Advances in Environmental Biology, 6(8): 2428-2433, 2012
ISSN 1995-0756

This is a refereed journal and all articles are professionally screened and reviewed **ORIGINAL ARTICLE**

Investigation of Spring Rapeseed Cultivars Reaction to Autumn and Winter Plantings in Mild Cold Area

Amir Hossein Shirani Rad

Research Associate Prof., Seed and Plant Improvement institute, Karaj, Iran.

Amir Hossein Shirani Rad; Investigation of Spring Rapeseed Cultivars Reaction to Autumn and Winter Plantings in Mild Cold Area

ABSTRACT

In order to investigation of spring rapeseed cultivars reaction to autumn and winter plantings in mild cold area , a research was performed during 2005 and 2007 growing seasons in the l split plot experiment on the bases of Randomized Complete Block Design (RCBD) with four replications in Seed and Plant Improvement institute, Karaj, Iran. Treatments were included: 1-Planting season in two levels as main plots such as common planting dates autumn planting(7 October) and winter planting(6March). 2-Varieties as sub plots in 24 levels, including of RGS 003, Amica, Sarigol, Option 500, Hyola 401, Hyola 42, Hyola 60, Hyola 420, Hyola 330, Hyola 308, Kimberly, RGS 006, 19-H, Syn-3, PR-401.16, pp-401.15E, pp 308.8, pp 308.3, ORS 3150-3006, ORS 3150-3008, RG 4403, RG 405.03, RGAS 0324, RG 405.02. The results showed that simple effects of planting season and variety and also interaction effect on seed yield and oil yield were significant ($P<0.01$). Hyola 401 in common planting date (4178 $kg.ha^{-1}$) had the highest seed yield and Hayola 330 in this planting date (1810 $kg.ha^{-1}$) had the highest oil yield. But RG405.03 in winter planting (2385 and 901.1 $kg.ha^{-1}$) had the highest seed yield and oil yield respectively. Simple effect of correlation among characters showed that seed yield with biologic yield and harvest index had significant correlation ($P<0.01$).

***Key words*:** Rapeseed, Planting Season, Seed yield and its Components, Variety

Introduction

Rapeseed (*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 [9]. Rapeseed is also important oilseed crops of Iran. The national requirement of edible oil is going to increase even further in the coming years due to high population growth rate and increase in per capita consumption. This huge import bill can only be reduced by increasing the domestic oilseed production. The production of oil seed in Iran is not high; about 80% of Iran's necessary oil is imported from foreign countries [1]. Planting dates obviously affect canola yield and yield components. In this regard, it has been reported that at the early planting date, seed yield and straw yields were greater than late planting [2]. Sowing time is an important factor that determines the length of growing season and hence yields. If planted in spring, they can be grown as summer crop but the seed yield would be decreased due to short growing season and lack of enough water at the end of growing season, thus, winter cropping is preferred. Early spring sowing of oil canola delayed flowering and reduced reflection of radiation during flowering which were important factors leading to the highest yields achieved by late sowing [8]. Planting time is one of the most important factors for maximizing canola yield especially in those areas where temperature, day length, rainfall and humidity vary throughout the year. Taylor & Smith (1992) reported that yields of seed and oil declined when sowing was delayed beyond May (the optimum period of canola sowing in Australia) [18]. Robertson *et al*., (1999) observed that yield declined with delay in sowing date i.e., the linear regression slope coefficient between sowing date and grain yield was negative and the average relative yield loss per week was -5.1 % [16]. A number of studies have shown yield decline in canola with delay in sowing [4,10]. In addition, canola oil content has been found to de cline with later sowing [4]. Horton(2006), found that highest yield of canola was observed from earlier sowings [5]. Growth and yield are functions of a large number of metabolic processes, which are affected by environmental and genetic factors. Number of pod per plant recorded higher in 14 October sowing compared to 29th October, 13 November and 28 November sowing

Corresponding Author

Amir Hossein Shirani rad, Research Associate Prof., Seed and Plant Improvement institute, Karaj, Iran.
E-mail: shirani.rad@gmail.com

[17]. Seeding earlier than normal incorporates operational diversity into a cropping system that diversifies weed management systems [3]. The detrimental effects of insects and diseases on canola yields, as well as the effect of delayed sowing on production cost, have been reported [19].

Materials and Methods

In order to investigation of spring rapeseed cultivars reaction to autumn and winter plantings in mild cold area , a research was performed during 2005 and 2007 growing seasons in the l split plot experiment on the bases of Randomized Complete Block Design (RCBD) with four replications in Seed and Plant Improvement institute, Karaj, Iran. Treatments were included:

1-Planting season in two levels as main plots such as common planting dates autumn planting (7 October) and winter planting (6March).

2-Varieties as sub plots in 24 levels, including of RGS 003, Amica, Sarigol, Option 500, Hyola 401, Hyola 42, Hyola 60, Hyola 420, Hyola 330, Hyola 308, Kimberly, RGS 006, 19-H, Syn-3, PR-401.16, pp-401.15E, pp 308.8, pp 308.3, ORS 3150-3006, ORS 3150-3008, RG 4403, RG 405.03, RGAS 0324, RG 405.02.

Each experimental plot consisted of four lines with line spacing of 4 meters, 30 cm and plant spacing on the line was 5 cm the two lateral lines are considered as marginal and 2, the middle line , to determine all the phenological stages and different characteristics: Plant height, number of branches per plant, pod number per plant, seeds per pod, 1000-seed weight, seed yield, seed oil, oil yield, biological yield and harvest index were used. Also after the second year experiment combined analysis of variance was performed for the traits. Before the beginning of experiment, soil samples were taken in order to determine the physical and chemical properties. A composite soil sample was collected from depth of 0-30 and 30-60 cm. It was air dried, crushed, and tested for physical and chemical properties. The research field had a clay loam soil. The first top dressing distribution at 4-6 true leaf stage (135 urea $kg.ha^{-1}$) and the second was conducted at the time of reproductive organs appearance . Hand weeding was done at 4-6 true leaf stage as well as mid- stem elongation stage. At the end of growing season and prior to crop harvest, 10 plants were chosen randomly from each experimental unit and were cut from the surface. At physiological maturity stage, for determining the seed yield, the crop was harvested from a 4.8 m2 area per each plot and was left in the field for drying until constant weight (up to 12% moisture). In order to separate seeds form pod, a Trashing combine harvester was used. The harvested seeds from each experimental unit individually weighed with a precision scale and thereafter seed yield expressed as kg/ha. Finally, eight samples of 100 seeds were taken from each seed lot of the experimental units and then weighed. Their average multiplied by 10 recorded 1000-seed weight (g). In order to measure the seed oil percentage of each experimental plot, about 3 grams of seed was prepared and using an NMR apparatus, the oil percentage was measured. The said apparatus works based on the magnetic induction of hydrogen nucleus which is a spectrometry method. One of the advantages of this method is its being destructive which accelerates the speed and accuracy of measuring the seed oil content. processed by the combined analysis of variance using SAS statistical software. Means comparison of the data was done by Duncan's multi-range test (DMRT) ($P<0.05$).

Results and Discussion

Pod number in plant:

Simple effects of planting season and varieties and also the interaction effect of planting season and varieties on number of pods per plant, were significant ($P<0.01$)(Table 1). Fall planting (7 October) with mean 133.3 towards the cultivation of winter (6 March) with an average of 81 , had a significant advantage. Varieties of this trait in the test groups were statistically different , so that ORS3150/3006 varieties with mean 140.7, maximum and varieties of Amica with an average 84.38 , allocated to the lowest number of Pod in Plant (Table 2). The mean comparison of the interaction effect of planting season and varieties, Showed that the tested varieties planted in different seasons , different groups were compared in terms of the character. So that Syn-3 varieties in autumn planting (7 October) with an average of 182.9, the highest and varieties of ORS3150.3006 in winter planting (6 March)with an averaging 51.7 , the lowest number of Pod in Plant was produced. Also in the autumn planting season (7 October), Syn-3 varieties and in the winter planting season (6 March), varieties PP308.8 allocated to highest the number of Pods per plant (Table 3).

Number of Pods per plant, grain yield is a major component, because the capacity of a seed Pod provides and green shell pods with photosynthesis and the percentage of ingredients, provides for canola seed filling. Mendham *et al.,* have reported that in their study the pod number of fertile genotypes of canola, is more subordinate to weather conditions, sowing date and plant density than other such determinants [11]. Furthermore, Degenhart and Kondra reported that the "pod number per plant" decreases by a delay in sowing. Thus they observed that, as a result of the decrease in the number of pods pre plant, the number of pods per stem decreases [12].

Table 1: Mean squares of traits in the combined analysis of 24 varieties of spring rapeseed (2005-2007).

		(MS)				
S.O.V	df	Pod number in plant	Oil yield	1000-seed weight	Seed yield	Plant height
Year	1	**	**	**	**	**
Error	6	63.04	3628.4	0.089	8792.4	41.2
Planting Season	1	**	**	**	**	**
Year * Planting Season	1	**	**	ns	ns	**
Error	6	82.06	25006.6	0.054	84020.7	50.4
Variety	23	**	**	**	**	**
Year*Variety	23	**	**	**	**	**
Planting Season *Variety	23	**	**	**	**	**
Year* Planting Season*Variety	23	**	**	*	**	**
Error	276	40.7	7219.8	0.028	35940.1	38.2
C.V. %	--	5.9	8.2	5.06	7.6	5.9

ns,*,** respectively: non- significant , significance in level of 5 and 1 %

Oil yield:

Simple effects of planting season and varieties and also the interaction effect of planting season and varieties on oil yield, were significant (P<0.01) (Table 1). Fall planting (7 October) with mean 1435.5(kg.ha^{-1}) towards the cultivation of winter (6 March) with an average of 631(kg.ha^{-1}) , had a significant advantage. Varieties of this trait in the test groups were statistically different , so that variety of Syn-3 with mean 1241(kg.ha^{-1}) , maximum and variety of Sarigol with an average 755.9(kg.ha^{-1}) , allocated to the lowest number of oil yield (Table 2). The mean comparison of the interaction effect of planting season and varieties, Showed that the tested varieties planted in different seasons, different groups were compared in terms of the character. So that Hyola330 hybrid in autumn planting (7 October) with an average of 1810(kg.ha^{-1}), the highest and varieties of Sarigol in winter planting (6 March)with an averaging 405.8(kg.ha^{-1}), the lowest number of oil yield was produced. Also in the autumn planting season (7 October), Hyola330 hybrid and in the winter planting season (6 March) ,varieties of RG405.03 allocated to maximum the oil yield (Table 3). Jasinka *et al*., (1989) reported that seed and oil yields decreased with delay in sowing date [17].

1000-Seed weight:

Simple effects of planting season and varieties and also the interaction effect of planting season and varieties on 1000-seed weight, were significant (P<0.01) (Table 1). Fall planting (7 October) with mean 3.6 (g) towards the cultivation of winter (6 March) with an average of 3.02(g) , had a significant advantage. Varieties of this trait in the test groups were statistically different, so that hybrid of Hyola 401 with mean 3.55(g) , maximum and hybrid of Hyola308 with an average 3.03(g) , allocated to the lowest number of 1000-seed weight (Table 2). The mean comparison of the interaction effect of planting season and varieties, Showed that the tested varieties planted in different seasons, different groups were compared in terms of the character. So that RG4403 varieties in autumn planting (7 October) with an average of 3.92(g), the highest and varieties of Option500 in winter planting (6 March) with an averaging 2.74(g) , the lowest number of 1000-seed weight was produced. Also in the autumn planting season (7 October), RG4403 varieties and in the winter planting season (6 March), varieties of RG405.02 allocated to maximum the 1000-seed weight (Table 3). Robertson *et al*. (2004) and Bhuiyan *et al*. (2008) stated that 1000-seed weight reduced with the delayed planting time [14,15]. Delay in planting season seed weight and seed yield is reduced [13].

Seed yield:

This in study of Simple effects of planting season and varieties and also the interaction effect of planting season and varieties on seed yield, were significant (P<0.01)(Table 1). Fall planting (7 October) with mean 3355(kg.ha^{-1}) towards the cultivation of winter (6 March) with an average of 1620(kg.ha^{-1}), had a significant advantage. Varieties of this trait in the test groups were statistically different, so that variety of Syn-3 with mean 2982(kg.ha^{-1}), maximum and variety of Sarigol with an average 1842(kg.ha^{-1}) , allocated to the lowest number of seed yield (Table 2). The mean comparison of the interaction effect of planting season and varieties, Showed that the tested varieties planted in different seasons, different groups were compared in terms of the character. So that Hyola401 hybrid in autumn planting (7 October) with an average of 4178(kg.ha^{-1}), the highest and varieties of Sarigol in winter planting (6 March)with an averaging 1064(kg.ha^{-1}) ,the lowest number of oil yield was produced. Different researches indicate that through the delay in the sowing date, there occurs a decline in the seed yield [5,14]. Also in the autumn planting season (7 October), Hyola401 hybrid and in the winter planting season (6 March), varieties of RG405.03 , allocated to maximum the oil yield (Table 3). Jasinska *et al*., reported that seed yield decreased with delay in sowing date [7]. Also Taylor and Smith concluded that seed yield declined when sowing date is delayed [6]. In the study of Morrison and Stewart as well as genetic differences

among the four varieties of canola seed yield has been reported [12].

Plant height:

Simple effects of planting season , varieties , and also the interaction effect of planting season and varieties on plant height were significant (P<0.01)(Table 1). Fall planting (7 October) with mean 117.1 cm towards the cultivation of winter (6 March) with an average of 92.4 cm , had a significant advantage. Varieties of this trait in the test groups were statistically different , so that Amica varieties with mean 114.1 cm , maximum and hybrid Hyola401with an average 92.67 cm , allocated to the lowest plant height (Table 2). The mean comparison of the interaction effect of planting season and varieties, showed that the tested varieties planted in different seasons, different groups were compared in terms of the character. So that 15E/PP-401 varieties in autumn planting (7 October) with an average of 129.4 cm, the highest and hybrid Hyola42 in winter planting (6 March)with an averaging 78.3 cm, the lowest plant height was produced. Also in the autumn planting season (7 October) ,PP- 401.15E varieties and in the winter planting season (6 March) , varieties Amica, allocated to the highest plant height (Table 3). Potts and Gardiner [15] proved that a delay in sowing does not significantly affect the plant height. Taylor and Smith [18] have reported that the delayed sowing causes a decrease in canola height. Hocking and Stapper [4] and Miralles and *et al* [11] also shorten the period of vegetative growth canola planting date delay factor in reducing plant height in mind.

Simple correlation between the studied traits:

Simple correlation between the traits test shows that, seed yield , had significant positive correlation with 1000-seed weight. Other traits did not show significant correlation with each other (Table 4). Gunasekera *et al.,* reported that canola seed yield is Strong correlation with shoot dry matter and harvest index [19].

Table 2: Main comparison of studied traits in spring rapeseed cultivars (2005-2007 years).

Treatment	Pod number in plant	Oil yield ($Kg.ha^{-1}$)	1000-seed weight(g)	Seed yield ($Kg.ha^{-1}$)	Plant height(cm)
Planting Date					
Autumn (7Oct.)	133.3a	42.8a	3.6a	3355a	117.1a
Winter (6 *March*)	81b	39.24b	3.02b	1620b	92.4b
Cultivar					
RGS 003	123.5cd	40.9d-k	3.1hi	2382f	96.9jk
Amica	84.3m	41.03c-j	3.05i	2254fg	114.1a
Sarigol	119.2d	40.3h-l	3.1hi	1842h	103.7gh
Option 500	92.5ijk	42.8a	3.1hi	2373f	110.5a-d
Hyola 401	93.4ij	41.6b-e	3.5a	2677d	92.6k
Hyola 42	98.4h	40.5g-l	3.1hi	2371f	98.9hij
Hyola 60	106.2f	41.9a-b	3.3efg	2241fg	92.8k
Hyola 420	89.7jkl	42abc	3.3c-f	2532e	110.2a-e
Hyola 330	124.4c	42.11ab	3.4b-e	2727cd	105.2fg
Hyola 308	104.4fg	41.2b-h	3.03i	2188g	94.6jk
Kimberly	111.3e	40.05jkl	3.1hi	2396f	109b-f
RGS 006	85.8m	41.28b-h	3.2fgh	2781cd	94.8jk
19-H	106.6f	40.4g-l	3.3c-f	2373f	113.9ab
Syn-3	124c	41.1b-i	3.5abc	2982a	110.5a-d
PR-401.16	85.6lm	41.3b-g	3.4a-d	2320fg	111.9abc
PP-401.15E	88.5klm	40.6e-l	3.4b-e	2821bcd	109.2a-f
PP 308.8	122.3cd	40.6f-l	3.2gh	2315fg	112.8abc
PP 308.3	100gh	41.6b-f	3.3d-g	2868abc	105.4efg
ORS 3150-3006	140.7a	39.8l	3.2fgh	2238fg	110.3a-e
ORS 3150-3008	96.5hi	40.4g-l	3.5ab	2960ab	102.3gh
RG 4403	134.7b	41.3b-g	3.5ab	2253fg	106.6d-g
RG 405.03	105f	40.15i-l	3.4a-e	2786cd	101.9ghi
RGAS 0324	130.5b	41.3b-g	3.4abc	2281fg	108.5c-f
RG 405.02	104.5fg	39.9kl	3.5a	2735cd	97.5ijk

For a given means within each column of each section followed by the same letter are not significantly different ($p < 0.05$).

Table 3: The means comparison of interaction effects of planting date and cultivars(2005-2007 years).

Cultivar	Pod number in plant		Oil yield ($Kg.ha^{-1}$)		1000-seed weight(g)		Seed yield ($Kg.ha^{-1}$)		Plant height (cm)	
	Autumn	Winter	Autumn	Winter	Autumn	Winter	Autumn	Winter	Autumn	Winter
RGS 003	141.9ef	105.1lmn	1409def	584.3qrs	3.5c-f	2.7r	3318e-h	1446rst	109.8gh	84.1pqr
Amica	102mno	66.7u-x	1124i	719.5lmn	3.3g-j	2.7r	2642k	1865nop	125abc	103.2ij
Sarigol	150.2cd	88.1p	1106i	405.8u	3.4efg	2.8qr	2620k	1064v	104.6hi	102.7ij
Option	106.2lm	78.8qr	1426de	620opq	3.5c-f	2.7r	3203f-j	1543qr	127ab	94.1k-n

500										
Hyola 401	114.3ijk	72.5r-u	1805a	477.4tu	3.9a	3.2i-r	4178a	1177uv	101.7ij	83.6pqr
Hyola 42	121.4hi	75.5rs	1392d-g	555.4qt	3.4fgh	2.8pqr	3248f-i	1493rs	119.6cde	78.4r
Hyola 60	145.5de	67u-x	1438de	477.8tu	3.7bc	2.8pqr	3306e-h	1175uv	97.3i-m	88.4nop
Hyola 420	119.6hij	59.9xy	1306gh	808.4kl	3.6cde	3.07k-o	3038ij	2027mno	123.2a-d	97.1j-m
Hyola 330	150.1cd	98.7no	1810a	530.6q-t	3.6cde	3.2j-m	4150a	1304stu	121.6bcd	88.8nop
Hyola 308	130.6g	78.1qr	1135i	675.7nop	3.2i-l	2.8pqr	2654k	1722pq	11.1fgh	78.3r
Kimberly	139.3ef	83.3pq	1427de	529.5q-t	3.4f-i	2.9o-r	3404d-g	1388r-u	127.4ab	90.6m-p
RGS 006	113.6jk	58.03yz	1541bc	765k-n	3.4f-i	3.07k-o	3611bcd	1952mno	103.2ij	86.5opq
19-H	123.6h	89.5p	1460cd	498.6st	3.7bcd	2.9m-q	3474cde	1272tu	127.8ab	100.1ijk
Syn-3	182.9a	65.1vwx	1778a	703.8mno	3.7abc	3.2h-k	4141a	1824op	123.4a-d	97.6i-l
PR-401.16	96.5o	74.7rst	1447d	507.6rst	3.7abc	3.1j-m	3376efg	1264tuv	124.9abc	98.9i-l
PP-401.15E	114.7ijk	62.3wxy	1546bc	744.9klm	3.6cde	3.1j-m	3632bc	2010mno	129.4a	89.1nop
PP 308.8	123.4h	121.1hi	1380d-h	539.5q-t	3.4fgh	3.02l-p	3257fgh	1373r-u	123.3a-d	102.3ij
PP 308.3	137.8f	62.3wxy	1546b	832.2j-k	3.5c-f	3.08k-o	3599bcd	2138m	123.3a-d	87.5nop
ORS 3150-3006	160.5b	120.9hi	1322fgh	509.7rst	3.5d-g	2.9n-r	3126hij	1350r-u	119.3cde	101.3ij
ORS 3150-3008	141.2ef	51.7z	1631b	783.8klm	3.7abc	3.2h-k	3791b	2129m	117.4def	87.2nop
RG 4403	155bc	114.3ijk	1289h	599.1pqr	3.9a	3.1k-n	3007j	1500rs	110.3gh	102.8ij
RG 405.03	141.9ef	68t-w	1328fgh	901.1j	3.7bcd	3.1j-m	3187g-j	2385l	110.8fgh	92.9l-o
RGAS 0324	149.4cd	111.6kl	1342e-h	569.5q-r	3.8ab	3.09k-o	3151hij	1411rst	114.1efg	102.3i-j
RG 405.02	137.9f	70.5s-v	1439d	773.3klm	3.8ab	3.3h-k	3411def	2060mn	114.7efg	80.3qr

For a given means within each column of each section followed by the same letter are not significantly different ($p < 0.05$).

Table 4: Simple correlation coefficients between the studied traits (2005-2007 years).

Traits	Pod number in plant	Oil yield ($Kg.ha^{-1}$)	1000-seed weight(g)	Seed yield ($Kg.ha^{-1}$)	Plant height (cm)
Pod number in plant	1	-0.182ns	0.25ns	0.14ns	-0.223ns
Oil yield		1		0.352ns	0.023ns
1000-seed weight			1	0.442**	-0.174ns
Grain yield				1	0.077ns
Plant height(cm)					1

ns,*,** respectively: non- significant , significance in level of 5 and 1 %

References

1. Crubbens, G.T.H. and O.A. Denton, 2004. Plant Resources of Tropical Africa. Vegetables, PROTA foundation, Wageningen, Netherlands /Backhuys Publishers, leiden, Netherlands / CTA, Wageningen Netherlands, pp: 668.
2. Daly, M.J., R.J. Martin, 1988. Oilseed rape: The effect of rate, timing and form of nitrogen application on a depleted in more soil. Proc. Ann. Conf. Agron. Soc. New Zealand, 18: 97-102.
3. Harker, K.N., G.W. Clayton, R.E. Blackshaw, J.T. O'Donovan and F.C. Stevenson, 2003. Seeding rate, herbicide timing and competitive hybrids contribute to integrated weed management in canola (*Brassica napus*). Can. J. Plant Sci., 83: 433-440.
4. Hocking, P.J. and M. Stapper, 2001. Effects of sowing time and nitrogen fertilizer on canola and wheat, and nitrogen fertilizer on Indian mustard. I. Dry matter production, grain yield, and yield components. Australian Journal of Agricultural Research, 52: 623-634.
5. Horton, D.S., 2006. Determination of optimum planting date of seven species of winter oil seeds in Mississippi, The ACSSA-SSSA. International Annual Meeting. http://a-c-s.confex.com/ crops/ 2006am/tech programs tatic files/banner.jpg.
6. Hoseinie Bay, S.K., 2003. Study and determine the most appropriate planting on rapeseed cultivars. Agriculture and Natural Resources Research Letters, pp: 8.
7. Jansinka, Z., A. Kotecki, W. Malarz, A. Horodyski, B. Musnicka, C. Musnicki, M. Jodlowski, W. Budzynski, K. Majkowski, E. Wrobel and B. Sikora, 1989. Effect of sowing date and sowing rate on the development and seed yields of winter rape cultivars. Buile. Institi. Hodowli - I - Aklimatyzacji Roslin., 169: 111-119.
8. Jenkins, P.D., M.H. Leitch, 1986. Effects of sowing date on the growth and yield of winter oil seed rape (*Brassica napus* L). J. Agric. Sci. UK, 107(2): 405-420.
9. Kauser, R., H.R. Athar and M. Ashraf, 2006. Chlorophyll fluorescence can be used as a potential indicator for rapid assessment of water stress tolerance in canola (*Brassica napus* L.). *Pak. J. Bot.*, 38(5): 1501-1510.
10. Mendham, N.J., J. Russell and N.K. Jarosz, 1990. Response to sowing time of three contrasting Australian cultivars of oilseed rape (*Brassica napus* L.). J. Agric. Sci., 114: 275-283.

11. Miralles, D.J., B.C. Ferro and G.A. Slafer, 2001. Developmental responses to sowing date in wheat, barly and rapeseed. Field Crops Res., 71: 211-223.
12. Morrison, M.J. and D.W. Stewart, 2002. Heat stress during flowering in summer brassica. Crop Science, 42: 797-803.
13. Ozer, H., 2003. Sowing date and nitrogen rate effects on growth, yield and yield components of two summer rapeseed cultivars. European J. Agronomy, 19(3): 453-463.
14. Ozer, H., E. Oral, U. Dogru, 1999. Relationships between yield and yield components on currently improved spring rapeseed cultivars. Tr. J. Agric. For., 23: 603-607.
15. Potts, M.J. and W. Gardiner, 1980. The potential of spring oilseed rape in the west of Scotland. Experimental Husbandry, 36(4): 64-74.
16. Robertson, M.J., J.F. Holland, R. Bambach and S. Cawthray, 1999. Response of canola and Indian mustard to sowing date in risky Australian environment. *Proc. 10th Int. Rapeseed Congress*, Canberra, Australia, 483.
17. Singh, S.K. and Singh, Gh., 2002. Response of Indian mustard (*Brassica juncea*) varieties to nitrogen under varying sowing dates in eastern Uttar Pradesh. Ind. J. Agron., 47(2): 242-248.
18. Taylor, A.J. and C.J. Smith, 1992. Effect of sowing date and seeding rate on yield and yield components of irrigation canola growth on red-brown earth in South Eastern Australia, Aust. J. Agric. Res., 7: 1629-1641.
19. Yadav Yogesh, C., M.L. Khichar, O.P. Bishnoi and M. Niwas, Ra., 2011. Effect of sowing dates on energy balance and yield in raya (*Brassica juncea*). Indian Journal of Agricultural Research, Abs., 21(2): 2011. [Accessed: Tuesday, 04 January 2011].