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The effect of planting date and nitrogen rate on agronomical traits of spring canola cultivar

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Abstract

This paper emphasizes the importance of rapeseed (*Brassica napus* L.) to become an alternate oilseed crop in Karaj, Iran during 2007 and 2008. Four planting dates were established at about 10 day intervals from mid March to late April (21 Mar, 31 Mar, 11 Apr, and 20 Apr 2007; and 31 Mar, 11 Apr, 20 Apr, and 29 Apr 2008). Four N fertilizer rates were established (0, 60, 140, and 220 kg/ha). In both years, there were effects on plant growth, yield, and yield components due to planting dates, nitrogen rates and cultivars. Cultivars tended to respond similarly to planting date and nitrogen rate for seed yield in both years of the study. From this study, it appeared that seeding rapeseed from 31 Mar to 11 Apr gives a greater assurance for higher yields. The present results highlight the practical importance of adequate N fertilization in yield formation in summer oilseed rape and suggest that the rate of 140 N kg/ha is adequate for the crop to meet its N requirements.

Keywords: Canola; planting date; grain yield; nitrogen rate

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Introduction

Yield response of rapeseed to increasing N rate varies with different environmental variables, including weather, soil type, residual fertility (especially nitrate), soil moisture, and cultivar. Nitrogen increases yield by influencing a number of growth parameters such as branches per plant and flowers per plant and by producing more vigorous growth and development (Allen and Morgan, 1972; Taylor et al., 1991). Wright et al. (1988) working on rapeseed in Australia, reported that N prolongs the life of leaves, improves leaf area duration after flowering and increases overall crop assimilation, thus contributing to increased seed yield. On the other hand, excessive use of N fertilizer can increase lodging with yield and quality reductions (Sheppard and Bates, 1980; Bailey, 1990). Since early frosts are common and cool conditions prevail in the late winter, planting date can play a major role in determining the seed yield and quality in regions with short growing season. Numerous research studies for different climates have shown that planting date influences the growth, seed yield and quality of rapeseed (Hocking, 1993; Miralles et al., 2001). Studies by Scott et al. (1973a) showed that reduced yields in late plantings were primarily related to a significantly lower number of pods per unit area and reduced seed weight. Degenhardt and Kondra (1981) also suggested that delayed seeding resulted in a significant decrease in seed yield, harvest index, racemes per plant and racemes per unit area. To date, management practices required for optimal yield of oilseed rape have not been described for Karaj in Iran. The objective of this study was to determine the appropriate management practices for production rapeseed under Karaj conditions by evaluating the effects of planting date and nitrogen rates on grain yield of two rapeseed cultivars.

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Materials and Methods

This experiment was carried out at Karaj farm in Iran, during the seasons 2007 and 2008. In this study, two spring rapeseed cultivars, Amica and Sarigol, were used. The study involves a randomized complete block design with four replicates, conducted at two years and consisted of a factorial combination of two rapeseed cultivars, four planting dates, and four nitrogen rates. Cultivars were sown on four dates each year: 21 Mar, 31 Mar, 11 Apr, and 21 Apr 2007; and 31 Mar, 11 Apr, 20 Apr and 29 Apr 2008. First planting and following plantings were delayed by about 10 days in 2008 when compared with 2007. Nitrogen rates of 0, 60, 140 and 220 N kg/ha was tested. Nitrogen was applied as split in two application; half with planting and the remaining half at the beginning of stem elongation. N fertilizer applied as ammonium sulphate [$(NH_4)2SO_4$] form. All plots received phosphorus at 85 kg/ha as triple superphosphate at planting in both years. The area of each plot was 14 m^2 consisting of four rows, 6 m long and 50 cm apart. Seed yields were taken at maturity by harvesting the centre two rows of each plot for grain yield determination. Seed yield was adjusted to a 12% moisture basis. Fifteen plants were collected randomly from the central two rows and the following growth and variables yield component were recorded for each plot; plant height, primary branches per plant, pod number per plant. Seed oil content was determined by the Soxhlet apparatus. All data were analyzed with the SPSS. Results for each year were analyzed separately because planting dates differed between the two seasons and were presented by individual year. For statistical analyses, planting date, cultivar, and nitrogen rate effects were considered fixed. When the F-test indicated statistical significance at the P= 0.05 level, the protected least significant difference (Protected LSD) was used to separate the means.

Results and Discussion

Yield components

The study showed that the main effect of planting dates and cultivars on branch number was significant (Tables 1 and 2). In contrast to previous observations in 2007 the lowest branching was detected in first planting (21 Mar). As mentioned earlier, this was probably a result of cool conditions experienced for the planting treatment. The highest branching was obtained from first and second planting dates in 2008 compared with 2007. Mendham et al. (1981) working with rapeseed, also founded that early planted plants produced more branches. In both years, increasing rates of nitrogen usually caused larger increases in branch number of rapeseed plants (Tables 1 and 2), as has been previously reported (Allen and Morgan, 1972). Number of pods per plant is commonly a major determinant of rapeseed yield and this character is dependent on the number of flowers produced by plant. The differences in planting dates had significant influences on pod number of rapeseed genotypes. This effect varied with the study years. This difference apparently relates to the adverse effects of environmental factors, especially conditions in flowering period on 21 Mar planting in 2007. The cultivar responses for pod number in 2007 were inconsistent over planting dates. This led to significant planting date x cultivar interaction (Table 1). In 2008, the cultivars consistently gave fewer pods due to the shorter growing period and less growth before a thesis as planting date was delayed (Table 2). Cheema et al. (2001) also showed that the number of pods per plant increased with increasing rates of N.

Seed Yield

Averaged across the planting dates, cultivars, and nitrogen rates, yields in 2007 and 2008 were 1982 and 2143 (kg/ha), respectively. In general, the low yields from this study were probably due to the short growing season and high altitude. Significant yield differences occurred between cultivars in both years. In 2007 years, Amica had higher seed yield than Sarigol (Table 1). This trend was not evident in 2008 when seed yield of the cultivars was similar (Table 2). Yield response of the cultivars to planting date or nitrogen rate was consistent across the two years, as indicated by the lack of a significant planting date x cultivar or cultivar x nitrogen rate interaction for seed yield (Tables 1 & 2). With delaying planting, yield generally tended to decrease in the two years, except the first planting (21 Mar) of the 2007 growing season. In 2007, the lower seed yield of first planting compared with the second and third plantings apparently relates to low vegetative stage temperatures and unfavourable cool conditions for pollination and pod set during the flowering in 21 Mar planting. This reduction in seed yield with delaying planting has been verified in early field studies (Johnson et al., 2006). The late planting usually causes a decline in growth, leaf area and a faster maturation (Mckay and Schneiter, 1990) thus, decreasing seed yield. In 2008, seed yield increased in the first and second planting date in response to each increment of added N, but decreased with additional N from 140 to 220 N (kg/ha) in the third and fourth planting dates (Table 2). Maximum seed yields were approximately 2233 (kg/ha) in 2007 and 2518 (kg/ha) in 2008. These maxima were attained at N rate of 140 and 220 (kg/ha) in 2007 and 2008, respectively, which clearly suggest the importance of nitrogen for higher seed production in rapeseed crops. However, significant yield increases with application of nitrogen up to only

Table 1: Effected of planting date, cultivar, and nitrogen rate on agnominal traits of canola cultivar, karaj in Iran

Treatments	df	Plant height(cm)	Branch number (no. plant^{-1})	Pod number (no. plant^{-1})	Seed yield (kg.ha^{-1})	Seed oil concentration (g .ka^{-1})
Planting date (D)						
11 Mar		187c	7.2b	329.1b	1906a	456.9b
31 Mar		214b	8.4a	378.2a	2217c	476.7a
11 Apr		224a	8.3a	370.7ab	2061b	472.9a
20 Apr		226a	8.5a	345.8ab	1744d	459.7b
Cultivar (C)						
Amica		204a	8.5a	357.9a	2060a	461.9b
Sarigol		221b	8.3a	353.9b	1902b	471.2a
Nitrogen rate (N)						
0		204b	7.3a	283.0c	1519c	486.1a
60		216a	8.2b	355.4b	1965b	470.4b
140		217a	8.5b	382.4a	2233a	461.9c
220		216a	8.3b	403.0a	2209a	447.8d
CV (%)		3.2	10.3	12.28	14.5	4.4
Analysis of Variance						
D	3	**	**	**	**	**
C	1	**	**	NS	**	**
N	3	**	**	**	**	**
D * C	3	NS	*	*	NS	*
D * N	9	NS	NS	NS	NS	NS
C * N	3	NS	NS	NS	NS	NS
D * C * N	9	NS	NS	NS	NS	NS

*, ** significant at the 0.05 and 0.01 level, respectively. For each main effect, values within columns followed by the same letter are not significantly at P = 0.05. CV, coefficient of variation; NS, nonsignificant.

Table 2: Effected of planting date, cultivar, and nitrogen rate on agnominal traits of canola cultivar, karaj in Iran

Treatments	df	Plant height (cm)	Branch number (no. plant^{-1})	Pod number (no. plant^{-1})	Seed yield (kg ha^{-1})	Seed oil concentration (g.kg^{-1})
Planting date (D)						
31 Mar		140.3a	7.4 a	298.9a	2408a	492.4a
11 Apr		138.5a	7.5 a	297.8a	2394a	487.1b
20 Apr		133.6b	7.2 b	269.3b	2020b	483.2b
29 Apr		126.8c	6.7 c	221.5c	1753c	461.8c
Cultivar (C)						
Amica		131.5a	6.31a	273.4a	2150a	475.0a
Sarigol		138.0b	6.40a	270.5a	2137b	487.2b
Nitrogen rate (N) (N)						
0		127.7b	5.7 c	220.6c	1498c	497.0a
60		134.5a	6.1 c	266.4b	2097b	483.6b
140		137.0a	6.4 b	296.4a	2462a	476.9b
220		139.9c	6.7 a	304.3a	2518a	467.0c
CV (%)		5.2	8.03	13.4	10.23	4.2
Analysis of Variance						
D	3	**	**	**	**	**
C	1	**	NS	NS	NS	**
N	3	**	**	**	**	**
D * C	3	NS	NS	NS	NS	NS
D * N	9	*	NS	NS	**	NS
C * N	3	*	*	NS	NS	NS
D * C * N	9	NS	NS	NS	NS	NS

*, ** significant at the 0.05 and 0.01 level, respectively. For each main effect, values within columns followed by the same letter are not significantly at P = 0.05. CV, coefficient of variation; NS, nonsignificant.

140 (kg/ha) were observed in both seasons (Tables 1 and 2).

Seed oil concentration

Seed oil concentration varied with the study years. Increased oil concentration in the second year Apr has been related to wetter weather conditions. In both years, except the first plantings in 2007, oil concentration generally reduced as planting was delayed. The pattern was more profound in 2008. These results are consistent with those reported by Pritchard et al. (2000), who reported that high oil contents were correlated with cooler spring temperatures. Others also have found that oil content occurred when rapeseed was seeded in early Apr rather than toward the middle or end of (Johnson et al., 2006). It is likely that increased temperature and water stress during seed filling was a major cause of reduced oil concentration due to late planting (Hocking and Stapper, 2001). In 2007, the reduction in oil content of plants seeded in the first planting date (19 Mar) was thought to be result of weather factors after anthesis. In both years, higher N rates usually reduced seed oil concentration (Table1).

Conclusions

The two rapeseed cultivars (Amino and Sarigol) showed differences for nearly all variables measured. Rapeseed's yield performance in regard to planting date was distinctive for each year of this study and was largely attributed to seasonal weather differences. In general, planting rapeseed from 31 Mar to 11 Apr was optimal for Karaj. Plantings after this time usually resulted in substantial seed yield reductions. Addition of N fertilizer led to significant responses in the growth and development of rapeseed. This N rate produced near maximum seed yields. The information provided by this experiment Apr be helpful for the recommendation of optimum N rate in rapeseed production in similar climatic and soil conditions.

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