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DETERMINING THE BEST TIME TO CULTIVATE DIFFERENT VARIETY OF CANOLA AND ITS EFFECT ON THE YIELD AND PERFORMANCE YIELD IN FASA

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ABSTRACT

To clarify the effect of the date of cultivation on the yield of different variety of canola, a test was conducted in the test farm of Fasa Azad University in Aban (November). In which two variety of canola that is RGS and Hybrid Hyola-401 as one factor and four dates of cultivation [15Aban (6 November), 30 Aban (21 November), 15Azar (6 December), and 30Azar (21 December)] as another factor in a factorial experiment and in a randomized complete block design with three replication on canola were cultivated. At the end, the time of germination, time of formation of seedling, shooting, flowering, the date of the appearance of the first flower, the length of stem, the number of minor branches, the distance between the first pod and earth, the number of pods in a plant, the number of seed in each pod, 1000 Kernel (g) and the yield were studied and analyses. In this test the number of flowers and day degrees (GDD) was also calculated and it was clear at the end that considering the measurements of GDD and other factors and final results it seems that Hyola-401 is better for Fasa because this variety in most factors had a better affect comparing to RGS. Furthermore too early or too late cultivation can affect the number of flowers, flower insemination, its survival, 1000 Kernel (g) and yield. So it seems considering the climatic conditions in Fasa it is better to cultivate canola in fall because there is no danger of hot weather and the weather is more suitable at this time.

Keywords: canola, cultivation, date, variety.

INTRODUCTION

The oil seed canola has already been in Iran and a lot of research has been conducted on it. In recent years because of paying more attention to the development and cultivation of canola its cultivation area has increased significantly. The special characteristics of this plant and its adaptation to different climatic conditions have increased the importance of this plant. Canola is an important plant in industry and cooking. Furthermore after extracting the oil the meal can be used as the food for livestock. So, it is an important plant requiring various researches in different areas. In an experiment on 4 varieties of canola with 4 dates of cultivation [15 sharivar (5 September), 25 sharivar (15 September), 4 Meher (25 September), and 14 Meher (5 October)] reported that the date of cultivation and different cultivars had a significant affect on yield and yield components [1]. In an experiment on 3 cultivars of canola and 3 cultivation dates [10 Aban (31 October), 25 Aban (15 November), 10 Azar (30 November)] reported that the cultivar has a significant affect on the yield and the yield components [2]. In an experiment surveyed 5 cultivars of canola in 3 cultivation dates [1, 15, 30 Azar (21 Novamber, 5 and 20 December] and reported that the highest number of sheats, number of seeds in each shrub, and the height had been seen on the 15th Azar [3]. Amir in an experiment on the density and different cultivars of canola reported that different cultivars had significant effects on the grain yield, the weight of a1000 Kernel (g), the number of pods in shrubs, number of seeds in pods [4]. There was a significant difference between different cultivars of canola in the height of the shrub, the number of sheats in a shrub, the number of seeds in sheats and the yield [1]. The results of variance analysis showed that the affect of the cultivation date was significant on traits like the height of the plants, the amount of the dry material, the index of the leaf surface, the number o pods in the plant, the length of the pods and yield were significant statistically, but the effect of cultivation date was not significant in the percentage of oil and the number of the seeds in sheaths. The first and second cultivation dates were also better than the others [5]. In a study on the effect of cultivation dates on traits of canola cultivars reported that the yield of the first cultivation date was significant and there was a significant difference among the cultivars [6]. While studying the effect of the cultivation configuration on 3 canola cultivars of Hyola-401, RGS003, PF7045/191 reported that the effect of the cultivar was significant on all the components of the yield except the number of shoots [7]. In an experiment on different canola cultivars in different cultivation dates reported that different cultivars in different cultivation dates can have a significant effect on the yield [8]. For canola production, the cultivar and the suitable cultivation dates are important [9]. While studying different canola varieties based on growth and development reported that the effect of the cultivar on the number of flowers isn't significant [10]. The cultivar can effect on the distance of the first sheath from the ground level. Clarke and *et al*. (1978) reported on the analysis of the canola growth stages [11]. The canola physiology and survey of different stages of growth were reported. The aim of the project: as canola has been paid attention by the organizations and production units of oil in recent years it has been paid a lot of attention [12]. As it is planted in many parts of Fasa the above mentioned project was performed on it. This plant is cultivated in autumn in Fasa

so the suitable cultivation date is necessary to confront the cold weather of winter and to have the on time germination and suitable yield.

MATERIALS AND METHOD

Before the experiments the sampling was done on the soil of the farm and based on the laboratory suggestions enough nutrients were added to soil. After preparation procedure of the land in defined dates, the cultivation process was done by hand the elimination of the weeds was done precisely by hand. The pest control was conducted at the suitable time using adequate amounts of appropriate poisons. During the growth stage the farm was visited regularly. To conduct the experiment, two canola cultivars (Hyola-401, RGS) were used in with 4 cultivation dates [15Aban (6 November), 30 Aban (21 November), 15Azar (6 December), and 30Azar (21 December)]. The experiment was done as factorial and in completely randomized blocks with three replications. The width of the plots was 2meters and their length was 5meters.To avoid marginal affects the harvest was done just in the four middle lines. To do it 0.5meter from the top and bottom of the middle line were excluded and the harvest was done only in the 4meters in the middle. The distance between the rows was 25cm and the distance between the bushes in the rows was 4cm. To determine characteristics such as germination time, the time of seedling initiation, the date of bud initiation, the date of floral initiation, the date of the appearance of the first flower, at specified times, the related notes were taken.

To determine the length of the stem, the number of secondary branches, the distance of the first pod from the ground, 10 shrubs from each plot were chosen in each plot randomly and the above mentioned characteristics were measured. The length was measured by tape measure and ruler. To determine the characteristic of the number of pods in each plant, 10 Shrub in each plot were selected randomly and this characteristic was measured. Also, to determine the number of seeds in each pod, 30 pods from 10 Shrubs were chosen randomly and this characteristic was measured. To determine the weight of 1000 Kernel (g), after harvesting 8 samples each containing 100 seeds were chosen randomly from each plot, their weight average was multiplied by10, so the weight of 1000 seeds was calculated.

By multiplying the weight of the seeds, the number of them in each sheath and the number of pods in bushes, the yield of the seeds in square meters was calculated. Furthermore in this test the number of flowers and day degrees (GDD) was also calculated. To analyze the data the MSTATS software with Duncan test in level of probability of 5% was used and to draw graph the EXCEL software was used. To calculate (GGD) a maximum and minimum thermometer was installed in the test environment and the max and min temperatures were recorded daily. Then the day degree was calculated using this formula:

$$GDD = \frac{Tmax + Tmin}{2} - Tb$$

Where Tmax, is the daily maximum temperature, Tmin is the daily minimum temperature and Tb is the base temperature or plant zero.

RESULTS AND DISCUSSIONS

Number of the flowers: The effect of the cultivars on the number of the flowers was not significant and according to Duncan test, in level of probability 5% the averages do not have significant differences. But, the effect of the cultivation date and the interaction between the cultivar and the cultivation date was significant on this factor (Table-4). Results indicated that among studied dates the first date had the greatest effect on the number of the flowers (Table-1). Results indicated that the effect of the cultivar on the number of the flowers is not significant [10].

The length of the stem: The simple effect of the cultivar and the cultivation date and also the interaction between the cultivar and the cultivation date were significant in stem length in plants (Table-4). Results indicated that early cultivation date [15Aban (6 November), 30 Aban (21 November)], has more effect on this factor (Table-1). Among the studied cultivars the cultivar HYOLA-401 had more effect on the stem length (Table-2) [1, 3].

The number of the secondary branches: The Cultivar did not have any affect on the secondary branches, but the cultivation date and interaction effect of the cultivar and the cultivation date had a significant affect on the number of secondary branches (Table-4). Considering the results, cultivation date had a significant affect on this factor (Table-1). In Table-2, the affect of the cultivar on the number of the secondary branches has not had a significant effect. Different cultivars can show different affects because of the genetics and different environmental conditions. The results also showed that the mutual effect of these two factors has a significant affect on the number of the secondary branches (Table-3) [7].

Distance of the first sheath from ground: Different cultivation dates had no significant effect on this factor (Table-4). The effect of the cultivation date on the distance of the first sheath to ground has been shown in Table-1 and different times in this factor are not significant. In Table-2 it is indicated that the effect of the cultivar HYOLA-401 on the distance of the first pod from the ground is more. In Table-3 the interaction between the date and the cultivar on the first pod distance from the ground is observed, and HYOLA-401 in different dates is better than RGS [11].

Number of the sheaths in plants: The simple effect of the cultivar and the cultivation date had no significant effect on the number of the sheaths in plants.

Interaction between the cultivars and the cultivation date has a significant effect on this factor (Table-4). According to results in Table-1, the different cultivation dates have had a significant effect on the number of pods in plants. Cultivars have no significant effect on the number of the pods in plants. The last cultivation time has a positive effect on the number of the sheaths and the remaining treatments also are different and statistically are in various levels (Table-3) [3].

The number of the grains in each sheath: The simple effect of the cultivar and the cultivation date on the number of the grains in each sheath was not significant. But interaction between the cultivar and the cultivation date had a significant effect on this factor (Table-4). In Table-1, the cultivation date did not have a significant effect on the grain number in pods. Different cultivars also have had no significant effect on the number of the seeds in pods, as shown in Table-2. In the interaction between the cultivars and the cultivation dates on the number of the grains in pods, the cultivar RGS has indicated the effect in the last cultivation date [5].

The weight of 1000 Kernels (g): The simple and interactive effects of the cultivar and cultivation date on the 1000 Kernels (g) shows a significant affect (Table-4). The results showed that the cultivation date of 30 of Aban (21 November) had a significant affect on this factor (Table-1). The cultivar HYOLA-401 had higher weight in the 1000 Kernels (g) (Table-2). The cultivar HYOLA-401 in most of cultivation period had a better affect on the 1000 Kernels (g) (Table-3) [2].

Seed yield: In this factor, the simple and interactive effect of the cultivar and the cultivation date indicate a significant effect (Table-4). Results indicated that 30 Aban (21 November) is better than all the treatments (Table-1). Cultivar HYOLA-401 also has a better yield than the other cultivars, as shown in Table-2 [4, 8].

GGD: To determine the GGD, a maximum, minimum thermometer was installed in the test environment. From the first day of Aban (November) to the end of Kordad (June), the daily max, min temperatures were recorded and finally it was calculated based on the formula of GDD. The base temperature is usually considered 5˚C for this plant, the best temperature for canola growth is 25 to 30˚C degrees centigrade. Of course, this plant can stand 40˚C for a short period of time, but the temperatures more than 35˚C destroys the germination ability and kills the pollens [13].

Germination GDD: The simple and interactive effect of variety and the date of cultivation on germination GDD is significant (Table-5). In row 9 of Table-1 the GDD calculated from the cultivation to germination can be seen. The cultivation date of Aban 15 (6 November) is significant. The seeds germinate three days after cultivation. The calculated GDD of the first cultivation date was 39.1. Considering row 9 in Table-2 it can be seen that the variety RGS is in a better condition for this factor. Considering row 9 of Table three the interactive effect of the variety and the cultivation date can be seen.

The GDD of the seedling initiation: The simple and interactive effect of the cultivar and cultivation date on the GDD of the seedling initiation was also significant. (Table-5). In row 9 of Table-1, the GDD of the cultivation to the formation of the seedling can be seen in which there is a significant difference between the cultivation dates. The RGS cultivar had also a significant affect on the GDD of the seedling initiation (row 10 Table-2). In row 9 of Table-3 the interactive affect of the cultivar and the cultivation date on the factor discussed can be seen.

The GDD of the buds initiation: In this case the simple and interactive affects of the cultivar and the cultivation date on the GDD of the buds initiation were significant too (Table-5). In row 11 of Table-1 the GDD of the buds initiation can be seen which is about 500-600 and it can be seen that the GDD of 462 is significant (Clarck *et al*., 1978). The Hyola-401 cultivar had a more significant affect on this factor that can be seen in row 11of Table-2. The interactive affect of this treatment can be seen in row 11 Table-3.

The GDD of the appearance of the first flower: Both the cultivar treatment and the cultivation date had a significant affect too (Table-5). In row 12 of the Table-1 the cultivation GDD until the appearance of the first flower can be seen, the necessary GGD for this stage is about 550-650(Daniels *et al*., 1986). The better effect of Hyola-401 cultivar on this factor can be seen in row 12 of Table-2. The interaction of this factor is shown in row 12 of Table-3.

Flowering GDD: All the affects in the case of flowering GDD are significant (Table-5). In row 13, Table-1 the cultivation GDD until the flowering can be seen, the necessary GDD for this stage is about 759-825 (clark *et al*. 1978). Hyola-401 cultivar had a significant affect on this factor (row 13 of Table-2). The interactive affect of the cultivar and the cultivation date on this factor can be seen in row 13 Table-3.

Harvesting GDD: The simple and interactive effects of the cultivar and cultivation date had a significant affect on harvesting GDD (Table-5). In row 14, Table-1, the cultivation to harvesting GDD can be seen. The necessary GDD for this stage is about 1432-1557 (clark *et al*. 1978). In row 14 of Table-2 the affect of the cultivar on this factor can be seen. The interactive affect of the cultivar and the cultivation date on harvesting GDD can be surveyed in row 14 of Table-3. In row 9 and 10, Table-1, the GDD of cultivation to germination and cultivation to seedling initiation can be seen, in the first cultivation date the necessary temperature for these two growth stages is provided. In rows 11 and 12, Table-1 the GDD of cultivation to bud initiation and the appearance of the first

flower can be seen in which the last cultivation date has provided enough temperature for these two factors but the flowers produced under adverse environmental conditions such as hot weather have not been able to effect the production positively. The reason may be the fact that because of the heat there has occurred a problem with flowers insemination. As it can be seen in row 13 and 14 of Table-1 the late cultivation dates have a lower yield despite having more flowers. In row 5 of Table-1 the GDD from cultivation to flowering can be seen. In this case the first and the second cultivation dates are also better. Considering Table-1 you can also see that the highest rate of flowering is in the first and the second cultivation dates. Therefore the necessary temperature for the appearance of flowers which cause a better yield can be obtained in the first and the second cultivation dates; because in these stages not only the necessary temperature for flowering is provided but also the produced flowers can have a role in production. Although the number of flowers produced is low, this low number has a significant role in the yield that can be observed in row 13 and 14 of Table-1 and also in Tables 1 and 2. Considering Table-1, you can see that the second cultivation dates has a positive affect on the weight of 1000 Kernel (g), this second cultivation date has been able to show a good yield in Table-1 and as you know the weight of 1000 Kernels (g) has a direct relationship with the yield. It should be mentioned that in the first cultivation dates flowers are produced which are completely inseminated and so can produce seeds which have a good average from the point of view of the 1000 Kernel (g). This has a positive affect on the yield. This case is quite clear in row 13 and 14 in Table-5 and the also Table-1. In Table-2 it can be observed that the Hyola-401 cultivar in the vital stages of bud initiation up to the harvest has a better GDD. As it can be seen in most cases Hyola-401 cultivar has a relative priority. Generally canola should be cultivated 6 weeks before the first frost [13].

Table-1. The effect of the cultivation date on measured factors.

Row	Measured factors	A1	A2	A3	A4
1	Number of flowers	480.5 a	419 b	283.8 c	278 c
2	Stem length (cm)	149.3 a	146.5 a	126.5 b	116 b
3	Number of shootings	12.83 c	16.50 b	20.33 a	16.83 b
4	Distance of the first pod in plant	62.33 a	63.83 a	53.67 a	54.58 a
5	Number of pods in plant	248 a	309 a	294 a	309 a
6	Number of seeds in the pod	27 a	30 a	31 a	31 a
7	1000 Kernels (g)	4.33 b	4.950 a	3.850 c	3.800 c
8	Seed yield (Ton/ha)	3.150 b	3.800 a	2.900 b	2.100 c
9	Germination GDD	39.1 a	28.85 b	34.2 ab	35.95 ab
10	Seedling formation GDD	65.9 a	57.9 c	63.7 b	58.82 c
11	Budding GDD	447.9 b	422.9 c	418.6 c	462 a
12	Appearance of the first flower GDD	459.5 b	434.8 d	447.3 c	488.7 a
13	Flowering GDD	17.9 c	1469 a	786.3 b	711.1 c
14	Harvest GDD	635 a	1540 c	1604 b	1480 d

A1: time to cultivate 15Aban (6 November) A2: time to cultivate 30 Aban (21 November)
A3: time to cultivate 15Azar (6 December) A4: time to cultivate 30Azar (21 December)

Table-2. The effect of the variety on measured factors.

Row	Measured factors	B1	B2
1	Number of flowers	395.2 a	371.5 a
2	Stem length (cm)	145.6 a	123.6 b
3	Number of shootings	16.08 a	17.17 a
4	Distance of the first pod in plant	73.08 a	44.13 b
5	Number of pods in plant	261.8 a	318.4 a
6	Number of seeds in the pod	28.67 a	30.83 a
7	1000 Kernels (g)	4.717 a	3.750 b
8	Seed yield (Ton/ha)	30825 a	2.150 b
9	Germination GDD	23.52 a	45.53 a
10	Seedling formation GDD	47.85 b	75.31 a
11	Budding GDD	501.3 a	374.3 b
12	Appearance of the first flower GDD	526.5 a	388.6 b
13	Flowering GDD	932.5 a	909.8 b
14	Harvest GDD	1642 a	1488 b

B1: variety Hyola-401 B2: variety RGS

Table-3. Interaction between cultivar and different dates on measured factors.

Row	Measured factors	A1B1	A1B2	A2B1	A2B2	A3B1	A3B2	A4B12	A4B2
1	Number of flowers	462.7 ab	498.3 a	410 c	428 bc	286 d	281 d	277.7 d	278.3 d
2	Stem length (cm)	162.3 a	136.3 bc	142.7 bc	150.3 ab	149.3 ab	103.7 d	128 c	104 d
3	Number of shootings	18.33 b	7.33 d	20.33 b	12.67 c	12 c	285.67 a	13.67 c	20 b
4	Distance of the first pod in plants	64.33 bc	60.33 bc	68.33 abc	59.33 c	83 a	24.33 d	76.67 ab	32.50 d
5	Number of the pod in plants	322.7 abc	172.7 d	340 ab	279 bcd	206 cd	382.3 ab	178.7 d	439.7 a
6	Number of seeds in the pods	35 a	33 ab	30.33 abc	30.33 abc	29.33 bcd	258.33 bcd	26.67 cd	25 d
7	1000 Kernels (g)	4.96 b	3.70 e	5.40 c	4.40 c	4.50 c	3.30 f	4.10 d	3.50 ef
8	Seed yield (Ton/ha)	3.50 c	2.80 d	5.10 a	2.50 d	4.30 b	1.50 e	2.40 d	1.80 e
9	Germination GDD	23.4 cd	54.8 a	15.8 d	41.9 b	26.1 c	42.3 b	28.8 c	43.1 b
10	Seedling formation GDD	51.1 e	80.7 a	41.9 g	73.9 c	49.9 ef	77.5 b	68.5 f	69.13 d
11	Budding GDD	483.6 b	412.3 d	465.5 c	380.3 e	490 b	347.1 g	566.2 a	57.7 f
12	Appearance of the first flower GDD	491.3 c	427.9 d	493.5 c	376.1 e	523 b	371.5 e	598.2 a	379.1 e
13	Flowering GDD	707.3 e	728.5 de	1490 a	1449 b	811.2 c	761.3 d	721.3 de	700.8 e
14	Harvest GDD	1595 d	1654 c	1616 d	1717 b	1364 e	1831 a	1378 e	1364 e

A1B1: time to cultivate 15Aban (6 November), variety Hyola-401 A1B2: time to cultivate 15Aban (6 November), variety RGS
A2B1: time to cultivate 30 Aban (21 November), variety Hyola-401 A2B2: time to cultivate 30 Aban (21 November), variety RGS
A3B1: time to cultivate 15Azar (6 December), variety Hyola-401 A3B2: time to cultivate 15Azar (6 December), variety RGS
A4B1: time to cultivate 30Azar (21 December), variety Hyola-401 A4B2: time to cultivate 30Azar (21 December), variety RGS

Table-4. Variance analysis of the number of the flowers, stem length, number of the shoots, distance of the first pod from the ground, number of the pods in the plant, number of the seeds in the pod, 1000 Kernel (g), economical yield square mean character.

Variation source (S.O.V)	**Degree of freedom**	**Number of flowers**	**Stem length** (cm)	**Number of shootings**	**Distance of the first pod in plants**	**Number of the seeds in the pods**	**Number of the seed in the pod**	**1000 Kernels** (g)	**Seed yield** (Ton/ha)
Replication	2	3563.042 *	40.667 *	6.125 ns	120.385 ns	1202.625*	7.125*	0.020*	0.000*
Time cultivate	3	60825.667**	1540.500*	56.375*	163.594 ns	5114.042 ns	12.722 ns	1.712 *	0.925*
Variety	1	912.667 ns	2904.400*	7.042 ns	5031.510*	19210.042 ns	28.167 ns	5.607*	5.134*
Variety × time cultivate	3	506.556*	730.11*	246.486*	1067.566*	56314.375 *	50.944 *	0.123 *	3.558
Error	14	95.762	594.994	5.125	77.409	4816.720	7.220	0.020	0.095

Ns, *, ** - Non significant and significant at the 5%, 1% level of probability.

Table-5. Variance analysis of GDD germination, seedling formation, budding, appearance of the first flower, flowering, harvest square mean character.

Variation source (S.O.V)	**Degree of freedom**	**Germination**	**Seedling formation**	**Budding**	**Appearance of the first flower**	**Flowering**	**Harvest** (Ton/ha)
Replication	2	113.292 *	25.167 *	157.875 *	30.386 ns	3037.500 *	70444.175 *
Time cultivate	3	23.037 *	78.015 *	3308.750 *	3186.626*	874152.939*	26371.334 *
Variety	1	3675.375 *	4606.510 *	90946.300*	114058.465*	3322.906 *	126222.546*
Variety × time cultivate	3	196.003 *	46.968 *	5312.744 *	376.086 *	1387.339 ns	135882.803*
Error	14	30.815	1.262	27.399	30.373	561.310	414.028

Ns, *, ** - Non significant and significant at the 5%, 1% level of probability.

GENERAL CONCLUSIONS

According to the GDD measured cases and other factors and drawn conclusion it seems that the cultivar Hyola-401 is more suitable to be planted in fasa (IRAN), because this cultivar had a better effect than the cultivar RGS. In addition to this, the very early or late cultivation can affect on the number of the flower, flower inoculation, flower duration, 1000 Kernels (g) and the yield. So, it seems that based on the good weather condition in autumn in fasa we can attempt to plant canola because there is not the risk of the hot weather. Similarly, the on time cultivation of the plant can produce plants which are resistance to cold winter. Therefore the early cultivation causes that the plant enters into the dormancy and in extreme cold winter exits from dormancy and it is damaging. The very late cultivation also can expose the sprouting and seedling production to cold risk which both of them are harmful to the plants.

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