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Research Article

MEASURING YIELD AND ITS COMPONENTS OF CANOLA GENO-TYPES IN DIFFERENT PLANTING DATE

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ABSTRACT
In south west of Iran (Khuzestan province) the conditions of alternative cropping in some case have a negative effect on yield after summer cropping, because of canola delay planting. So to determine the relationship between yield components with planting date is essential. So effect of planting date on yield associated traits in spring genotypes, were evaluated by split plot experiment based Randomized Complete Block Design with three replications. Four planting dates (November 6th and 21st. December 6th and 21st) in main plots and four genotypes (Hyola401, PP401, RGS003 and Option500) were studied in sub-plots. According to analysis of variance results, grain yield, yield components and total dry matter were significantly affected by planting date. First planting date (November 6th) was more effective according to the studied traits. Genotypes also showed a significant difference for grain yield, yield components and other traits. The highest grain yield was found in Hyola401 hybrid and the lowest grain yield obtained from at Option 500 cultivar. The first planting date and Hyola401 hybrid, showed the best interaction results because of higher seed yield, yield components and total dry matter.

Keywords: *Yield, Yield Components, Canola, Genotypes, Planting Date*

INTRODUCTION
Canola (*Brassica napus* L. and *Brassica campestris* L.) are the important oilseed crops throughout the world which rank third among the oilseed crops after soybean and oil palm in production of vegetable oils, while fifth in the production of oilseed proteins. Rapeseed is also important oilseed crops of Iran. Winter oilseed rape, the most important species of oilseeds, must compete economically with cereal crops and to meet this challenge, the yield of rapeseed crops must increase significantly. In this regard, it has been reported that at the early planting date, seed yield and straw yields were greater than late planting (Daly and Martin, 1988; Miri and Bagheri, 2013). Spring rapeseed, with its broad leaves and high photosynthetic capacity, provides a convenient alternative as a break crop, in continuous cereal based agricultural systems (Khachatourians *et al.*, 2001; Mahasi and Kamundia, 2007).
Determining appropriate planting date is very important in maximizing yield. Planting dates affect seed yield by influencing several yield parameters including days to flowering, duration of flowering, plant height, and pods per plant (Sharief and Keshta, 2002). Optimizing yield is one of the most important goals for most rapeseed growers. Seed yield is a complex character affected positively or negatively by several yield parameters. Therefore, in order to single-out the component(s) having the greatest effect on yield, contribution of each of the several components have to be determined. Therefore, information on the association of plant characters with seed yield is of great importance to a breeder in selecting a desirable genotype (Thurling, 1991).
Different researches indicate that through the delay in the sowing date, there occurs a decline in the pod number per plant (Asgari and Moradi, 2008), pod number per plant (Angadi *et al.*, 2003), plant height, pod number (Nanda *et al.*, 1999), stem number per plant (Ozer, 2003) and finally seed yield and oil quality (Hocking, 2001; Miralles *et al.*, 2001). Christmas (1996) observed that different canola genotypes do not respond so much to the weather conditions. Also Sun *et al.*, (1991) announced that, like different species, different genotypes adapt themselves to specific climatic conditions. Yadav (2011) found that highest yield of canola was observed from earlier sowings. Also Taylor and Smith (1992) concluded that seed yield declined when sowing date is delayed. Johnson *et al.*, (1995) evaluated three canola cultivars at four sowing dates and found that seed yield was the highest at the first two sowing dates. Shafique *et al.*,

(1999) in Pakistan evaluated ten canola varieties and reported that delaying sowing date significantly decreased plant growth and consequently low yield.

Kirkland and Johnson (2000) stated that seed yield was greater in the early sowing dates and smaller in the later sowing dates. Horton (2006) found that highest yield of canola was observed from earlier sowings. Growth and yield are functions of a large number of metabolic processes, which are affected by environmental and genetic factors. Delayed planting causes a decrease in period from planting time to flowering or maturity.

Therefore, the decrease in yield, which occurs because of planting delay, is basically as a result of decrease of biomass during the maturity period. In order to choose a genotype, we need to determine adaptability of a genotype for each region (Robertson and Holand, 2004; Desai, 2004). Yet Maralyan *et al.*, (2007) were reported that planting date had not significantly affect on number pods in plants. Also, Miralles *et al*., (2001) Reduction in crop yield and Plant growth delay in planting date, were reported. Reduction in grain yield and Reduction in harvest index to shorten the growth period of canola was appointed, so that the potential yield of canola in early sowing date was obtained. The ideotype concept helps define the desired high yield phenotype in terms of several relatively simple plant characters (Sagir *et al*., 2004; Mahasi *et al.,* 2007; Agahi *et al.*, 2007; Marjanovic-Jeromela *et al.*, 2007). Therefore, knowing the variations of the quantitative traits under different environmental conditions make the breeding programs move successful (Sharief and Keshta, 2002; Marjanovic-Jeromela *et al.,* 2009). To determine the effect of independent variables on a particular dependent variable a certain amount of interdependence among the independent variables is expected (Aytac and Kinaci, 2009; Ogrodowczyk and Warzyniak, 2004; Sabaghnia *et al.,* 2010; Scheiner *et al.,* 2000).

According to the results about average yield in dry regions, Hyola 308, Hyola401 hybrids, also Pf 7045.91 and Taporo varieties, respectively with yielding of 2996, 2783, 2231, and 2191 $Kg.ha^{-1}$, were superior over other genotypes and are recommended to be planted in dry climate of southwest regions (Rahnama and Bakhshandeh, 2005). The Early maturing varieties with high-potentiality have higher yield, comparing with serotinal varieties (Gunasekera *et al*., 2006; Diepenbrock, 2000). Because planting date in comparison with other agronomic factors has more influence on phenologic and physiologic characteristics of the plant, determining a proper planting date makes the maximum coordination between plant growth process and climate conditions (Hakan-ozer and Unsal, 1999; Hodgson, 1979). This research was conducted to study the phenologic and physiologic characteristics of canola genotypes in different planting dates and to determine most suitable planting date considering climatic conditions of regions to achieve best yield.

MATERIALS AND METHODS

Field and Treatment Information's and Soil Characteristic

This research has been fulfilled at split plot experiment based on Randomized Complete Block Designs (CRBD) with three replications, which was conducted at Experimental Field of Khouzestan Agricultural Research and Natural Recourses Organization (Ahvaz station), in south west of Iran with moderate winters and hot summers. Planting on November 6 and 21 as the customary sowing date and planting dates of December 6 and 21 as the delayed planting in the main plots and the subplots were with the four genotypes (Hyola401, Pp401, R.G.S003 and Option500).

The texture of the soil pH was silty clay loam, electrical conductivity of condensed saturation was 3.5 $ds.m^{-1}$ and the soil was 7.3. The average annual precipitation was 248 mm, the long-term average temperature (in 30 years) was 24-45 ^{0}C, the average precipitation in the growing season was 68-136 mm and the average temperature was 20 ^{0}C. Each plot consisted of 8 rows with 30 cm apart from each other and each row was 6 meters long. The average distance between plants was considered to be 3 to 4 cm. using the fertilizers in this land was based on information's which was obtained about soil. Therefore 100 kilograms urea, 100 kilograms triple super phosphate and 200 kilogram potassium sulfate per hectare was used as the basic fertilization. During the stem growing period, was 200 kilograms of urea fertilizer per hectare utilized as dressing fertilizer.

Traits Measure

In order to determine the grain yield components during physiologic maturity, 10 plants were chosen randomly from each plot. Then the number of grains per pod and 1000 grain weight were assessed. In the final harvest area, from each plot (one- squared meter land), grain and biological yields were calculated.

Software's

Data analysis was performed by the SAS (Ver. 8) software and mean comparisons were fulfilled according to Duncan's multiple rang test at 5% probability level.

RESULTS AND DISCUSSION

Number of grain per pod

The effect of planting date and genotype on trait of the number of grain per pod was significant (Table 1). The first planting date (with 18.8 grains) had the maximum, and the fourth planting date (with 13.7 grains) had the minimum number of grains per pod (Table 2). Hyola401 hybrid (with 20.2 grains per pod), showed better results than other varieties.

The interaction effect of planting date and genotype on this trait was significant. In the first planting date, Hyola401 hybrid (with 21.3 grains), devoted the maximum number of grains per pod to itself (Table 3). Decrease in this yield component (because of delayed planting), was similar to findings of some researchers (Ozer, 2003, Siose *et al.*, 2006).

Number of pods per plant

The effect of planting date and genotype on the number of pods per plant was significant (Table 1). The maximum number of pods per plant was seen in the first planting date (November 6) which contained about 98.8 pods per plant. Second, the third and fourth planting dates afterward, had respectively average pods of 82.3, 70.1 and 62.4 per plant, which were categorized in the next groups (Table 2).

Delayed planting and end-season heat had led to physiologic limitations in the flowering period. This status occurs due to poor growth of the plant or limited leaf expansion. Therefore, nutrient ingredients are limited to the end of flowering and as a result, the number of pods per plant decreased (Mendham and Salisbury, 1995; Ozer *et al.*, 1999).

Hyola 401 hybrid with 91.2 pods, and Option 500 variety with 67.8 pods, respectively generated the maximum and minimum number of pods per plant (Table 3). The interaction effect of planting date and genotype on the mentioned trait was significant (Table 4).

The maximum number of pods per plant was obtained from Hyola401 hybrid with 118.5 pods at the first planting date. Some scientists have proclaimed superiority of Hyola401 hybrid to other varieties because of the reason mentioned above (Gabrielle *et al*., 1998).

Grain Weight

The effect of planting date and genotype was significant on 1000- grain weight: 2.93 g at the first planting date decreased to 2.17 g in the fourth planting date as a result of delayed planting (Tables 1 and 2). In delayed plantings, the grain filling period meets high temperature of the environment, and heat prevents optimized grain filling.

Hyola401 hybrid (with 3.04 g), presented maximum 1000 grain weight among the varieties. Theses results were conformed to the results of Angadi *et al.*, (2003).

As we can be seen in Table (1), the interaction effect of genotype by planting date on grain weight trait was significant. The maximum 1000 grain weight (2.98g) was obtained from Hyola401 hybrid in the first planting date (Table 4).

Plant Height

The effect of planting date and genotype on plant height was significant (Table 1). The first planting date (with 181.3 cm), and the fourth planting date (with 111.9 cm), respectively had the maximum and minimum plant height (Table 2).

By having a delayed planting, the plant loses the chance of saving photosynthesis materials. This finding was confirmed by some researchers. RGS003 variety, (with 158.7 average stem height), had excellence over other genotypes (Table 3).

Table 1: Analysis of variance for tested traits

S.O.V	df	Pods per plant	Grains Per pod	1000 grain weight	Plant Height	Total dry Matter	Harv-est index	Grain yield
Replication	2	235.9	2.8	0.16	695.2	227.02	71.12	36548.1
Planting date	3	3596.4**	82.0**	1.75**	13702.5**	174453**	86.95**	377812.7**
Error	6	47.5	1.7	0.05	65.3	33.43	0.0508	89643.1
Genotype	3	1517.2**	105.9**	1.16**	2379.6**	91498**	30.16**	237854.3**
Planting date × Genotype	9	105.3*	5.9**	0.07*	374.7*	6533.2**	11.47**	331796.9**
Error	24	25.1	0.7	0.03	180.8	26.1	0.0103	20513.8
CV (%)		8.8	7.8	6.8	6.5	3.65	4.08	7.0

*ns, * and ** : not significant, significant at 5% and 1% level of probability, respectively*

Table 2: Mean comparisons of grains yield, yield components, total dry weight and harvest index affected by planting dates.

Treatment	Pods per plant	Grains per pod	1000 grain weight (g)	Plant Height (cm)	Grain yield ($kg.ha^{-1}$)	Harvest Index (%)	Total dry Matter ($g.m^{-2}$)
Planting dates							
6.11	96.7 [a]	18.8 [d]	2.93 [a]	181.3 [a]	2611.6 [a]	22.72 [a]	1271.25 [a]
21.11	82.3 [b]	18.0 [a]	2.78 [a]	157.5 [b]	2252.6 [b]	19.4 [b]	1165.91 [b]
6.12	70.1 [c]	16.3 [b]	2.70 [b]	139.7 [c]	1792.4 [c]	16.48 [c]	1068.5 [c]
21.12	62.4 [d]	13.7 [c]	2.17 [c]	111.9 [d]	1515.3 [c]	14.7 [d]	1025.1 [c]

***Similar letters in each column show non-significant difference at 5% level in Duncan's Multiple Rang Test*

Table 3: Mean comparisons of grains yield, yield components, total dry weight and harvest index affected by genotypes

Treatment	Pods per plant	Grains per pod	1000 grain weight (g)	Plant Height (cm)	Grain yield ($kg.ha^{-1}$)	Harvest Index (%)	Total dry Weight ($g.m^{-2}$)
Genotypes							
Hyola401	91.2 [a]	20.3 [a]	3.04 [a]	157.5 [a]	2608.5 [a]	20.03 [a]	1248.91 [a]
Pp401	76.5 [b]	16.9 [b]	2.55 [b]	137.5 [b]	1874.4 [b]	16.97 [c]	1091.5 [b]
R.G.S 003	76.2 [b]	15.0 [c]	2.47 [b]	158.8 [a]	1942.0 [b]	17.61 [b]	1112.5 [b]
Option 500	67.8 [c]	14.6 [c]	2.51 [b]	136.6 [b]	1747.1 [c]	16.44 [c]	1046.0 [c]

***Similar letters in each column show non-significant difference according to 5% level in Duncan's Multiple Rang Test*

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Table 4: Mean comparisons of interaction effect of traits by Duncan's test

	Treatment	Pods per plant	Grains per pod	1000 grain weight (g)	Grain yield (kg. ha $^{-1}$)	Plant Height (cm)	Harvest Index (%)	Total dry Matter (g.m^{-2})
6.11	Hyola 401	118.5 ^{a}	21.3 ^{ab}	3.75 ^{a}	3603.5 ^{a}	175.0 ^{b}	26.5 ^{a}	1225.95 ^{a}
	Pp401	86.8 ^{bc}	19.5 ^{bd}	2.98 ^{cd}	2387.9 ^{c}	167.5 ^{bc}	21.6 ^{b}	1210.35 ^{bc}
	R.G.S 003	95.8 ^{b}	16.5 $^{f-i}$	2.63 ^{ef}	2480.3 ^{c}	201.3 ^{a}	23.3 ^{ab}	1205.45 ^{b}
	Option 500	86.0 ^{bc}	18.0 $^{c-f}$	2.78 ^{de}	1974.6 $^{d-f}$	181.3 ^{b}	19.5 ^{b}	1195.0 ^{b}
21.11	Hyola 401	93.5 ^{df}	21.5 ^{a}	3.25 ^{bc}	3030.9 ^{b}	168.8 ^{bc}	22.1 ^{ab}	1185.25 ^{df}
	Pp401	80.5 ^{cd}	16.8 $^{e-h}$	2.55 ^{de}	1974.5 $^{d-f}$	150.0 ^{cd}	18.2 ^{c}	1125.16 ^{cd}
	R.G.S 003	82.3 ^{cd}	17.8 $^{d-g}$	2.75 ^{de}	2116.9 ^{d}	167.5 ^{bc}	20.4 ^{bc}	1160.15 ^{bc}
	Option 500	73.0 ^{b}	26.0 $^{g-i}$	2.55 ^{ef}	1888.2 ^{ef}	143.8 ^{de}	17.1 ^{d}	1110.11 ^{de}
6.12	Hyola 401	78.5 ^{cd}	19.8 $^{a-c}$	3.03 ^{bc}	20209.0 ^{de}	168.8 ^{bc}	17.9 ^{d}	1080.96 ^{ef}
	Pp401	75.3 ^{de}	16.5 ^{fi}	2.73 ^{e}	1868.3 $^{e-g}$	127.5 ^{ef}	16.3 ^{de}	1041.9 ^{de}
	R.G.S 003	66.0 ^{eg}	14.8 ^{ig}	2.43 ^{f}	1664.7 $^{g-i}$	141.3 ^{df}	16.5 ^{de}	1063.65 ^{ef}
	Option 500	60.8 ^{gh}	14.3 ^{j}	2.63 ^{f}	1607.7 ^{hi}	126.3 ^{ef}	15.2 ^{e}	1015.3 ^{gh}
21.12	Hyola 401	74.3 ^{de}	18.5 ^{ce}	2.5 ^{ef}	1170.6 $^{f-h}$	122.5 ^{fg}	15.9 ^{e}	1049.30 ^{fg}
	Pp401	63.5 ^{fg}	15.0 ^{kj}	2.1 ^{g}	1266.8 ^{j}	105.0 ^{gh}	14.6 ^{f}	1015.42 ^{ef}
	R.G.S 003	60.8 ^{gh}	11.0 ^{k}	2.2 ^{g}	1506.2 ^{i}	125.0 ^{ef}	14.8 ^{f}	1022.66 ^{de}
	Option 500	51.3 ^{h}	10.3 ^{k}	1.9 ^{g}	1517.9 ^{i}	95.0 ^{h}	13.8 ^{g}	1009.74 ^{h}

** Similar letters in each column show non-significant difference according to 5% level in Duncan's Multiple Rang Test.*

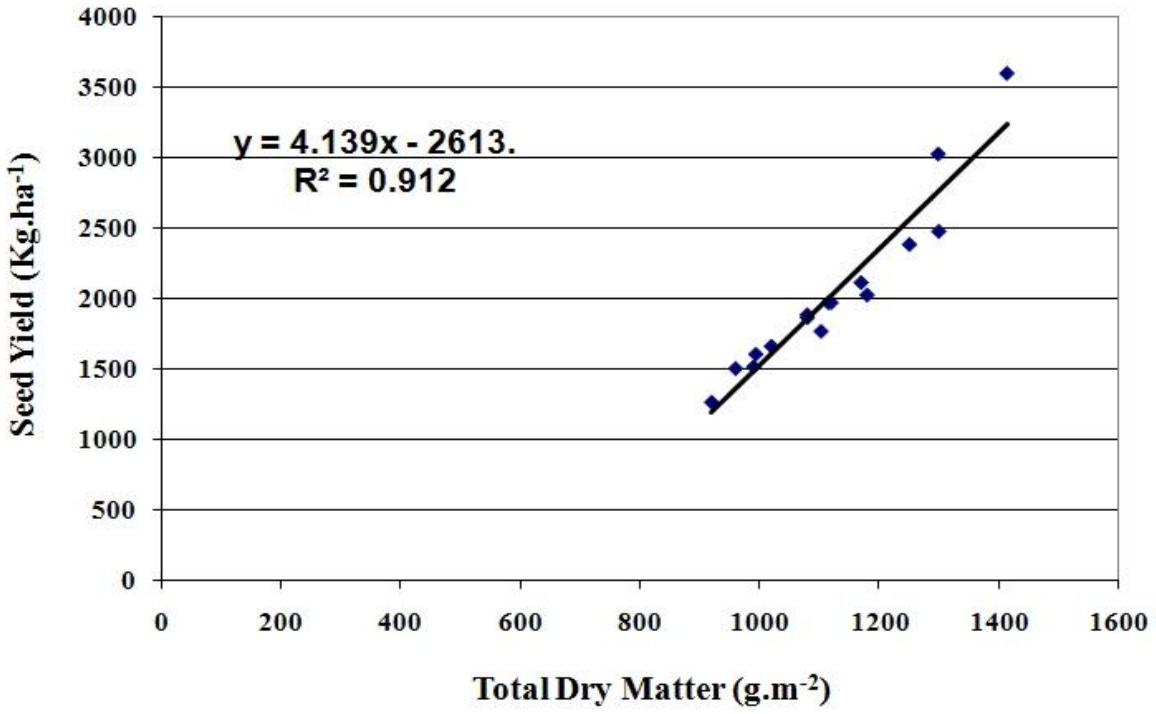

Figure 1: Correlation between Seed yield and Total Dry Matter

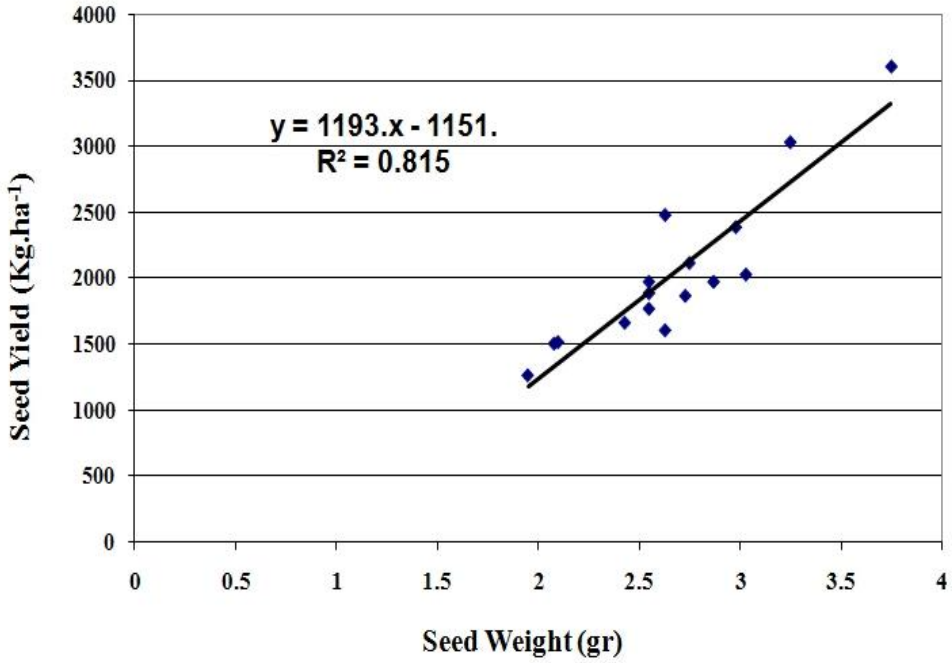

Figure 2: Correlation between Seed yield and Seed Weight

Grain Yield

The effect of different planting dates was significant on grain yield. Other researchers have reported the same findings (Robertson and Holland, 2004). Grain yield decrease from the first planting date to the fourth date (from 2611.6 to 1515.3 $Kg.ha^{-1}$). At the first planting date, benefiting from environmental conditions resulting in the optimum photosynthesis had maximum yield (Table 2). Hyola401 hybrid by having 2608.5 $Kg.ha^{-1}$ yields had the maximum yield (Table 3). The interaction effects of planting date and genotype on grain yield was significant. Maximum grain yield was observed in Hyola401 hybrid at first planting date, while minimum grain yield was in Option 500 at the fourth planting date (Table 4).

Harvest Index

Harvest index was decreased with delayed planting. The significant differences indicated that a change in planting date can seriously affect dry matter accumulation, in plant sinks. By 15, 30 or 45 days delay in planting date. The harvest index which was 20.72 % in the first planting date, decreased to 19.14 % in the second planting date, 16.48 % in the third and 14.7 % in the fourth planting date (Table 2). Choosing a proper planting date can cause an increase in the harvest index, and finally can lead to a better transmission of photosynthesis materials to grains. Genotypes which were studied in this experiment had totally different potentialities according to their plant dry matter distributions and their economic crop components. Hyola401 hybrid (by 20.03% harvest index), had better conditions for these potentialities comparing with other varieties (Table 3).

Correlation

The most positive and significant correlation was observed between seed yield and total dry matter trait and seed weight (Figure 1 and 2). As a result, the more this trait is observed, the bigger sink plant would have for metabolic materials.

Conclusion

Delayed planting date, especially among the serotinal genotypes, is encountered with increase of temperature and humidity tensions during March and April, which are the most sensitive time for growing process of plants. This can cause negative effects on grain, yield. The first planting date and Hyola401 hybrid, showed the best interaction results because of higher seed yield, yield components and total dry matter.

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