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Evaluation of Influences of Drought Stress in Terminal Growth Duration on Yield and Yield Components of Different Spring *Brassica oilseed* Species

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Abstract: This study was conducted to investigate influences of drought stress in terminal growth duration on yield and yield components of spring canola, which is an oil seed plant. The experiment was conducted in RCBD with three replicates and in two conditions including: drought stress and control with nine cultivars of three different species during two successive seasons 2008-2009 and 2009-2010 in Experimental farm of Razavi Khorasan Agricultural and Natural Resources Research Centre (Mashhad- Iran). The results of combined analysis of variances showed that drought stress final plant height, seed yield, number of seeds per pod and number of lateral branches was significantly affected under water stress at 1% level and for number of pods per plant at 5% level, while the 1000 seeds weight was not significant affected. Comparing cultivars average yield showed that Hyola 401, Hyola 330 of *Brassica napus*, respectively with 3383.3 and 3345.8 kg/ha had maximum seed yield. Whereas, Lundrace and Bp. 18 of *B. juncea* with 1547.2 and 1630.5 kg/ha had minimum seed yield. In total, in this study cultivars of *B. napus* showed more resistance to drought stress in terminal growth duration in comparing with cultivars of *B. rapa* and *B. juncea* and had more yield.

Key words: Canola · Oil seed · *Brassica* · Drought stress · Yield and yield components

INTRODUCTION

Oil seeds are the second source of food after cereals. Canola, as an important oil crop in the world, it is rich of oil and proteins in their seeds. Canola seeds content 40 to 42 percent of oil. Edible seeds of canola have more than 25% of protein [1-3]. Based on FAO [4] canola is the third most important source of oil seeds crop in the world after soybean and palm oil. Investigation on area of canola cultivation at the world and Iran showed that area of canola cultivation at the most important countries for canola production increased to 19.9 million hectare from 1965 to 2005. Increasing of cultivation and production of canola in developed countries had been higher than developing countries. In Iran in 2000 extension of canola cultivation has been based the main work of agricultural ministry of Iran, so its cultivation improved.

Environmental stresses specially drought stress in the most part of arid and semi arid area of the world, limited yield of crop plants such as canola [5, 6].

Boyer (1996) announced that role of physical and chemical stress in the environment of plant growing is 65% on yield reduction [7].

Iran with 240 mm annually average rainfall listed on the dried and semidried area of the word. High evapotranspiration, water source limitation and other factors caused lots of limitation in crop production and forced to study effects of drought stress and selection of resistant cultivars [8, 9].

This study was conducted with goal to evaluation of yield and yield components in different Spring *Brassica Oilseed* species in drought stress condition based on agronomical and physiological traits to gain drought stress resistant cultivars.

MATERIALS AND METHODS

This study was conducted in experimental farm of Razavi Khorasan Agricultural and Natural Resources Research Centre (Mashhad- Iran) with Latitude: 36° 16', N and Longitude: 59° 38', E. This experiment was conducted in the form of RCBD with three replicates and in two conditions including: drought stress and control in two successive years.

In this study nine cold resistant spring canola cultivars of three species including: Hyola 401, hyola 330,

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RGS 003, Sarigol and Zarfam of *Brassica napus* species and Goldrush and Parkland of *Brassica rapa* species and Landrace and B.P 18 of *Brassica juncea* species.

After field preparing each treatment including eight 30cm rows with 6m long, 3cm row spacing, with 93 plants/m^2 was cultivated amounting to 4 kg/ha with seed planter trademark Winter eshniger. Irrigation was done in stress condition based on 110 mm evaporation and in control condition based on 60mm evaporation with Furrow irrigation and Hydrofix system and regarding to the climate condition of the study's place, drought stress was conducted in the flowering duration and pod formation. Data recording was done during of the different phenological stages of canola cultivars. After physiological maturation, with marginal omit, crop was harvested and yield and yield component was determined. Then, data was analyzed by statistical softwares and combined analysis of variances.

RESULTS AND DISCUSSIONS

The combined analysis of variances (Table 1) showed that drought stress affect on agronomical traits including; plant height, seed yield, seed numbers per pod and number of lateral branches was significant at $P \leq 0.01$ level and for number of pods per plant was significant at $P \leq 0.05$, while the 1000 seeds weight was not significantly affected.

The interaction between location x cultivar and location x year x cultivar were not significant, while year x cultivar and location x year were significant on seed yield ($P \leq 0.01$) (Table 1).

Means comparison of simple effects (Table 2) showed drought stress reduced the measured traits (with the exception of 1000 seeds weight). As, means comparison of seed yield at non-stress condition was 2869.2 kg/ha and 2114.3 kg/ha under stress conditions.

Table 1: Summery of combined analysis of yield and yield components (for 2years)

		Mean square of traits					
S.O.V	df	Plant height	Seed yield	1000 seeds weight	Seeds no per pod	Pods no. per plant	Number of lateral branches per plant
Location	1	7401.98**	15383503.34**	0.04898ns	416.54**	21444.22*	142.29**
Year	1	26970.60**	5914642.87**	2.6445**	2066.02**	310047.45**	15.48*
Location xYear	1	2946.37**	25725896.39**	0.5489ns	615.85**	602.87ns	7.59ns
Block x (Location x Year)	8	167.99ns	278606.04ns	0.81897*	25.32ns	5731.70ns	2.95ns
Cultivar	8	1766.37**	5495933.94**	3.8151**	244.78**	20322.56**	9.48**
Location xCultivar	8	46.869ns	286756.35ns	0.2127ns	19.70ns	5144.40ns	4.21ns
Year x Cultivar	8	804.22**	664460.23**	0.2882ns	63.15*	7574.12ns	3.41ns
Location x Year x Cultivar	8	64.82ns	170572.74ns	0.0609ns	58.84*	3695.72ns	4.05ns
Error	64	177.68	148858.0	0.30304	23.83	4440.6	2.25
CV (%)		9.5	15.48	18.5	26.74	28.8	28.5

Table 2: Means comparison of simple effects (of year, place and cultivar) yield and yield components by Duncan,s test at 5% level (for 2years)

Main effects		Plant height (cm)	Seed yield (kg.ha^{-1})	1000 seed weight (g)	Seed no. Per pod	Pod no. Per Plant	Number of lateral branches per plant
Plaece	1	130.64b	2114.3b	2.99a	16.28b	149.1b	4.10b
	2	147.19a	2869.2a	2.91a	20.21a	177.28a	6.39a
Year	1	154.72a	3025.8a	2.81a	22.6a	216.77a	4.87a
	2	123.12b	1957.7b	3.12a	13.87b	109.61b	5.62a
Cultivars	Hyola 401	120.98e	3383.3a	3.26ab	22.58a	165.76bc	4.92bc
	Hyola 330	126.01de	3345.8a	3.45a	21.67a	166.0bc	5.12bc
	RGS003	130.07cde	2837.5b	3.26ab	22.05a	165.74bc	4.55c
	Sarigol	135.51cd	2779.3b	2.81bc	18.78a	139.96c	5.16bc
	Zarfam	150.01ab	2376.4c	3.30a	22.32a	118.67c	3.87c
	Goldrash	140.16bc	2567.4bc	3.66a	18.99a	120.1c	4.65c
	Parkland	140.87bc	1958.3d	2.74c	14.17b	136.97c	6.2ab
	Landrace	148.06ab	1547.2e	2.03d	12.74b	219.71ab	6.5a
	B.P 18	158.6a	1630.5e	2.20d	10.91b	235.77a	6.23ab

Table 3: Means comparison of year * cultivar interactions for yield and yield components by Duncan,s test at 5%level (for 2years)

	Means of traits											
	Plant height (cm)		Seed yield (kg.ha^{-1})		1000 seed weight (g)		Seeds no per pod		Pods no. per plant		Number of lateral branches per plant	
Cultivars	Year 1	Year 2	Year 1	Year 2	Year 1	Year 2	Year 1	Year 2	Year 1	Year 2	Year 1	Year 2
Hyola 401	133.33d-f	108.63g	3740.3a	2426.4 c-e	2.86c-e	3.66ab	30.44a	14.73d-g	228.0bc	103.51f	4.6bcd	5.1bcd
Hyola 330	127.50d-g	124.51e-g	3565.3ab	2526.4 cd	3.37a-d	3.53a-c	23.44a-c	19.90c-e	215.05cd	116.95ef	4.83bcd	5.41bcd
RGS003	147.50cd	112.63fg	2684.7 b-d	2390.2 c-e	3.16b-d	3.36a-d	29.16ab	14.93d-g	212.88cd	118.58ef	4.66bcd	4.45bcd
Sarigol	147.50cd	123.52e-g	2730.6 bc	2228.1 c-e	2.70d-f	2.93b-e	22.44b-d	15.13d-g	160.50c-f	119.41ef	4.16cd	6.16abc
Zarfam	169.21ab	130.86d-f	2065.3 c-g	2087.5 c-g	2.95b-e	3.66ab	28.94ab	15.70cd-g	160.72c-f	76.61f	4.27bcd	3.46d
Goldrash	149.16cd	131.15d-f	2197.2 c-f	2337.5 c-e	3.400a-d	3.93a	23.55a-c	14.43d-g	14077c-f	99.41f	4.5bcd	4.8bcd
Parkland	159.16bc	122.58e-g	1890.3c-g	1426.4 e-g	2.81c-e	2.66d-f	17.38c-f	10.96fg	199.83c-e	74.11f	6.05abc	6.35ab
Landrace	177.50ab	118.63e-g	1341.7 fg	1152.7 fg	2.00f	2.06f	15.00d-g	10.48fg	304.27ab	135.13d-f	5.61abc	7.4a
B.P 18	181.66a	135.51de	1616.7d-g	1044.4 g	2.08f	2.33ef	13.22e-g	8.60g	328.83a	142.70c-f	5.05bcd	7.41a

Table 4: Means comparison (of place* cultivar interactions) for yield and yield components by Duncan's test at 5% level (for 2years)

	Mean of traits											
	Plant height (cm)		Seed yield (kg.ha^{-1})		1000 seed weight (g)		Seeds no. per pod		Pods no. per plant		Number of lateral branches per plant	
Cuitivars	Place 1	Place 2	Place 1	Place 2	Place 1	Place 2	Place 1	Place 2	Place 1	Place 2	Place 1	Place 2
Hyola 401	112.15f	129.81b-f	2480.5 b-e	3686.1a	3.31a-c	3.21a-c	20.38ab	24.78a	179.37a-c	152.14bc	3.98d-g	5.86b-d
Hyola 330	117.93ef	134.08a-f	2647.2 b-d	3444.4 ab	3.35a-c	3.55a	19.04a-c	24.30a	143.14bc	188.86a-c	4.71c-g	5.53b-e
RGS003	122.65d-f	137.48a-f	2293.0 c-e	2781.9 a-c	3.45ab	3.08a-d	18.01a-c	26.08a	142.70bc	188.76a-c	3.42e-g	5.79b-e
Sarigol	126.48c-f	144.53a-f	2111.1 c-f	2847.5 a-c	2.98a-d	2.65b-f	18.05a-c	19.52a-c	108.37bc	171.54a-c	3.74e-g	6.58a-c
Zarfam	139.21a-f	160.81ab	1994.4 c-f	2158.3 c-f	3.36a-c	3.25a-c	20.45ab	24.18a	95.65c	141.68bc	3.14g	4.6c-g
Goldrash	135.05a-f	145.26a-e	1713.9 d-g	2820.8 a-c	3.63a	3.70a	17.47a-c	20.51ab	114.15bc	126.03bc	3.94d-g	5.35c-f
Parkland	129.98 b-f	151.76a-d	1229.1 gf	2087.5 c-f	2.90a-e	2.58c-f	10.81bc	17.54a-c	156.57bc	117.37c	4.26d-g	8.13a
Landrace	139.48a-f	156.65a-c	904.1 g	1590.3 e-g	1.88f	2.18ef	12.87bc	12.61bc	210.15a-c	229.26ab	5.63b-e	7.37ab
B.P 18	152.81a-d	164.36a	955.5 g	1705.5 d-g	2.06f	2.34d-f	9.45c	12.36bc	191.72a-c	279.81a	4.05d-g	8.42a

Table 5: Means comparison of place * year interaction yield and yield components by Duncan,s test at 5% level (for 2years)

	Mean of traits					
Interaction effects	Plant height (cm)	Seed yield (kgha^{-1})	1000 seeds weight (g)	Seed no. per pod	Pod no. per plant	Number of lateral branches per plant
P1xY1	151.67a	2536.4^{ab}	2.76b	18.27b	205.04a	3.98c
P1xY2	109.61c	2315.1^{b}	3.22a	14.30c	93.15b	4.21c
P2xY1	157.78a	1092.2^{c}	2.86ab	26.97a	228.49a	5.75b
P2xY2	136.62b	2823.2a	3.04ab	13.45c	126.06b	7.04a

P1: Stress Location

P2: Control Location

Y1: Year 1

Y2: Year 2

Reasons of this difference under drought stress condition may be due to the reduction of soil moisture storage, pod no per plant, seeds per pod, number of lateral branches and plant height. These reduction caused shorten of flowering period, non-fertilization of some flowers and reduction of photosynthetic resources [10-12].

In the 2nd year, the reduction of measured traits was higher than 1st year. In other words, year effect on measured traits was significant (Tables 1, 2). Rate of precipitation of 2nd year was 65.5% lower than 1 st year. Effect of cultivar was significant ($P \leq 0.01$). Means comparison of simple effects (Table 2) showed that Hyola 401, Hyola 330 from *B. napus* species had the highest seed yield equal to 3383.3 and 3345.8 kg/ha, respectively. Landrace and B.p18 cultivars as *B. juncea* species had the lowest seed yield (1547.2and 1630.5 kg/ha, respectively).

Leaf area duration, longer flowering period and seed formation, more 1000 seed weight, highest number of seed per pod and higher productivity potential at different climate of *B. napus* cultivars than *B. juncea* and *B. rapa* cultivars are the main causes for higher seed yield of *B. napus* cultivars. These results are compatible with other studies reported by [3, 13, 15].

Means comparison of year*cultivars showed (Table 3) that seed yield of Hyola 401 and Landrace in 1st year with 3740.3 and 1341.7 kg/ha had higher and lower seed yield, respectively. However, in 2nd year Hyola 330 with 2526.4 kg/ha and BP.18 with 1044.4 kg/ha had higher and lower seed yield respectively.

Seed yield and other cultivar's yield component in 2nd year in comparison with 1 st year showed reduction. Such reduction may be due to decrease of precipitation and increase of temperature at the terminal growth duration in the 2nd year.

The interaction between location x cultivar (Table 4) and location x year (Table 5) also showed decrease of seed yield and yield component under stress condition in comparison with control. Similar results were reported by [3, 13, 16].

Based on this study's results, cultivars of *B. napus* are more compatible and have more production potential than cultivars of two other species (*B. rapa* and *B. juncea*) for climate condition of under study region. Although, we suggest more studies by using other different genotypes in regions that comfort with drought stress to find and introduce productive cultivars that are resistant to drought stress.

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