Effect of planting date on canola phenology, yield and yield components

Mona Pouriesa, Majid Nabipour

Department of agronomy and plant breeding, faculty of Agriculture, Shahid Chamran University, Iran
Email: m_pureisa@yahoo.com

Abstract

To investigate the effect of planting date on canola (*Brassica napus L.*) growth period, yield, and yield components and to study the possibility of a correlation between these characters in three canola cultivars, an experiment was conducted in an experimental field at Agricultural College, during 2003-4 cropping season. Shahid Chamran University of Ahwaz. The experiment was designed as split plot planned as completely randomized blocks with three replications. Plots and sub-plots were respectively consisted of four dating plots (November 16, December 6, December 26, January 15) and three cultivars (Hyola 401, RGS003, and Pf 704). Results indicated that with different planting dates, there were significant differences in seed yield and pods per plant at the probability level of %99. Significant differences were also found in seed per pod, oil contents, and protein percentages at the probability level of %95, but not in 1000 seed weight. Three cultivars exhibited considerable differences in the characters yield, pods per plant, and seed per pod at the probability level of %99 but not in 1000 seed weight, oil and protein percentages. Moreover, phenological traits like lengths of growth period, periods of planting date till the apperance of flower buds, lengths of flowering period, lengths of podding period, and grain filling differed significantly at the probability levels of %99 as the result of different planting dates and canola cultivars. Among yield components, pod per plants was the trait with the highest correlation with yield (r=0.7), however, no significant correlation was found between 1000 seed weight and yield production which was highly correlated with all phenological characteristics mentioned above.

Key words: canola, Brassica napus Var. olifera, planting date, phenology, yield

Introduction

Traits specifically found with canola plants, e.g. possessing of winter- and spring- and also intermediate cultivars, and consequently high adaptation to different environmental conditions, the possibility of growing of canola winter-cultivars during fall, and therefore, reduction of the needed irrigation water, higher yield compared to other oil crops, and that such cultivars can be grown in the absence of more economically profitable cash crops have led to the raise of the canola cultivation importance as a promising crop to provide edible oil. Additionally, wheat-canola rotations increase the yield of the cereal partner. Hence, it is significantly important to focus on the plant phonological characteristics in relation to its adaptation to various environmental conditions encountered because of different planting dates.

Nanda *et al*. (1996) considered different *Brassica* species (*B. campestris*, *B. juncea*, *B. napus*, and *B. carinata*) over two years with seven planting dates in each year. All species completed their life cycles in less calendar time as planting date was delayed after October 13 with the time to maturity reducing on average by 0.62 day for every day's delay. The duration of the phase from plant emergence to the bud visible stage measured in thermal time, was however, progressively reduced as mean temperature declined from 24 to 12 °C. They also found that durations of the developmental phases after budding were apparently determined only by temperature, and so, within a species, required the same thermal time for completion regardless of planting date(9).

Jenkins and Leitch (1986) revealed the generally reducing effect of the delayed sowing on the number of the canola pods produced. Also, Mendham et al., (1981) indicated that with the canola cultivar, Victor, planted in Britain during seven growing seasons and in different planting dates, the development rate is proportional to the average temperature during a period from flowering till physiological maturity, so that with every 1°C increase in the temperature, the physiological maturity precedes 8 days (7). Consistently, Nanda et al., (9) demonstrated the decrease of this period as the result of the delayed planting, which was true with all the studied species. Similarly, Robertson et al., (10) found that the postponed planting led to the shortened period since planting to 50% flowering and maturity. They indicated the reduced yield occurred as the consequence of biomass reduction during maturity. Moreover, positive correlations was found between oil content, and the harvest index and seed size, however, a negative correlation was proven between oil content and thermal conditions after pollination (Robertson et al.,). As the accomplishment in regional canola production depends on the optimized usage of climatic characters of a region, therefore, the adaptability of the plant growth trend during its growth and development to the climatic conditions is a determinant factor, the comprehensive information on this topic, can be usefully helpful in the interpretation and explanation of the differences encountered with different cultivars.

Regarding the fact that the planting date is a treatment, which is of the most effects on the crop phenological traits in comparison with other agronomical treatments, therefore, it is feasible to establish the most fitness between plant growth trend and climatic conditions. The present research has been carried out to study the phonological traits of canola cultivars under different regimes of planting dates, and to determine the most appropriate planting date from the stand point of the fitness among various phonological stages in one side, and the climatic conditions as well the final crop yield in the other side.

Materials and Methods

The experiment was performed in the experimental farm belonged to the Agronomy and Plant Breeding Department, Agricultural faculty, Shahid Chamran University, Ahwaz during 2003-2004. This farm has located in western south of the city Ahwaz an on the western shore of the river Karoun, with the latitude of 31°, 20' N and longitude of 48°, 41' E at the height of 20 m over the free sea level. Pedological tests indicated that the level of soil electric conductivity (EC) was equal to 2.9 ds/m. N, P and K at 70: 60: 50 kg·ha^{-1} was applied before sowing. The mean rainfall for this city during the last 50 years has been determined as 241.mm annually. The highest and the lowest temperatures during the green season were respectively 38 and 4 °C. Each experimental plot included eight seeding rows 450 cm in length and 30 cm distant from each row aside. Five plants were selected randomly and bound with white colored bands, daily inspected; and the changes in their development were recorded based on the Silvester-Bradley growth key (6).

Results and Discussion

Phonological traits

The period of planting to bud visible

As can be seen in table-1, planting date, cultivars, and their interaction effects differed in the planting to bud visible period. The first and the fourth seeding dates, respectively of the mean periods of 73 and 55 days, led to the most latest and the most earliest appearance of flower buds. Also, the cultivar Pf with the period of 69 days and Hyola hybrid with that of 63 days exhibited the longest and the shortest planting-to-bud visible periods(table 2). Appearance of bud is under the influence of three factors including temperature, the necessity of vernalization, and photoperiod. Vernalization and photoperiod mainly act before the initiation of flower bud. Here, the factor of temperature does not represent the mean temperatures in different planting dates, but rather it is the thermal time obtained by the plant, i.e. to enter the reproductive stage, the plant should obtain the minimum required thermal time. The vernalization factor is ignored because it is not necessary for the spring-cultivars. With the delay in planting, the number of days needed to reach the thermal time required for plant entrance to the reproductive stage increases as the result of the decrease in temperature. The mean temperatures since planting-to-bud visible periods related to the first to the forth planting dates were respectively as 15, 20, 19, and 22 °C, and indicated a descending trend. The differences found in the plant-to-bud visible periods of various cultivars are attributed to the genetic variation among different canola cultivars from the view point of their required thermal times needed to enter the reproductive stage.

Lengths of growth period

Results from statistical analyses indicated that there were significant differences among seeding date, cultivar, and interactions between seeding date and cultivar at the error probability level of %1(table 1). So that the first sowing date with 160 days and fourth sowing date with 134 days of period, indicated the longest and shortest growth period respectively (table 2). Among all the cultivars the longest and shortest growth period were found with pF 704 and Hyola cultivars respectively of 151 and 141 days. Considering all the cultivars and seeding date, Pf in first and Hyola in fourth seeding date with 134 respectively, exhibited the longest and shortest periods of seed filling.

Lengths of flowering period

Result from statistical analyses indicated that were significant differences among seeding date, cultivar and interactions between seeding date and cultivar at the error probability level of %1(table 1). So that the first sowing date with 31 days and fourth sowing date with 23 days of period, indicated the longest and shortest period of flowering respectively (table 2). Among all the cultivars the longest and shortest period of flowering were found with Pf 704 and Hyola cultivars respectively of 34 and 22 days. Considering all the cultivars and seeding date, Pf in first and Hyola in fourth seeding date with 38 and 18 days respectively, exhibited the longest and shortest periods of flowering. Flowering is the most critical stage influencing the yield of rapeseed.The most limiting process starts shortly after the onset of flowering when the decrease in the total leaf area accelerates due to shading, initially by the flowers and later by the pods.The increasing flower cover intensifies photon reflectivity and absorption to 60±65% of incoming radiation. At the same time, photosynthesis of the crop decreases by 40%. The developing pod surface can intercept and use incoming solar radiation to a great extent. there is a sharp minimum at their photosynthetically active area, caused by the drastic decline in the LAI from the start of flowering and the simultaneously slow increase in the pod area index (PAI). With the delay in planting date the mean temperature in flowering period was increased and lead to accelerate in decrease of LAI and shorten of the period.

The period of pod formation

Results from statistical analyses indicated that there were significant differences in the period of pod formation among different seeding dates (P= %95) and cultivars (P= %99). However, the interactions between seeding date and cultivar were not of statistically significant effect on the period of pod formation (table 1), so that the first sowing date with 28 days and fourth sowing date with 17 days of the period, indicated the longest and the shortest periods of pod formation, respectively. Among all the cultivars tested during these studies, the cultivar Pf with the pod formation period of 27 days, and Hyola hybrid with 16 days exhibited the longest and the shortest periods of pod formation.

The period of seed filling

Result from statistical analyses indicated that were significant differences among seeding date, cultivar and interactions between seeding date and cultivar at the error probability level of %1(table 1). So that the first sowing date with 46 days and third sowing date with 33 days of period, indicated the longest and shortest period of seed filling, respectively (table 2). Among all the cultivars the longest and shortest period of seed filling were found with pF 704 and RGS003 cultivars respectively of 52 and 46 days. Considering all the cultivars and seeding date, Hyola 401 in first and fourth with 69 and 34 days respectively, exhibited the longest and shortest periods of seed filling.

Yield and yield component

Pod per plant

Results from statistical analyses indicated that there were significant differences among seeding date, cultivar, and interactions between seeding date and cultivar at the error probability level of %1(table 3). Also, based on Duncan's test made, the first and fourth seeding dates respectively of the mean pod per plant of 204 and 11 led to the most and the least pod per plant. The most and the least numbers of pods per plant were found with PF 704 cultivar and Hyola 401 hybrid respectively of 149 and 91 pods per plant. Also, based on Duncan's test made, Pf 704 in second seeding date and Hyola 401 hybrid in fourth seeding date respectively, led to the most and the least pod per plant. Results indicated that the interaction effects differed significantly in the error level of 1 percent, so that the cultivar Pf at the second planting date and Hyola 401 hybrid at the fourth date of planting were respectively of the most abundant and the least numbers of pods per plant (table 4). With an increase in the flowering period, the temporal opportunity for the more formation of pods increases, therefore, any factor effective on this period is also able to change the pod numbers per plant. Delay in planting results in physiological limitations for example weak plant growth, and restricted development of leaves as effect of the unfavorable conditions (like hot temperatures) prevailed during this period. Consequently the transport and deliver of assimilates to the tips of the florescence, and finally the flowering period is limited, and the production of pods per plant comes down. These results confirm the findings of other authors (Hodgson et al,(1979) Jenkins et al, (1986) Scarisbrick et al, (1981) Mendham et al.(1981))

The number of seeds per pod

There were found significant differences in the seed numbers per pod among different seeding dates (P= %95) and cultivars (P= %99). However, the interactions between seeding date and cultivar were not of statistically significant effect on the number of seeds per pod (table 3). Based on the results from Duncan test, the first planting date with the 22 seed per pod, and the fourth planting dates with 18 seed per pod respectively produced the most and the least numbers of seeds (table 4). The leaf area index (LAI) during the flowering period and the beginning of the pod filling is regarded as the major determinant factor of the number of seeds per pod. Also, the level of assimilation in the pods reduces, and the level of respiration in pods increases with the increase in temperatures during the periods of pod formation and seed filling that leads to the loss of assimilates and seeds. With a delay in planting, and with the earlier beginning of flowering period, the canola plants enter the stages of pod formation and seed filling, while they are still of less leaf areas. As the result, the number of seeds inside a pod decreases. These findings are in accordance with those of other researchers like Shir Ismaili et al., (3). Hyola hybrid with 23 seed per pod, Pf with 18 seed per pod were respectively of the most abundant and the fewest numbers of seed per pod.

With a given cultivar, the more the number of pods per plant, the more decrease of the seed number per pod occurs. Therefore, the increase in the pod number tends to compensate the reduced number of seed per pod. For instant, the cultivar Pf was of the most abundant number of the pods per plant and however, of the least number of seeds per pod. Compared with other cultivars, however, it was only the cultivar Pf wherein the decrease in seed number per pod could be completely compensated through the increased pods formation by plant. Through comparative studies on two plant species, Turling and coworkers (18) concluded that the pod number per plant negatively correlates with the number of seed per pod. Clark and collaborators also indicated that the number of pods per plant could be different in various cultivars.

Weight of thousands seed

Considering the weight of thousands seed as the last yield component under study, planting dates, cultivars, and interaction between them were not of any statistically considerable impacts.

The weight of thousands seed is the final yield component determined during plant development. This yield component is affected more weakly by the environmental factors compared to other yield components. Generally, there is a weak relationship between the final yield and the weight of thousand seed. It seems that this yield component is almost governed genetically rather than by environmental factors.

Seed yield

Results from statistical analyses indicated that there were significant differences among seeding date, cultivar, and interactions between seeding date and cultivar at the error probability level of %1. Also, based on Duncan's test made, the first and fourth seeding dates respectively of the mean seed yields of 2277 kg/ha and 1065 kg/ha led to the most and the least seed yields. With a delay in seeding date, the appropriate accordance between phenological stages and environmental conditions is lost, and the stages become shorter than those related to the first seeding date. The increase of temperature at the final stages of canola growth reduces the number of seeds per pod, 1000 seed weight, and the filling period. If pod development stage, during which the dry material of the seed is provided, synchronizes with the higher environmental temperatures, the amount of the produced assilmilates decrease. Furthermore, high temperature is accompanied with water stress and in turn leads to the disordered re-translocation of the assimilates into the developing seed. Therefore, prematured, light and hollow seed with little dry materials are yielded. The most and the least seed yields were found with PF 704 and RGS 003 cultivars respectively of 1955 and 1693 kg seed/ha. Considering all the cultivars and seeding dates, RGS

003 was of the most and the least seed yields respectively in the first (2333 kg/ha) and fourth (864 kg/ha) seeding dates.

Table 1 : Efect of planting date on phonological rait

	Degree of freedom	The period of planting to bud visible	lengths of growth period	lengths of flowering period	The period of pod formation	The period of seed filling
Replication	2	8.778	6.681	13.583	5.333	8.631
Planting date	3	323.361**	1524.843**	175.287**	244.963**	1707.731**
Mean error	6	0.33	0.898	0.509	0.185	0.176
cultivar	2	303.694**	348.694**	102.25**	23.25**	721.194**
Planting date * cultivar	6	50.583**	49.065**	8.731**	19.88**	33.676**
Secondary erroer	12	0.194	0.514	0.111	0.222	0.306

Table2

treatment	Level of treatment	The period of planting to bud visible	lengths of growth period	lengths of flowering period	The period of pod formation	The period of seed filling
Planting date	1	72[a]	158[a]	30[a]	27[a]	58[a]
	2	64[b]	147[b]	26[b]	21[b]	50[b]
	3	63[c]	140[c]	23[c]	19[c]	39[c]
	4	52[d]	127[d]	19[d]	14[d]	26[d]
cultivar	Hyola 401	60[c]	147[c]	22[c]	15[c]	51[a]
	RGS 003	64[b]	143[b]	24[b]	22[b]	35[c]
	Pf704	70[a]	148[a]	28[a]	23[a]	43[b]

Table3: Efect of planting date on yield and yield component

	Degrees of freedom	Seed yield	Pod per plant	Seed per pod	Weight of thousands seed
Replication	2	1220.1	2653.543	6.694	0.136
Planting date	3	2531852.917**	74737.607**	32.347*	0.146 ns
Mean error	6	1086.778	4168.484	5.521	0.039
cultivar	2	177052.111**	9831.423**	75.134**	0.114 ns
Planting date * cultivar	6	46163.333**	13849.817**	12.619 ns	0.308 ns
Secondary erroer	12	1120.111	1.153	5.153	0.262

Table4

treatment	Level of treatment	Seed yield	Pod per plant	Seed per pod	Weight of thousands seed
Planting date	1	2177a	204a	21a	3.4a
	2	2048b	187a	21a	3.1b
	3	1937c	81b	21a	3.3ab
	4	10654d	11c	18a	3.3ab
cultivar	Hyola 401	1828a	91b	23a	3.2a
	RGS 003	1712b	122ab	21b	3.3a
	Pf704	1955c	149a	18c	3.2a

References

1- Bilsborrow, P. E., Norton, G. 1984. A consideration of factors affecting the yield of oilseed rape. Aspects Appl. Biol. 6: 91-100.

2- Diepenbrock, W. 2000. Yield analysis of winter oilseed rape (Brassica napus L.): a review. Field Crops Research. 67: 35-49.

3- Evans, E. J. 1984. Pre-anthesis growth and its influence on seed yield in winter oilseed rape. Aspects Appl. Biol. 6: 81-90.

4- Gabrielle, B., Denoroy, P., Gosse, G., Justes, E., Andersen, M.N., 1998b. A model of leaf area development and senescence of winter oilseed rape. Field Crops Res. 57: 209-222.

5- Hodgson, A. S. 1979. Rapeseed adaptation in Northern New South Wales. III. Yield, yield components and grain quality of Brassica campestris and Brassica napus in relation to planting date. Aust. J. Agric, Res. 30: 19-27.

6- Jenkins, P. D. and Leitch, M.H. 1986. Effects of sowing date on the growth and yield of winter oil-seed rape (Brassica napus). J. Agric. Sci., Camb. 105: 405-420.

7- Mendham, N. J., Shipway, P. A. and Scott, R.K; 1981a. The effects of delayed sowing and weather on growth, development and yield of winter oil-seed rape (Brassica napus L.). J. Agric. Sci., Camb. 96., 389-416.

8- Miralles, D., and F.Brenda. (2001). Developmental responses to sowing date in wheat,barley and rapeseed. Field Crops Research.71:211-223. 14- Nanda, R., Bhargava. S. C., Tomar D. P. S. and H. M. Rawson. 1996. Phenological development of *Brassica compestris*, *B.juncea*,*B.napuse* and *B. carinata* grown in controlled enviroments and from 14 sowing dates in the field.Field Crops Research. 46:93-103.

9- Robertson, M. j. and Holand, J. F. 2004. Response of canola and Indian mustard to sowing date in the grain belt of north-eastern Australia. Australian journal of experimental agriculture. 44:43-52

10- Scarisbrick, D.H., Daniels, R. W. and Alcock, M. 1981. The effect of sowing date on the yield and yield components of spring oil- seed rape. J. Agric. Sci. Camb. 97: 189-195.

11- Sylvester-Bradley, R. and Makepeace, R. J. 1984. A code for stages of development in oilseed rape (*Brassica napus L.*). Aspects Appl. Biol. 6: 399-419.

12- Thurling.N. and L. D. Vejendradas. 1979. The relationship between perantesis development and seed yield of spring rape (*Brassica napus* L.).Aust. J. of Agric. Res. 31:25-36.