simple effects of variety was significant at $P<0.05$. Interaction between irrigation and cultivars in the mean comparison of the condition of drought stress showed that the highest value of 1000-seed weight was obtained by Zarfam variety (4^a) by cutting at the water in the stage of jointing and flowering, while the lowest value was attributable to the opera variety for the condition of stress in the jointing and flowering stage (Table 3). Sadaqat et al. (2003), in the physiological study of drought tolerance in canola, said that under drought conditions, there are no significant differences in 1000-seed weight. It seems that in this study, a few numbers of pods per plant kept their weight and remained as seed pods due to water stress. Analysis of variance of the seed oil was determined for the variety by the effect of these traits that were significant at $P<0.01$ (Table 2). Also, in the mean comparison of the effect between variety and irrigation, Zarfam variety had the highest oil percent (40.5%) in the condition of common irrigation and it obtained the highest oil percent (42.5%) in the condition of drought stress, but did not for the condition of water cutting in the jointing and flowering stage (Table 2).

Jensen et al. (1996) showed that drought stress in

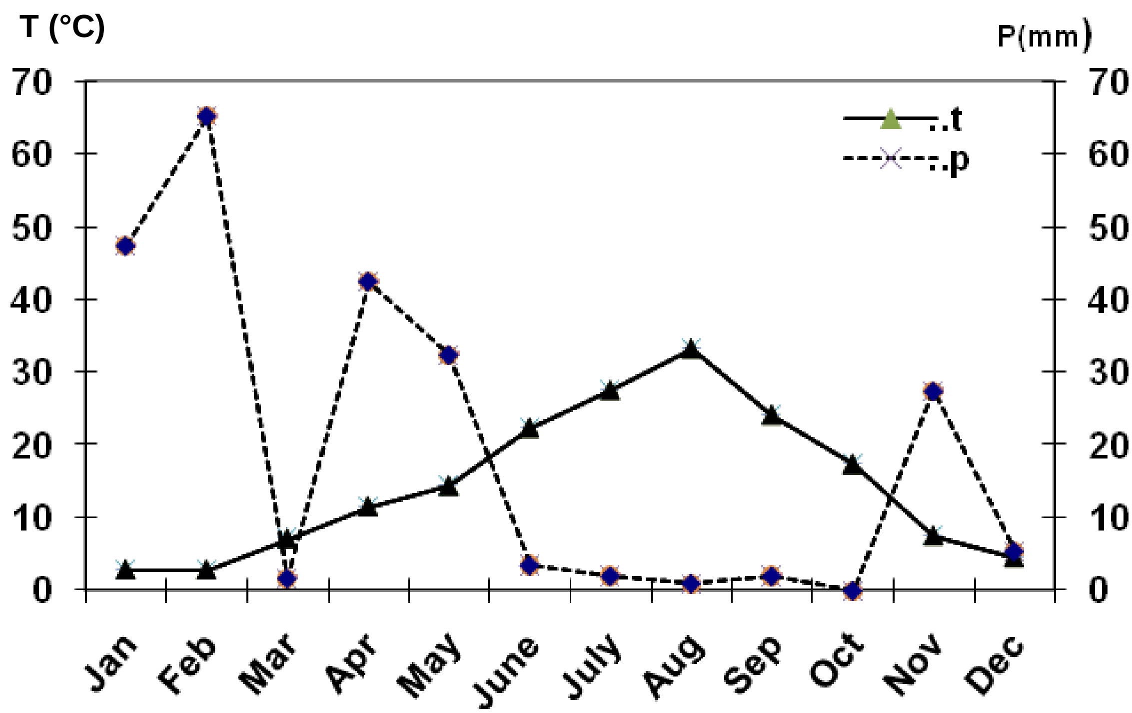

Figure 1. Ombrotermic curve of Karaj-Iran (2005 to 2006).

Table 1. Irrigation stage and amount of irrigation (m^3).

Irrigation and stress stage	Irrigation phase	Irrigation amount
Regular irrigation	8	5120
Cutting irrigation in stage of jointing	7	4480
Cutting irrigation in stage of flowering	7	4480
Cutting irrigation in stage of forming pods	7	4480
Cutting Irrigation in stage of jointing and flowering	6	3840
Cutting irrigation in stage of jointing and forming pods	6	3840
Cutting Irrigation in stage of flowering and forming pods	6	3840

canola (where the soil was sandy in only one of the experiments) caused 3.3% reduction in the amount of oil seeds and significantly affected other tests.

The number of seeds per pod is an important trait such that in canola, yield plays a very important role. Analysis of variance showed that the number of seeds per pod was significant ($P<0.05$) and also the property interaction between varieties and irrigation was significant. Comparison of means in the interaction between irrigation and varieties under drought stress conditions yielded the maximum number of seeds per pod as against the opera variety with an average of 20.6. Thus, this value was obtained with the cutting irrigation in stage jointing (Table 2). Niknam and Turner (2003) stated that drought stress during pollination and grain filling in the canola crop will reduce the number of seeds per pod. In the present study, the number of seeds per pod was low due to drought stress (Opera). This result is consistent with that of other researches (Halshem et al., 1998; Poma et al., 1999; Sana et al., 2003), all of which reduced the number of seeds per pod of stress.

A simple effect of the variety was significant ($P<0.01$) for oil seed yield. Comparison of means in the interaction between irrigation and varieties yielded the maximum oil yield, averaging 1945 kg/ha obtained by Zarfam variety in drought conditions, where the Zarfam variety was allocated to the stages in Table 2 due to drought stress. Also, during flowering and pod feeding, it had a sharp reduction in oil yield. This could be due to water shortage at this stage of plant growth (Table 2). More so, the results of this experiment are consistent with those of other researches (Sadaqat et al., 2003; Poma et al., 1999;

Table 2. Mean comparison the interaction of irrigation and variety effect on some traits of rapeseed.

Parameters	Grain yield		1000-seed weight		Oil content		No. of grain in forming pods		Oil yield	
Irrigation	Variety Zarfam	Variety Opera	Variety Zarfam	Variety Opera	Variety Zarfam	Variety Opera	Variety Zarfam	Variety Opera	Variety Zarfam	Variety Opera
Regular irrigation	4800[a]	3996[abcd]	3.77[abc]	3.82[ab]	40.57[bcd]	39.49[cd]	16.2[abc]	19.5[c]	1945[ab]	1574[abcd]
Cutting irrigation in stage of jointing	3758[abcd]	2971[bcde]	3.8[abc]	3.77[abc]	40.5[bcd]	39.63[bcd]	15.3[c]	20.6[a]	1521[bcde]	1177[cde]
Cutting irrigation in stage of flowering	3108[abc]	2167[e]	3.84[ab]	3.61[bc]	41.49[ab]	40.5[bcd]	17.6[abc]	13.6[c]	1289[abcd]	879.5[e]
Cutting irrigation in stage of forming pods	3204[abcd]	2438[cde]	3.78[abc]	3.69 [abc]	41.26[abc]	39.19[d]	13.3[abc]	15.3[abc]	1321[abc]	955.4[cde]
Cutting irrigation in stage of jointing and flowering	2850[a]	2321[abc]	4[a]	3.45[c]	42.52[a]	39.85[bcd]	18.3[abc]	14[bc]	1211[a]	924[abc]
Cutting irrigation in stage of jointing and forming pods	2625[de]	2805[abcde]	3.83[ab]	3.66[abc]	41.23[abc]	38.75[bcd]	19.6[ab]	15[abc]	1080[de]	1085[bcde]
Cutting irrigation in stage of flowering and forming pods	2452[ab]	2100[abcd]	3.92[ab]	3.84[ab]	42.56[a]	40.32[bcd]	16.3[abc]	15[abc]	1043[ab]	846[abcd]

Means in each column having similar letter (S) are not significantly different at the 5% level (DMR-test).

Table 3. Simple correlation coefficients among different traits of rapeseed cultivars.

Grain yield	Grain yield	1000-seed weight	Oil content	No. of grain in forming pods	Oil yield
	1	0.137ns	0.202**	0.163ns	0.993**
1000- Seed weight		1	0.446**	0.104ns	0.169ns
Oil Content			1	0.356*	0.308*
No. of grain in Forming pods				1	0.203ns
Oil yield					1

ns * and ** : Non significant at the 5% and 1% levels probability respectively.

Pritchard et al., 1999; Das, 1998). The correlations between traits indicated that the number of seeds per pod with seed oil percent and seed oil yield had a positive and significant correlation at P<0.05, while it had a significant and positive correlation with grain yield at P<0.01. Also, the correlation between these traits was positive and significant with seed oil percent and seed oil yield at P<0.01 (Table 3).

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