African Journal of Agricultural Research Vol. 7(25), pp. 3677-3684, 3 July, 2012
Available online at http://www.academicjournals.org/AJAR
DOI: 10.5897// AJAR11.2446
ISSN 1991-637X ©2012 Academic Journals

Full Length Research Paper

Effects of water shortage in late season on agronomic traits of rapeseed (*Brassica napus L.*)

Shirani Rad, Amir Hosein[1], Shahsavari, Nasser[2]* and Jais, Hasnah Mohd[3]

[1]Seed and Plant Improvement Research Institute, Karaj, Iran.
[2]Science and Research Branch, Islamic Azad University, Sirjan, Iran.
[3]School of Biological Sciences, University Sains Malaysia, Penang, Malaysia.

Accepted 27 February, 2012

Water deficit in the fall cultivation of Rapeseed occurs in cold and cool temperate regions, usually in the late period of growth, that is, the late spring and early summer. To examine the possibility of dealing with water deficit in the late season, appropriate experimental cultivars of the plant were cultivated in 2008 to 2009 and 2009 to 2010 cropping seasons at Karaj of Iran. An experiment was carried out in a split plot design based on RCBD with four replications over two years. Irrigation was the main factor in two levels including "normal irrigation" (irrigation after 80 mm evaporation from class A basin) and "stopping irrigation after flowering stage". The cultivar as the sub factor consisting of 34 new rapeseed cultivars at 34 levels was considered. The simple effects of irrigation and cultivar, as well as interaction of irrigation and cultivar on grain yield and oil yield were significant at 1% level. In normal irrigation conditions, Sunday cultivar had the highest grain and oil yield. In the conditions of stopping irrigation after flowering stage, ORW20-3002 cultivar had the highest grain yield and oil yield. Simple correlation between the experimental traits indicate that there was a highly significant positive relationship between grain yield and number of pod per plant, number of grain per pod, oil content, oil yield, biological yield and harvest index.

Key words: Rapeseed, water deficit, grain yield, oil yield, biologic yield, harvest index.

INTRODUCTION

Water deficit is one of the most important factors limiting a plant's growth and its production. Currently, there is no reasonable way to increase precipitation during drought periods; therefore, the best way to fight drought is applying appropriate agricultural operations and using plant varieties that are more drought tolerant (Shirani et al., 2010). In Karaj of Iran and similar areas, there is frequent rainfall (according to the 10-year weather data) usually in March and April, which partly provide the water requirements of the plant in the stem growing stage. Consequently, Rapeseed cultivation in these areas can be developed practically by saving water (especially in the flowering, pod growing and seed filling stages, which coincides with the early irrigation of spring cultivations) and finding varieties that have acceptable economic yield in irrigation deficit conditions and can tolerate these intense conditions. Some spring varieties of Rapeseed are tolerant of cold weather and can endure winters in areas such as Karaj. They are cultivated later than the fall varieties in the fall and harvested ahead of them in spring, therefore, due to early ripening and not facing the dryness of the late season, they can play an important role in the semiarid areas with cool temperate conditions and limited irrigation. Studies have shown that the average annual yield loss due to drought around the world has been 17% and can be increased to more than 70% in any year (Edmeades et al., 1994). Among the most important factors in assessing the reaction of different genotypes to environmental conditions are studying the interaction of genotypes and the environment, and examining grain yield sustainability through the lack of significant changes in different

*Corresponding author. E-mail: shahsawari110@gmail.com.

Table 1. Monthly precipitation rate (mm) in 2008-2009 and 2009-2010 cropping seasons at Karaj.

Month / Year	September	October	November	December	January	February	March	April	May	Total
2008-2009	1.8	26.7	5.6	49.3	75.2	3.1	42.4	11.4	2.5	218
2009-2010	0.8	21.2	12.1	44.8	77.5	19.7	39.1	18.9	1.9	236

environmental conditions (Fernandes, 1992). Irrigation after 50 mm evaporation from class A basin caused the highest grain yield of Rapeseed in Karaj.

Irrigation after 100 and 150 mm evaporation from class A basin caused the grain yield to decrease significantly. The most sensitive stage of Rapeseed growth to water deficit is the flowering and filling the seed stage (Chongo and McVetty, 2001). Overall, water deficit can significantly reduce Rapeseed grain yield (Fanaei et al., 2009). The method of irrigation can also influence the efficiency of water consumption and Rapeseed grain yield (Butar et al., 2006). Heat and drought during the flowering and seed filling period can stop flowering and cause seed formation, oil percentage and grain yield to decrease (Faraji et al., 2009; Johnston et al., 2002). The present study aims to evaluate the drought tolerance of Rapeseed varieties and selecting those compatible with water deficit conditions in the late stages of the growth period for the development of growing Rapeseed in cold temperate and semiarid regions. Considering the afore-mentioned points for identifying varieties that are able to have the highest performance in the drought conditions of the late season with the least damage, the research was conducted using 34 varieties.

MATERIALS AND METHODS

The study was conducted at the farm of Seed and Plant Improvement Institute (SPII) in Karaj, Iran. The test site was at 35° 48´ N, 50° 75 ´E, and altitude of 1321 m above the sea level. Having 150 to 180 dry days, it is considered as being in the hot and dry Mediterranean climate zone. It is also considered to be a semiarid region due to the dry and wet winters and hot and dry summers. The average annual precipitation in the test region based on the 30-year average data is 243 mm (Table 1). In order to prepare the ground, the desired land was irrigated before the experiment and then plowed by a moldboard plow. Next, for softening the clods and flattening the soil, a disk and trowel were used on the land. Then samples were taken from the soil at depths of 0 to 30 and 30 to 60 cm. Based on the soil analysis and fertilizer recommendations, fertilizer (some parts of nitrogen fertilizer and all required phosphorus and potash fertilizer) was spread and 2.5 L per ha of Treflan herbicide was distributed uniformly across the field. Next, the fertilizer and herbicide was mixed with the soil by the light disk. For optimal use of nitrogen, the rest of the required nitrogen fertilizer was consumed at the beginning of the stem elongation and appearance of first flower buds. After performing the experiment according to the planting plan and appearance of the seedlings, the storage operation including pest control, particularly waxy aphids was performed using pesticides like Metasystox (1.5 L per ha), Ocatin (1 L per ha) or Diamicron (0.50 L per ha). The experiment was done in a split plot design based on RCBD with four replications over 2 years (2008 to 2009 and 2009 to 2010 cropping seasons).

In this study, irrigation was of the main plot including two levels of "normal irrigation" (irrigation after 80 mm evaporation from class A basin) and "stopping irrigation after flowering stage". Plant cultivar was the sub plot including Ebonite, Elite, Talent , Olpro, Sinatra, Sahara, Celsius, Sunday, Modena, Geromino, Opera, ARC-5, ARC-2, ARG-91004, Milena, Dexter, SLM046, Zarfam, Okapi, Talaye, Licord, Herkules, Vectra, GKHelena, GKOlivia, GKGabriella, Orient, RN * 3304, NKBilbao, ORW201-3001, ORW20-3002, RG4504, Dante and Frederic. Each experimental plot included four 4-m lines with 30 cm space between the lines. The space between plants on the line was 4 cm and two lateral lines were considered as margins; two middle lines were used for determining all phenological stages and different characteristics of the plant such as number of pod per plant, number of seeds per pod, grain yield, oil content, oil yield, biologic yield and harvest index. At the end of each year, simple variance analysis of the desired traits and comparison of the means were performed. After the second year of the experiment, analysis of the combined variance was performed for these traits. To determine traits such as number of pod per plant, 10 plants were randomly selected from each experimental plot and these traits were measured in them. To determine the number of seeds per pod, 30 pods were randomly selected from the 10 selected plants and this trait was calculated accordingly. To measure the 1000-seed weight after harvest, eight samples, each containing 100 seeds from the experimental plots were randomly selected and by multiplying their average weight by 10, the 1000-seed weight was calculated. For measuring biologic yield, plants in experimental plots were picked before removing the seeds from the pod. Then, the total weight of plants (leaf, stem, pod and seed) was determined and the biologic yield per hectare was calculated.

After removing the seeds from the pod, grain yield was determined and after dividing it by biologic yield, the harvest index was obtained. After determining the oil content of each experimental plot, the oil yield is calculated through multiplying of oil content with grain yield.

RESULTS AND DISCUSSION

The irrigation treatment significantly influenced all measured traits including plant height, number of pod per plant, number of seeds per pod, 1000-seed weight, oil content, oil yield, grain yield, biological yield and harvest index (Figures 1, 2, 3 and 4). The simple effect of irrigation and cultivar and the interaction effect of irrigation by cultivar on through traits except oil content were significant ($P<0.01$) for all analysis (Table 2). The comparison of the average interaction of irrigation and cultivar showed that the tested cultivars at different levels of irrigation were placed in statistically different groups in terms of grain yield and oil yield (Table 3). The Sunday cultivar in normal irrigation, with an average of 4,938 $kg.ha^{-1}$, and the RG4504 and Sahara cultivars in the

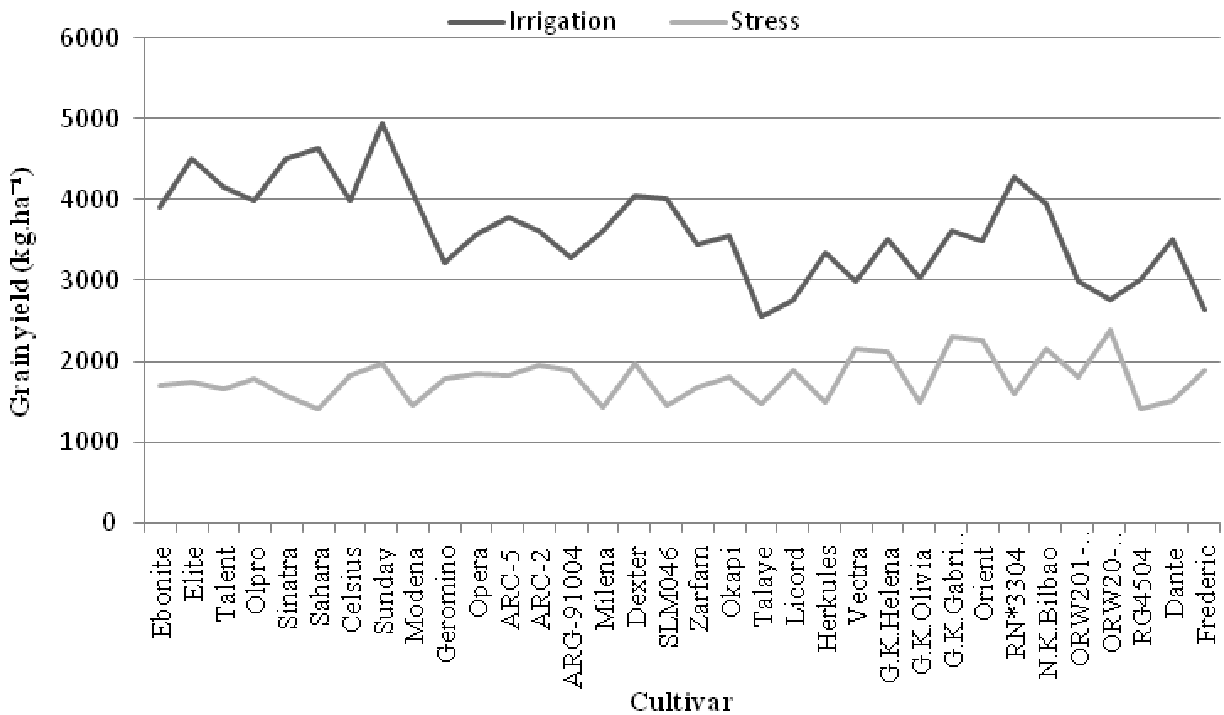

Figure 1. Mean comparison of the interaction effect of irrigation by cultivar on grain yield.

Figure 2. Mean comparison of the interaction effect of irrigation by cultivar on oil yield.

condition of stopping irrigation after flowering stage, with an average of 1,416 kg.ha^{-1} had the highest and lowest grain yield, respectively (Figure 1). However, the Sunday cultivar in normal irrigation, with an average of 2,317 kg.ha^{-1}, and the G. K. Olivia cultivar in the condition of stopping irrigation after flowering stage, with an average

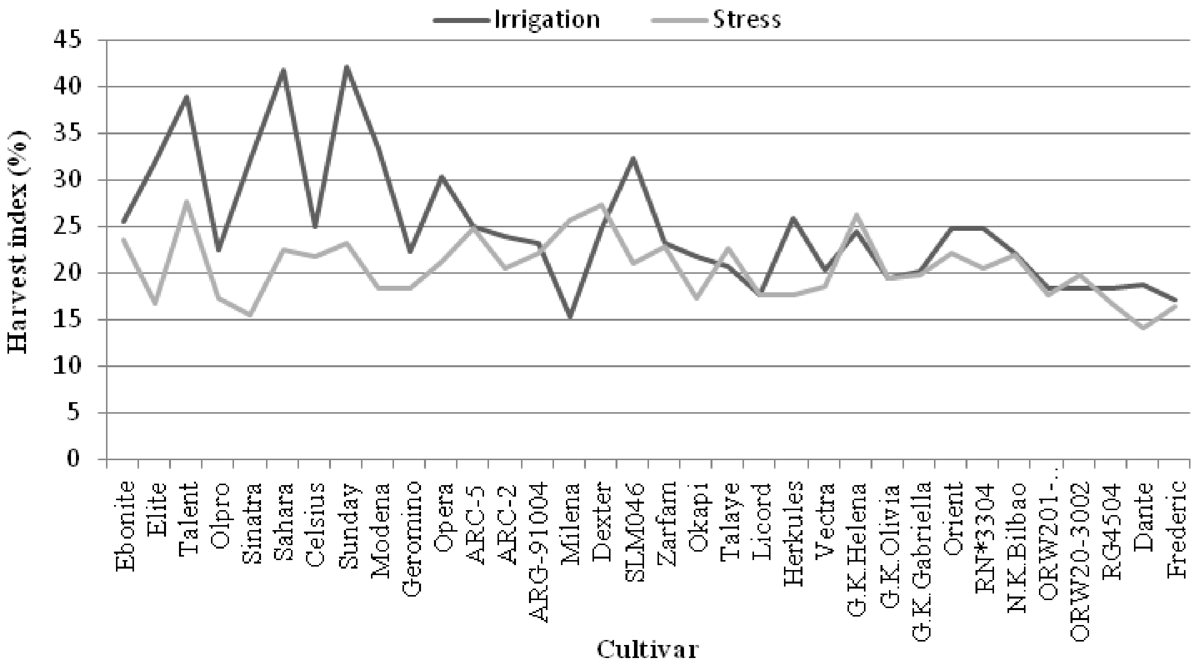

Figure 3. Mean comparison of the interaction effect of irrigation by cultivar on harvest index.

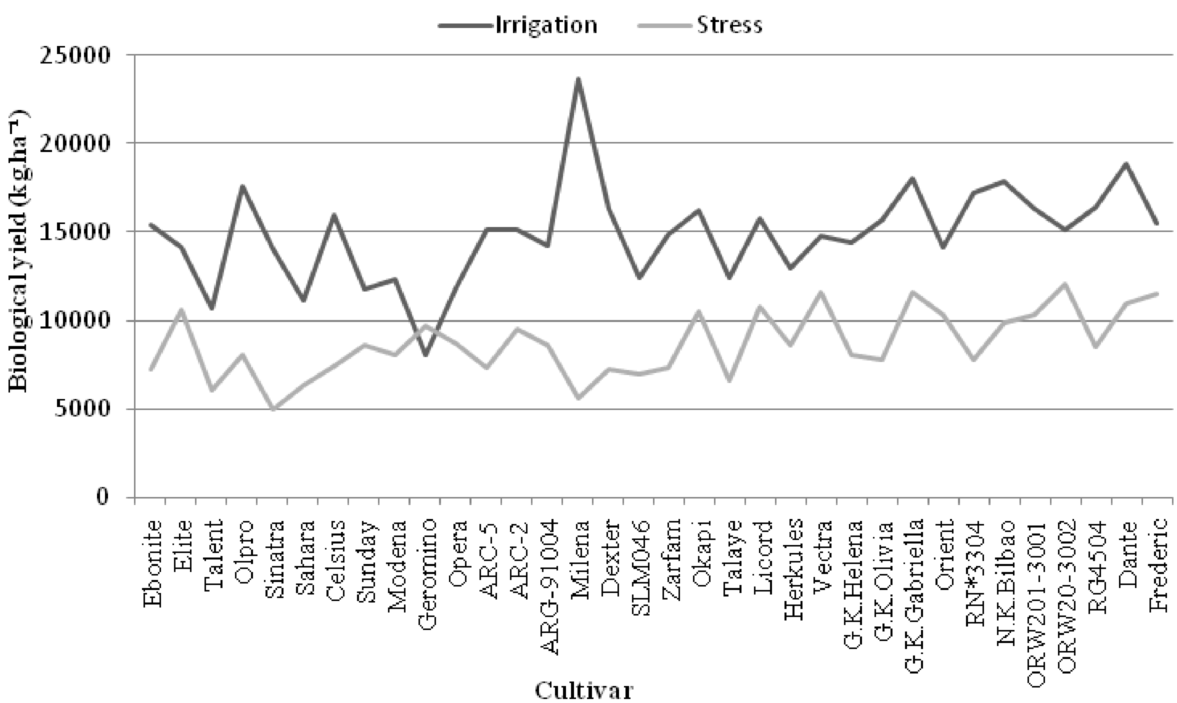

Figure 4. Mean comparison of the interaction effect of irrigation by cultivar on biological yield.

of 611.7 $kg.ha^{-1}$ had the highest and lowest oil yield, respectively (Figure 2). Water deficit occurs in the plant when the amount of water it receives is less than the amount it loses. This may be due to excessive water loss or reduced intake or both. Reduced osmotic potential and total water potential along with the loss of inflammation, closure of stomata and growth reduction are among the specific symptoms of water deficit. If the intensity of water deficit is high, it will cause severe reduced photosynthesis, disrupt physiological processes, stop

Table 2. Combined Analysis of variance for plant characteristics.

		MS				
S.O.V	**d.f**	**Biological yield**	**Grain yield**	**Oil content**	**Oil yield**	**HI**
Year (Y)	1	**76500000.0	76490700.1**	6306.0**	37433862.8**	3242.4**
Ea	6	681724.5	9744.11	1.849	4156.2	4.875
Irrigation(I)	1	4705905882.3**	459057857.2**	735.6**	101882122.3**	3026.8**
(Y ×I)	1	8500000.0**	8496850.4**	252.73**	6567452.2**	8.3**
Eb	6	34008.8	2953.12	7.145	6982.3	0.8
Variety (V)	33	41677948.5**	1514689.2**	26.6**	372647.4**	275.9**
(Y × V)	33	0.325 ns	0.2 ns	21.9**	32902.6**	1.0 ns
(I × V)	33	30165364.2**	1916869.4**	1.8 ns	397636.6**	186.9**
(Y×I × V)	33	0.323 ns	0.2 ns	3.6 ns	14542.9**	0.9 ns
E	396	516120.8	15909.6	3.4	6376	3.5
C.V (%)	-	6.07	4.66	4.35	6.75	8.17

ns, Non-significant; **, Significant at 1% probability level.

Table 3. Mean comparison of plant characteristics.

Cultivar	Grain yield (kg.h^{-1})				Oil yield (kg.h^{-1})			
	Irrigation		Stress		Irrigation		Stress	
Ebonite	3909	f	1700	wz	1750	def	732.5	wxy
Elite	4503	b	1753	vy	2047	b	743.3	vwx
Talent	4152	cd	1669	yz	1838	d	700.3	xyz
Olpro	3984	ef	1797	vy	1773	de	756.6	vwx
Sinatra	4504	b	1581	z	2057	b	685.9	xyz
Sahara	4628	b	1416	z	1980	bc	577.6	z
Celsius	3981	ef	1831	tw	1790	de	768.7	vwx
Sunday	4938	a	1979	s	2317	a	888.9	stu
Modena	4094	de	1459	z	1834	d	614.5	z
Geromino	3209	l	1778	vy	1457	kl	752.6	vwx
Opera	3576	hi	1846	sw	1582	hij	770.5	vwx
ARC5	3774	g	1821	tx	1718	ef	778	vwx
ARC2	3609	h	1947	stu	1625	gh	815.3	uvw
ARG91004	3281	kl	1894	sv	1509	ijk	815.7	uvw
Milena	3612	h	1444	z	1680	fg	641.6	z
Dexter	4036	def	1963	st	1830	d	832	tuv
SLM046	4010	ef	1466	z	1803	de	617.6	z
Zarfam	3450	ij	1681	xyz	1564	hij	714.6	xyz
Okapi	3544	hi	1813	uy	1595	hi	769.9	vwx
Talaye	2548	o	1481	z	1085	q	589.2	z
Licord	2766	n	1889	sv	1197	op	762.6	vwx
Herkules	3346	jk	1503	z	1350	mn	579	z
Vectra	2994	m	2153	qr	1212	o	894.5	stu
G. K. Helena	3511	hi	2119	r	1552	hij	865.5	stu
G. K. Olivia	3033	m	1497	z	1332	n	611.7	z
G. K. Gabriella	3616	h	2292	p	1536	hk	905	st
Orient	3491	hi	2269	pq	1498	jkl	916..6	st
RN*3304	4273	c	1600	z	1956	c	693.6	xyz
N.K.Bilbao	3950	f	2153	qr	1801	de	930.4	rs
ORW2013001	2981	m	1800	vy	1323	n	751.3	vwx
ORW203002	2761	n	2384	p	1234	o	999.8	r

Table 3. Contd.

RG4504	2999	m	1416	z	1421	lm	619.5	z
Dante	3503	hi	1528	z	1581	hij	652.2	yz
Frederic	2632	o	1891	sv	1126	pq	777.3	vwx

Means in each column followed by similar letter(s) are not significantly different at 5% probability level using Duncan's Multiple Rang Test.

Table 4. Mean comparison of plant characteristics (continued).

Cultivar	Biological yield ($kg.h^{-1}$)				HI (%)			
	Irrigation		Stress		Irrigation		Stress	
Ebonite	15341.44	f	7206.44	tu	25.48	hk	23.59	kp
Elite	14124.84	hi	10528.52	no	31.88	cd	16.65	z
Talent	10657.08	no	6023.09	xy	38.96	b	27.71	fg
Olpro	17601.42	cd	8011.59	rs	22.43	ot	17.21	z
Sinatra	14039.90	hi	4928.30	z	32.08	cd	15.4	z
Sahara	11082.37	n	6276.59	xy	41.76	a	22.56	ns
Celsius	15962.30	f	7341.61	tu	24.94	il	21.8	ov
Sunday	11701.42	lm	8548.59	qr	42.2	a	23.15	lq
Modena	12239.16	k	7981.70	rs	33.45	c	18.28	yz
Geromino	14441.94	hi	9694.65	p	22.22	ot	18.34	yz
Opera	11794.19	lm	8666.66	qr	30.32	de	21.3	qw
ARC5	15102.04	fg	7286.91	tu	24.99	il	24.79	im
ARC2	15062.60	fg	9456.04	p	23.96	jo	20.59	rx
ARG91004	14160.55	hi	8585.67	qr	23.17	lq	22.06	ou
Milena	23654.22	a	5594.73	yz	15.27	z	25.81	gj
Dexter	16320.25	ef	7179.95	tu	24.73	in	27.34	fgh
SLM046	12414.86	k	6938.00	w	32.3	cd	21.13	qw
Zarfam	14838.70	fgh	7334.20	tu	23.25	lq	22.92	lq
Okapi	16212.25	ef	10473.71	no	21.68	pv	17.31	z
Talaye	12368.93	k	6527.10	vy	20.6	rx	22.69	mr
Licord	15724.84	f	10732.95	no	17.59	z	17.6	z
Herkules	12903.97	ij	8549.84	qr	25.93	gj	17..58	z
Vectra	14719.76	gh	11581.49	lm	20.34	sy	18.59	xyz
G. K. Helena	14407.05	hi	8057.03	rs	24.37	im	26.3	ghi
G. K. Olivia	15642.08	f	7708.54	stu	19.39	mno	19.42	wz
G. K. Gabriella	18043.91	c	11587.46	lm	20.04	mn	19.78	vy
Orient	14122.16	hi	10271.61	op	24.72	cf	22.09	ou
RN*3304	17188.25	de	7782.10	stu	24.86	cde	20.56	rx
N. K. Bilbao	17857.14	c	9822.08	p	22.12	ij	21.92	ov
ORW2013001	16254.08	ef	10262.25	op	18.34	opq	17.54	z
ORW203002	15054.52	fg	12028.25	k	18.34	opq	19.82	vy
RG4504	16361.15	de	8468.89	qr	18.33	opq	16.72	z
Dante	18823.21	b	10890.94	n	18.61	nop	14.03	z
Frederic	15500.58	f	11502.43	lm	16.98	q	16.44	z

Means in each column followed by similar letter(s) are not significantly different at 5% probability level using Duncan's Multiple Rang Test.

growth and finally lead to plant death (Ma et al., 2004). Due to the closure of stomata, which limits the CO^2 release into the leaf, or non-stomatic factors such as inhibition of ATP and Rubisco synthesis, water deficit

Table 5. Simple correlation coefficients between plant characteristics.

Characteristics	Plant height	Pod per plant -1	Grain per pod-1	1000 Grain weight	Grain yield	Biological yield	Oil content	Oil yield	Harvest index
Plant height	1	0.836**	0.842**	0.568**	0.779**	0.664**	0.578**	0.402*	0.423*
Pod.plant -1		1	0.747**	0.475*	0.68**	0.538**	0.45*	0.225 ns	0.392 ns
Grain.Pod-1			1	0.626**	0.807**	0.722**	0.639**	0.406*	0.491*
1000 Grain weight				1	0.506**	0.51**	0.47*	0.299 ns	0.329 ns
Grain yield					1	0.691**	0.528**	0.319 ns	0.408*
Biological yield						1	0.975**	0.668**	0.666**
Oil content							1	0.703**	0.674**
Oil yield								1	-0.23 ns
Harvest Index									1

ns, Non-significant; * and **, Significant at 5% and 1% probability levels, respectively.

results in a considerable reduction in photosynthesis (Lawlor and Cornic, 2002).

Heat and drought during the flowering and seed filling period can stop flowering and cause seed formation, oil percentage and grain yield to decrease (Faraji et al., 2009; Johnston et al., 2002). Water deficit decreases photosynthesis and the construction of materials produced by this process in the leaves. As a result, the amount of photosynthetic materials produced in leaves is reduced and ultimately, it will reduce seed formation (Naderkharaji et al., 2008). The normal irrigation compared to non-irrigated from flowering stage conditions had a significant superiority. Water deficit in flowering and pollination stages has the worst effect on Rapeseed grain yield (Istanbulluoglu et al., 2010). The number of pod per plant is one of the significant components of grain yield, because the pod provides the capacity for seed formation and, on the other hand, the green membrane of the pod provides some of the necessary materials for filling the seeds through photosynthesis (Germchi et al., 2010). The research (Kamkar et al., 2011) also showed that 1000-seed weight in the Modena and Zarfam varieties decreased because of drought. This weight loss was probably due to the reduction in the production and transfer of photosynthetic materials to the seed. It may have been impossible for the plant to transfer these materials again due to drought.

The Sunday cultivar under normal irrigation conditions had the highest grain yield, oil yield and harvest index (Figures 1, 2 and 3). The grain yield and harvest index in drought and the lack of water conditions can be good indicators of the tolerance of genotypes to water deficit (Francois et al., 1998). Yahyavi et al. (2003) expressed that the reduction of the harvest index with the irrigation treatment being limited to the flowering stage of the Rapeseed, is the main reason for the reduced number of seeds in the pod. Under non-irrigated conditions from flowering stage conditions, the ORW20-3002 cultivar had the highest grain and oil yield (Figures 1 and 2). Changes in the components of grain yield, depending on environmental, climatic and genetic variations causes a change in grain yield.

Some reports have been presented denoting the negative impact of water deficit on the pod formation stage and the number of pod in the plant (Sinaki et al., 2007). Of course, the increase in the number of seeds per pod is subject to some limitations, because the production capacity of this component of yield is mostly under the influence of genetic factors. The results of experiments by Gunasekera et al. (2006) prove this point.

Conclusion

The simple effect of irrigation and cultivar and the interaction effect of irrigation by cultivar on through traits except oil content were significant (P<0.01). The normal irrigation compared to non-irrigated from flowering stage conditions had a significant superiority. The Sunday cultivar under normal irrigation conditions (irrigation from 80 mm evaporation from class “A” pan) and the ORW20-3002 cultivar, under drought tension (non-irrigated from flowering stage) had the highest grain yield and grain oil yield. Simple correlation between the experiment traits indicated that there was a highly significant positive relationship between grain yield and number of pod per plant, number of grain per pod, oil content, grain oil yield, biological yield and harvest index (Table 5).

REFRENCES

Buttar GS, Thind HS, Aujla MS (2006). Methods of planting and irrigation at various levels of nitrogen affect the grain yield and water use efficiency in transplanted oilseed rape (*Brassica napus* L.) Agric. Water Manage., 85(3): 253-260.

Chongo G, McVetty PBE (2001). Relationship of physiological characters to yield parameters in oilseed rape (Brassica napus L.). Canadian J. Plant Sci., 81(1): 1-6.

Edmeades GO, chafman SC, Bolonas J, Banziger M, Lafitte HR (1994). Recent evaluation of progress in selection for drought tolerance in tropical maize. Fourth Eastern and Southern African Regional Maize

Conf. Herare. Zimbabwe.
Fanaei HR, Galavi M, Kafi M, Bonjar AG (2009). Amelioration of water stress by potassium fertilizer in two oilseed species. Inter. J. Plant Prod., 3(2): 41-54.
Faraji A, Latifi N, Soltani A, Rad AHS (2009). Grain yield and water use efficiency of canola (*Brassica napus* L.) as affected by high temperature stress and supplemental irrigation. Agric. Water Manage., 96(1): 132-140. DOI: 10.1016/j.agwat.2008.07.014.
Fernandes GCJ (1992). Effective Selection Criteria for assessing plant stress tolerance. pp. 257-270. In: Proceedings of the International Symposium on adaptation of Vegetables and other food crop in temperature and water stress. Taiwan.
Francois J, Sanchez M, Eusebio F, Jose Andres L, Tonorio L, Ayerbe L (1998). Turgour maintenance,osmotic adjustment and soluble sugars and praline accumulation in 49 pea cultivars in response to water stress. Field Crops Res., 59(3): 225-235.
Germchi S, Shekari F, Hassanpooraghdam MB, Benam MB, Shekari FK (2010) Water deficit stress affects growth and some biochemical characteristics of rapeseed (*Brassica napus* L.). J. Food Agric. Environ., 8(2): 1126-1129.
Gunasekera CP, Martin LD, Siddique KHM, Walton GH (2006). Genotype by environment interactions of Indian mustard (*Brassica juncea* L.) and canola (*B. napus* L.) in Mediterranean-type environments. 1. Crop growth and grain yield. Europ J. Agron., 25(1): 1-12. DOI: 10.1016/j.eja.2005.08.002.
Istanbulluogl A, Arslan B, Gocmen E, Gezer E, Pasa C (2010). Effects of deficit irrigation regimes on the yield and growth of oilseed rape (Brassica napus L.) Biosyst. Eng., 105(3): 388-394. DOI: 10.1016/j.biosystemseng.2009.12.010.
Johnston AM, Tanaka DL, Miller PR, Brandt SA, Nielsen DC, Lafond GP, Rivelan NR (2002). Oilseed crops for semiarid cropphng systems in the Northern Great Plains. Agron. J., 94: 231-240.
Kamkar B, Daneshmand AR, Ghooshchi F, Shiranirad AH, Safahani Langeroudi AR (2011). The effects of irrigation regimes and nitrogen rates on some agronomic traits of canola under a semiarid environment. Agric. Water Manage., 98(6): 1005-1012. DOI: 10.1016/j.agwat.2011.01.009.
Lawlor DW, Cornic G (2002). Photosynthetic carbon assimilation and associated metabolism In relation to water deficits in higher plants. Plant Cell Environ., 25: 275-294.
Ma Q, Turner DW, Levy D, Cowling WA (2004). Solute accumulation and osmotic adjustment in leaves of *Brassica* oilseeds in response to soil water deficit. Austral. J. Agric. Res., 55(9): 939-945. DOI: 10.1071/AR03183.
Naderikharaji R, Pakniyat H, Biabani AR (2008). Effect of drought stress on photosynthetic rate of four rapeseed (*Brassica napus*) cultivars. J. Appl. Sci., 8(23): 4460-4463. DOI: 193923/jas.2008.4460.4463
Shirani Rad A h, Naimi V, Esfahani S N (2010). Evaluation of terminal drought tolerance in spring and autumn cultivars of rapeseed. Iran. J. Agric. Sci., 12(2): 122-132.
Sinaki JM, Heravan EM, Rad AHS, Noormohammadi Gand G, Zarei G (2007). The effects of water deficit during growth stages of oilseed rape (Brassica napus L). American-Eurasian J. Agric. Environ. Sci., 2(4): 417-422.
Yahyavi TS, Sadrabadi S (2003). Impact of limited irrigation on yield and yield components of three rapeseed spring cultivars in Tabriz. Iranian J. Agric. Res., 1(2): 305-312.