Evaluation of canola genotypes under water deficit conditions with using stress indices

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In order to study spring canola (Brassica napus) genotypes under drought stress, this experiment was conducted in zahak Agirculture Research station of zabol, in 2005-2006 cropping season. This site located in South Eastern of Iran with precipitation less than 50 mm in year. From between Sixteen genotypes assessment in first year under water of different conditions, nine genotypes selected on basis high yield and other suitable traits. These genotypes were evaluated in two separate experiments. First experiment was non stress,(irrigation in rosset, budding, flowering, poding and grain filling stages) and second experiment was early season of drought stress that from sowing timing until budding stage approximately (80 day after sowing) water interruption (pre-anthesis drought stress). An randomized complete block design was used with three replications. Results of analysis of variance of grain yield showed significantly difference between genotypes. Mean grain yield of canola genotypes were 4074 kg/ha, and 3227 kg/ha, under non-stressed and stressed conditions, respectively. Among the genotypes Hyola 401 and Hyola 420 Hybrids were outstanding in non-stress and stressed conditions, respectively. Stress tolerance index (STI), stress susceptibility index (SSI), geometric mean productivity (GMP), mean productivity (MP) and tolerance index (TOL) were calculated based on the grain yield of the genotypes in both conditions. In non-stress and stress conditions, have above genotypes highest amount of stress tolerance index (STI), geometric mean productivity (GMP), and mean productivity (MP). Results showed positive and significantly correlation between STI, GMP and MP indices and grain yield under both conditions. Therefore these indices can be used to identify high yielding and tolerant genotypes under both conditions. On the basic this results Hyola401, RGS003 and Hyola 420 genotypes have high yield stability in non-stressed and stressed conditions than other genotypes then can be used as genetically basis of drought tolerance in breeding programs.

KeyWords: **Rapeseed, Water deficit ,Stress indice, Grain yield**

Introduction: Drought is main environmental stress and about 20 percent of produce the crops has limited in around the world (Mcdonald and et al., 2003). In arid and semi-arid regions that is not appropriate distribution of rainfall, potential yield under stress was not the best measure of drought resistance, but compare and yield stability in stress and non-stress as more appropriate criteria for response to the drought have been introduced. Fernandez (1992) introduced stress tolerance index (STI) and geometric mean performance index (GMP). Fernandez (1992) in assessing comparison of methods drought tolerance in susceptible genotypes stated that the selection based on drought tolerance (TOL) caused that breeding programs directed towards selected genotypes with low yield, however, selection on based average performance (MP) because selected genotypes with high yield. While the stress tolerance index (STI) choice to shift toward selected genotypes with high, yield and drought tolerant. and any its value is high, indicative greater tolerance to drought stress and result is high performance. According to report (Daneshian et al, 2008) both stress and non-stress conditions indicators MP, GMP and STI to select varieties tolerant to drought with high yield for soybeans suitable were detected, but indicators SSI and TOL to choose drought tolerant varieties with low yields were effective.

Materials and Methods: In order to study spring canola (Brassica napus) genotypes under drought stress, this experiment was conducted in zahak Agirculture Research station of zabol, in 2005-2006 cropping season. From between Sixteen genotypes assessment in first year under water of different conditions, nine genotypes selected on basis high yield and other suitable traits. These genotypes were evaluated in two separate experiments. First experiment was non stress,(irrigation in rosset, budding, flowering, poding and grain filling stages) and second experiment was early season of drought stress that from sowing timing until budding stage approximately (80 day after sowing) water interruption (pre-anthesis drought stress). An randomized complete block design was used with three replications. Seeds were sown on 27 October using Winterashtiger Seeder. Each plot consists of 6 rows of 5 m length, with distance of 20 cm between rows. A ratio of 380, 250 and 150 kg/ha urea, sulphate dipotash and super-phosphate, were applied respectively, (according to results of soil analysis). All plots received one-third of urea and all sulphate dipotash and super-phosphate at sowing. In each plot, plants of four central rows

were harvested to determine seed yield. For assess of genotypes from view drought tolerance used of mean (MP), tolerance (TOL), stress susceptibility index (SSI), stress tolerance index (STI) and geometric mean performance index (GMP) indices. Data were analyzed by using MSTAT-C statistical package. Duncan Multiple Range Test was used to comparing means (P≤0.05).

Results and Discussion

Yield and yield components under stress and non-stress conditions:

The highest grain yield in non-stress condition belonging to genotypes Hyola 401 , Hyola 420, RGS003 and Hyola 308 but in drought conditions of early season the highest grain yield belonged to genotypes Hyola 420, Hyola 401, RGS003 and line PP-308 /8 .

Table 1. Mean grain yield and yield components genotypes under stress and non stress conditions.

1000 Grain weight		Grain. silique^{-1}		Silique. Plant^{-1}		Grain yield Kg/ha		Genotypes
Y_{s1}	Y_p	Y_{s1}	Y_p	Y_{s1}	Y_p	Y_{s1}	Y_p	
3.23bc	2.98c	25a	24bc	233ab	307ab	3502bc	4455a	RGS003
3.86a	4.08a	26a	27a	234ab	284bcd	3573b	4457a	Hyola401
3.24bc	3.11c	19a	21d	228ab	318a	3000e	4248ab	Hyola60
3.38bc	3.51b	25a	25ab	234ab	302abc	3238d	4026abc	Hyola330
3.04c	3.11c	26a	27ab	207b	308ab	2963e	4398a	Hyola308
3.56ab	3.32bc	24a	27a	239a	277bcd	3838d	4508a	Hyola420
3.20bc	3.66b	21a	26ab	228ab	268cd	3193d	3650bcd	Option 500
3.5ab	3.67b	21a	23cd	223ab	259d	2411f	3531cd	PR-401/15E
3.28bc	3.61b	24a	24bc	231ab	288bcd	3323cd	3390d	PP-308/8
3.37	3.45	24	25	229	290	3227	4074	Average

Means followed by the same letters in each column are not significantly different at the 5% level, according to Duncan's Multiple Range Test.

Genotypes, Hyola 308, Hyola 401 and RGS003, in both of early season drought, and non stress conditions produced grain yield higher of average performance all cultivars (Table 1). Significant reduction in grain yield in stress conditions can be related to reduce yield components of genotypes such as number of silique in plant and seed in silique and weight seed. Albarak (2006) reported reduction grain yield due to drought stress, that confirmed result of this study.

Study of Drought tolerance of canola genotypes using indices:

Selected on based STI : On based STI index any what differences between grain yield in non-stress and stress conditions be most, STI is smaller. The high this index is indicator more tolerance of genotypes to stress. Among the genotypes under study, genotypes, Hyola 420, Hyola 401 and cultivar of RGS003 had the highest value (Table 2). On based results presented specific that (STI) stress tolerance index due to selection lines with high performance in both conditions is high performance efficiency (Table 2). Mozaffari et al., (1998) reported that this index, (STI) was suitable in selected tolerant genotypes in soybean and sunflower.

Selected on based SSI: Stress susceptibility index (SSI) shows that any what value it less the relative tolerance to stress is higher. This index most for eliminate susceptible genotypes was used. Genotypes PP-308 /8 and Option 500 under early season stress conditions with have lower values of this index in compared with other genotypes had of less sensitivity and more tolerance to stress (Table 2). Naderi et al., (2000) reported that this indicator in identifying genotypes that both stress and non-stress environmental have good yield were not successful.

Selected on based TOL: Tolerance index (TOL) is expressed on based difference between the grain yield in stress and non-stress condition. On based tolerance index (TOL), great tolerance is related to the genotype that has smaller of TOL (Rosielle and Hamblin, 1981).The study of tolerance genotypes with using this index showed that the genotypes PP-308 / 8, PR-401/15E and Option 500 had greater tolerance under early season stress conditions in compared with other genotypes (Table 2).

Table 2.Comparison of mean grain yield canola of genotypes and drought tolerance indices under early season stress conditions

STI	SSI	GMP	TOL	MP	Ys_1	Yp	Genotypes
0.94	1.02	3950	953	3978	3502	4455	RGS003
0.96	0.94	3991	884	4015	3573	4457	Hyola401
0.77	1.4	3570	1248	3624	3000	4248	Hyola60
0.78	0.93	3611	788	3432	3238	4026	Hyola330
0.78	1.56	3604	1445	3675	2963	4398	Hyola308
1.042	0.71	4159	670	4173	3838	4508	Hyola420
0.70	0.60	3414	458	3422	3193	3650	opion500
0.51	1.51	2918	112	2971	2411	3531	PR-401/15E
0.68	0.09	3357	68	3357	3323	3390	PP-308/8
0.79	0.99	3626	847	3650	3227	4074	Average

Yp= Seed yield in non stress condition , Ys_1= Seed yield in early season stress condition, Tol=Stress tolerance STI=Stress tolerance index, SSI=Stress succeptibility , MP=Mean productivity GMP=Geometric mean productivity

Selected on based MP: According to this index hybrids Hyola 420, Hyola 401, and cultivar of RGS003 under early season stress condition as the most tolerant genotypes were evaluated (Table 2). Fernandez (1992) announced that this index in selection cultivars with high-performance in stress conditions is not good, because large differences of yield in environmental because increased this index. According to this index, two genotypes PP-308 / 8 and PR-401 / 15E with the least this index as most sensitive genotypes under early stress were identified (Table 3).

Selected on based GMP: On based geometric mean performance index (GMP), genotypes are more tolerant that have larger amounts of this indicator (Fernandez, 1992). On based study with this indicator, genotypes, Hyola 420, Hyola 401, and cultivar of RGS003 under early season stress conditions were determined as more tolerant genotypes, to stress. Genotypes of, PP-308 /8 and PR-401/15E were assessed as sensitive genotypes under early season stress (Table 3,). Fernandez (1992) stated that due to less sensitivity GMP index to values yield in stress and non- season stress conditions, this indicator has a superior than indicator is MP. Results of most research indicate that STI, GMP and MP indices are most suitable indicators for evaluation drought tolerant genotypes (Mozaffari et al., 2001 and Fernandez, 1992), which with results this experiment accordant.

Correlation coefficients of indices with grain yield

As that from table correlation coefficients observed between grain yield in early season stress and non stress conditions was positive correlation and non-significant. (Table 3). Grain yield in early season stress condition with indicators, STI, GMP and MP, has been shown a significant positive correlation and between indices above the highest correlation coefficient achieved between yield and STI and GMP indices in early season stress (Table 3). Also grain yield in non-stress conditions has showed positive correlation and significant with the STI, GMP, MP indices. In condition this experiment was determined that indicators of STI, GMP and MP, have such property and can be good indicators for this subjection. Danshian et al., (2008) introduced indices of STI, GMP, and MP as good indicators for selection tolerant genotypes to stress in limited irrigation for soybeans.

	YP	YS	TOL	MP	GMP	SSI	STI
YP	1						
YS	0.524^{ns}	1					
TOL	0.537^{ns}	0.438$_{ns}$-	1				
MP	0.881**	0.864**-	0.074$_{ns}$	1			
GMP	0.85**	0.893**	0.014ns	0.998**	1		
SSI	0.374^{ns}	0.589^{ns}	0.978**	0.106^{ns}-	0.165^{ns}-	1	
STI	0.85**	0.891**	0.015^{ns}	0.996**	0.998**	0.158^{ns}-	1

Table 3. Correlation coefficients among tolerance indices under early season stress
ns and ** : Not significant and significant at 0.01 probability levels, respectively

Conclusion

From results this experiment can be conclude that affected shortage water, grain yield due to impressed, morphological traits and yield components reduced. However, genotypes can be shows response differently in different situations. Among genotypes under study in this experiment hybrids Hyola 401, Hyola 308 and cultivar of RGS003 have highest, STI, GMP and MP of indices. On basic evaluation with these indicators, above genotypes were detected as genotypes with high grain yield in both non-stress and stress conditions. Also, STI, GMP and MP indices due to high correlation coefficient their with seed yield under both conditions (non-stress and early season stress) can be used in selection tolerant cultivars to drought.

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