EFFECT OF DROUGHT STRESS ON YIELD AND YIELD COMPONENTS OF RAPESEED CULTIVARS IN IRAN(ISFAHAN) REGION

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Abstract

Rapeseed is one the oil plants that today because of the extent of compatibility, cultivated in many parts of the world. Water deficient is one of the important problems for successful crop production the most of word country. One of the method for water conservation is increase the efficiency of water resources and irrigation distribution proportional to plant needs it can increase water use efficiency. This experiment in order to study the response of Autumn Colza cultivars to the cut irrigation during various stages of growth was conducted in 2007-2008 at the Isfahan Agricultural Research Station (Iran).This experiment had a split-plot layout in the randomize complete block design with three replications. Factors included the cut of irrigation in seven stages (D_1: normal irrigation or irrigation after 80mm evaporation from class A pan to physiological maturation as an check treatment (D_2: Cut of irrigation in stem elongation stage (D_3: cut of irrigation in flowering stages, (D_4: cut of irrigation in pod production stages,(D_5: deletion of irrigation at stem elongation and at flowering stage, (D_6: deletion of irrigation at stem elongation and pod production stages, (D_7: deletion of irrigation at flowering and pod production stage) as main plots and four Autumn Colza cultivars included Opera, Okapi, Zarfam and Modena as sub-plots. In this experiment, the number of days to flowering, flowering period, the number of days to physiological maturation, the height of plant, the number of pod in the plant, the number of seeds in the plant, the weight of 1000 seeds, grain yield, biological yield, harvest index, Straw yield, oil seed percent and oil yield were measurement. The results showed that the effect of cut irrigation on the number of days to flowering, flowering duration, number of days to physiological maturation, number of pod in the plant, number of seeds in the pod, the weight of 1000 seeds, grain yield, biological yield, harvest index, straw yield and oil yield were significant $P \leq 0.01$. According to the results, the most sensitive growth stage to drought stress were first stem production stags and then flowering stage and finally the early of pod production. According to the obtained results cut of irrigation must be avoided during flowering and pod production.

Introduction

Rapeseed is an important oilseed crop in the agricultural systems of many arid and semi arid areas where its yield is often restricted by water deficit and high temperatures during the reproductive growth. Seed yield can be primarily limited even by the relatively short period of soil moisture shortage during the reproductive development

The effect of water stress on crop is a function of genotype, intensity and duration of stress, weather conditions and developmental stages of rapeseed (Robertson and Holland, 2004). The occurrence time is more important than the water stress intensity (Korte et al, 1983). Seed yield potential of Brassica crops depends on the events occurring prior to and during the flowering stage, while the reproductive period is most susceptible to stress (Mendham and Salisbury, 1995). Severe stress decreases the duration of reproductive growth (Hall, 1992) and stress during flowering or ripening stages results in large yield losses (Stoker and Carter, 1984).

Water stress occurring at any time during reproductive growth can result a drastic change in seed yield. The worst time to experience water stress on many grain crops is during stem elongation and flowering. Gan et al. (2004) found that canola stressed at earlier growth stages exhibited recovery, whereas stressed during pod development severely reduced most of the yield components. Masoud Sinaki et al. (2007) found that the highest rapeseed yield reduction was obtained when water stress occurred at flowering and then at pod developmental stages. They reported that seed yield reduction by short term water stresses during stem elongation, flowering and pod development were mostly associated with the reduction of pods per plant. Rahnema and Bakhshande (2006) reported that the highest seed yield reduction occurred when irrigation was only once applied in spring. Muhammad Tahir et al. (2007) found that the highest seed yield was obtained with three times irrigation at early vegetative, flowering and seed formation. Henry and MacDonald (1978) showed that severe drought decreased oil and increased protein contents of rapeseed. Water limited conditions, rapeseed limits its reproductive organs differentiation like number of seeds/silique, number of siliques/plant and also shows a strong 1000 seeds weigh reduction(Ignazio et al,1999).

Irrigated rapeseed (*Brassica napus* L.) cultivation is currently expanding in rotation with winter cereals in Iran where its reproductive growth is often exposed to water deficit in many parts, particularly in the center of country. The objective of this experiment was to determine the influences of water stress at different growth stages by cut irrigation at different growth stages on yield and yield components of rapeseed in Isfahan region, a main rapeseed growing area in center of Iran where is a high potential for expansion of rapeseed cultivation in these regions as a promising alternative crop for diversification and economical use of land and water resources.

Methods and Materials

This experiment was conducted in order to study the response of Autumn Colza cultivars to the cut irrigation during various stages of growth in 2007-2008 at the Isfahan Agricultural Research Station with 32° 23′ N latitude and 51° 16′ E altitude with 16 centigrade and 120 mm annual temperature and rainfall respectively and a silty clay loam soil. Experiment had a split-plot layout in the randomize complete block design with three replication. Factors included the cut of irrigation in seven stages (D_1: normal irrigation or irrigation after 80mm evaporation from class A pan to physiological maturation as an check treatment (D_2: Cut of irrigation in stem elongation stage (D_3: cut of irrigation in flowering stages, (D_4: cut of irrigation in pod production stages,(D_5: deletion of irrigation at stem elongation and flowering stage, (D_6: deletion of irrigation at stem elongation and pod production stages, (D_7: deletion of irrigation at flowering and pod production stage) as main plots and four Autumn Colza cultivars included Opera, Okapi, Zarfam and Modena as sub-plots. cultivation practices were included plowing, disking and ridging plots (sized 4 by 4 m). Weeds were controlled by Triflouralin (2 L ha-1) that was applied prior to planting and incorporated into soil by disking. The seeds were sown in plots by Pneumatic grain drill (model Accord, Germany). To reach exact plant density plant thinning was performed at 5 leaf growth stage. Some traits such as number of days to flowering, flowering period, the number of days physiological maturation, the height of plant, the number of pod in the plant, the number of seeds in the pod, the weight of 1000 seeds, grain yield, biological yield, harvest index, straw yield, oil percent and oil yield were measurement

Results and Discussion

Plant height:

Results showed that the cut irrigation had significant effects on the plant height (Table 1). The control produced the maximum plant height (97.42 cm), but except cut irrigation in stem, others treatments no had significantly different with control The minimum plant height was recorded in cut irrigation after stem (91.08). It seem that drought stress after stem no have any badness effect on plant height of rape seed. Cultivars had no significant difference about plant height .

Pod Number per Plant (PNPP):

Results exhibits that cut irrigation and cultivars had highly significant effect on PNPP. Maximum PNPP(64.17) were obtained in plots that received irrigation in all vegetative and reproductive period (Table1). The minimum PNPP (39.75) was produced in cut irrigation after stem. The worst time to experience water stress on many grain crops is during stem elongation and flowering (Gan et al. 2004),They found that canola stressed at earlier growth stages exhibited recovery, whereas stressed during pod development severely reduced most of the yield components. seed yield reduction by short term water stresses during stem elongation, flowering and pod development were mostly associated with the reduction of pods per plant (Masoud Sinaki et al, 2007).

1000-Seed weight:

Results showed that the seed 1000-weight increased with increasing in irrigation period (Table 1). Thus, the highest and lowest values of this trait were obtained from 3.84 and 2.13 g in control and cut irrigation after stem respectively. Severe stress decreases the duration of reproductive growth (Hall, 1992) and stress during flowering or ripening stages results in large yield losses (Stoker and Carter, 1984). Water limited conditions, rapeseed limits its reproductive organs differentiation like number of seeds/silique, number of siliques/plant and also shows a strong 1000 seeds weigh reduction (Ignazio et al,1999).

Oil seed rate :

Results showed that the cut irrigation had significant effects on the oil seed rate (Table 1). The control produced the maximum oil seed rate (46.12), and the minimum oil seed rate was recorded in cut irrigation after stem, cut irrigation after flowering , deleting irrigation in flowering and poding (43.24, 42.59, 43.00 percent) respectively. It seem that drought stress in reproductive stage of rapeseed have badness effect on syntheses of oil in seed of rape seed. Cultivars had no significant effect on oil seed rate. Henry and MacDonald (1978) showed that severe drought decreased oil and increased protein contents of rapeseed.

Grain yield:

Result indicated that cut irrigation, cultivar and its interaction had significant effect on seed yield(Table 1). Rapeseed seed yield varied from 3801.66 to 1311.83 kg/ha, with the highest and lowest seed yields at control and cut irrigation after stem respectively. The difference between the lowest and the highest seed yields was 1500 kg/ha. Seed yield potential of Brassica crops depends on the events occurring prior to and during the flowering stage, while the reproductive period is most susceptible to stress (Mendham and Salisbury, 1995). Severe stress decreases the duration of reproductive growth (Hall, 1992) and stress during flowering or ripening stages results in large yield losses (Stoker and Carter, 1984). Water stress occurring at any time during reproductive growth can result a drastic change in seed yield. The worst time to experience water stress on many grain crops is during stem elongation and flowering(Gan et al. 2004)

Table 1 – mean comparison of some traits at the irrigation treatments

Treatment	Plant height(cm)	Number pod per plant	1000 seed weight(g)	Oil seed %	Yield (kg/ha)
control	97.42 b	64.17 a	3.85 a	46.12 a	3801.66 a
Cut irrigation after stem	91.08 b	39.75 e	2.13 e	43.24 b	1311.83 f
Cut irrigation after flowering	94.75 a	44.83 d	3.06 d	42.59 b	2755.42 cd
Cut irrigation after poding	94.42 a	49.50 c	3.55 b	43.93 ab	3085.58 b
Irrigation deleting in stem and flowering	94.58 a	48.08 cd	3.31 c	43.99 ab	2547.42 e
Irrigation deleting in stem and poding	94.67 a	53.67 b	2.92 d	43.70 ab	2722.50 d
Irrigation deleting in flowering and poding	96.67 a	46.35 cd	2.91 d	43.00 b	3013.66 bc

In each column that the means have at least one common letter do not have significant difference at one percent probability level based on Duncan test

Reference

Gan, Y., S.V. Angadi, H. Cutforth, V. V. Angadi and C.L. Mc Donald, 2004.Canola and mustard response to short periods of temperature and water stress at different developmental stages. Can. J. Plant Sci., 84: 697-704.

Hall, A.E., 1992. Breeding for heat tolerance. Plant Breed. Rev., 10: 129-168.

Henry, J.L. and K.B. McDonald, 1978. The effects of soil and fertilizer nitrogen and moisture stress on yield, oil and protein content of rape. Can. J. Plant Sci., 58: 303-310.

Ignazio P., Giacomo, V., Luciano, G., 1999. Rapeseed (Brassica napus L. var. oleifera D.C.) ecophysiological and agronomical aspects as affected by soil water avialability. Canbrra. Australia.

Korte, L.L., J.H. Williams, J.E. Specht and R.C. Sorenson, 1983. Irrigation of soybean genotypes during reproductive ontogeny: II. Yield component responses. Crop Sci., 23: 528-533.

Masoud Sinaki, M.J., E. Majidi Heravan, H. Shirani Rad, G. Noormohammadi and G.H. Zarei, 2007. The effects of water deficit during growth stages of canola (*Brassica napus* L.). Am-Euras. J. Agric. Environ. Sci., 2: 417-422.

Mendham, N.J. and P.A. Salisbury, 1995. Physiology, crop development, growth and yield. In: Kimber, D.S. and D.I. McGregor. (Ed.). Brassica Oilseeds: Production and utilization. CAB International, London. pp: 11-64.

Muhammad, T., A. Ali, M.A. Nadeem, A. Tanveer and Q.M. Sabir, 2007. Performance of canola (*Brassica napus* L.) under different irrigation levels. Pak. J. Bot., 39: 739-746.

Rahnema, M. and A.M. Bakhshande, 2006. Determination of optimum irrigation level and compatible canola varieties in the Mediterranean environment. Asian J. Plant Sci., 5: 543-546.

Robertson, M.J. and J.F. Holland, 2004. Production risk of canola in semiarid subtropics of Australia. Aust. J. Agric. Res., 55: 525-538.

Stoker, R. and K.E. Carter. 1984, Effect of irrigation and nitrogen on yield and quality of oilseed rape. N. Z. J. Exp. Agric., 12: 219-224.