The effect of plant density and time of nitrogen application on some agronomical characteristic of rape seed (*Brassica napus* L.)

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Abstract

In order to study the effects of plant density and time of nitrogen application on some agronomical characters of rapeseed, an experiment was conducted at college of Agriculture, Shahid Chamran University of Ahvaz. The design of the experiment was a split plot in complete randomized block basis with 4 replications. In this study, main plots and sub-plots were consisted of 3 levels of plant density (60, 80 and 100 plants per m^2) and 3 times of nitrogen fertilizer application (T_1: application of nitrogen in 3 times, 1/3 at sowing date, 1/3 when stem elongation starts and 1/3 at the beginning of flowering. T_2: application of nitrogen in 2 stage: 1/3 at sowing date and 2/3 when stem elongation starts. T_3: application of nitrogen in 2 times: 1/2 at sowing date and 1/2 at stem elongation), respectively. The results showed that different levels of plant density affected the harvest index (HI), seed yield, oil yield and number of pod per m^2 significantly, but not affected number of seeds per pod and 1000 seed weight. Time of nitrogen application has significant effect on seed yield and number of pod per m^2. The Highest grain yield and oil yield (4404.4 and 1825.0 kg/ha respectively) were obtained with 100 plants per m^2 and application of nitrogen at 3 times (D_3T_1).

Key words: Rape seed, Time of nitrogen application, Plant density, Yield, Yield components

Introduction

Canola is the third most important source of plant oil in the world after soybean and palm oil. Rapeseed exports are now the second largest volume oilseed traded following soybeans. (Sovero, 1997). It is also an excellent rotation crop to control cereal diseases, pests and weeds. It has a good stable yield, which requires normal farm equipment. Presently, over 90% of vegetable oil consumed in Iran is imported from abroad. In general, Rapeseed is a new and promising oilseed crop for this region. There are agricultural opportunities to increase canola production and the expansion of canola (*Brassica napus* L.) in Iran has been dramatic. However, for newly introduced crops, it is necessary to asses the appropriate production technology to different environments. Among many of others, the nutritional requirements of the crop are considered to be the most important factor. Nitrogen (N) fertilizers play a vital role in enhancing crop yield. A higher rate of N application increases leaf area development, improves leaf area duration (LAD) after flowering and increases overall crop assimilation, thus contributing to increased seed yield (Cheema, et al., 2001). Allen and Morgan (1972) concluded that N increases yield by influencing a variety of growth parameters such as the number of branches per plant, the number of pods per plant, the total plantr weight, the leaf area index (LAI), and the number and weight pods and seeds per plant. Leach, Stevenson, Rainbow and Mullen (1999) showed the effect of high plant density in reducing the number of pods per plant as well as dry matter per plant. Moreover, they observed that at very high densities, 1000 seed mass was increased.

Materials and Methods

A field experiment was conducted in 2003-2004 at Agronomic Research Area, college of Agriculture, Shahid Chamran University of Ahvaz (31°19'N, 48°41'E), Iran. This area is situated at an elevation of 22 m above sea level. During conduction of experiment it has average minimum and maximum temperature 13.6 and 25.6, respectively. The soil at the experimental site (0-30 cm soil layers) was a silty clay loam; the pH and EC were 7.95 and 2.9 mmohs, respectively. The experiment was split-plot designs, with plant densities as the main plots and the time of nitrogen application as subplots randomized within them. The experiment was replicate four times. The area of each sub plot was 10 m^2 consisting of eight rows, 4 m long and 30 cm apart. N fertilizer applied (180 kg N ha^{-1}) as urea form. All plots received phosphorus at 110 kg ha^{-1} as phosphate de ammonium and potassium at 100 kg ha^{-1} as potassium sulfate at sowing. The crop (*Brassica napus* L var. Hyola 401) was sowing at a 25-mm seeding depth on 18 November 2003. Plots were thinned to final plant density of about 100 plants m^2 at seedling stage. A 0.8-m alley was left around each plot to avoid plot to plot N contamination during irrigation. Weeds were controlled with hand weeding or by mechanical cultivation as needed. Seed yields were taken at maturity by harvesting the center two rows of each plot for seed yield determination. Seed yield was adjusted to a 10.0% moisture basis. Eight plants were collected randomly from the central two rows and the following growth and yield component variables were recorded for each plot; plant height, number of branches per plant, pod number per plant and 1000-seed weight. Seed oil content was determined by the Soxhlet apparatus and seed N concentration by micro-Kjeldahl method. All data were analyzed with the GLM procedure using the SAS package (SAS Institute, 1996).

Result and discussion

Seed yield

The study showed that the main effect of plant densities and time of nitrogen applications on seed yield was significant (Tables 1). The seed yield increased with increasing the number of plant per m^2 up to D3 treatment (100 plant m^{-2}) so the maximum and minimum seed yield was obtained at 100 and 60 plant per m^2 by 4247.4 and 2177.2 Kg ha^{-1} respectively (Table 2). Increasing the seed yield in highest plant densities to lower was due to highest pods per m2 and higher LAI in higher plant densities (Angadi et al., 2003). As see at Table 2 application of nitrogen at 3 times (T_1) increased seed yield significantly. The higher seed yield in this treatment was largely due to higher pods per m^2. Means comparison of interactions by Duncan indicated that there was significant difference among different treatments (Table 2). Generally in each plant population level, application of nitrogen at 3 times significantly increased seed yield. Maximum and minimum seed yields were approximately 4404.4 and 1818.4 kg ha^{-1} that obtained from 100 plant per m2 and application of nitrogen at 3 times (D_3T_1) and 60 plants per m^2 and application of nitrogen at 2 times, 1/2 at sowing date and 1/2 at stem elongation, (D_1T_3) respectively. These findings clearly suggest the importance of nitrogen for higher seed production in rapeseed crops. Seed yield of rapeseed was much altered by N fertilization as suggested by Hocking et al. (1997), Cheema et al. (2001).

Harvest index (HI)

Increasing the number of plant per m^2 up to 80 plants per m^2 increased the HI significantly (Table 2). But time of nitrogen application had no significant effects on HI. highest and lkowest HI was obtained at 100 and 60 plant densities (27.5 and 17.5, respectively). Means comparison of interactions on HI by Duncan indicated that there was significant difference among different treatments. As can be seen from Table 2, at each level of plant density application of nitrogen at 3 times increased HI. This is duo to effect of nitrogen on assimilate partitioning. These results are consistent with those reported by Noreldin et al., 1993.

Oil content

The different levels of plant densities and time of nitrogen application did not affect the oil content (Table 1). Means comparison of interactions on oil content by Duncan indicated that there was significant difference among different treatments. In general use of nitrogen at the beginning of flowering (T_1) led to decreasing of oil content. This results was not surprising as similar effects have been reported (Noreldin et al., 1993; Cheema et al., 2001).

Oil yield

The study showed that the main effect of plant densities on oil yield was significant however the effects of time of nitrogen application weren't significant (Tables 1). The oil yield increased with increasing the number of plant per m^2 up to D3 treatment (100 plant m^{-2}) so the highest and lowest oil yield was obtained at 100 and 60 plant per m^2 by 1770 and 886.2 Kg ha^{-1} respectively (Table 2). Increasing the oil yield in highest plant densities to lower was due to highest seed yield in higher plant densities. Similar results were reported by many other workers (Leach et al., 1999; Prakash, and Irdormader 1981; Shaberi and Komar 1981). Means comparison of interactions on oil yield by Duncan indicated that there was significant difference among different treatments. Maximum and minimum oil yields were approximately 1825 and 763.8 kg ha^{-1} that obtained from 100 plants per m^2 and application of nitrogen at 3 times (D_3T_1) and 60 plants per m^2 and application of nitrogen at 2 times, 1/2 at sowing date and 1/2 at stem elongation, (D_1T_3) respectively. As can be seen from Table 2, at each level of plant densities application of nitrogen at 3 times increased oil yield. This is duo to effect of nitrogen on seed yield.

1000-seed weight

There were no significant differences in mean seed weight among the different levels of plant densities and time of nitrogen application (Table 1). Similar results were reported by many other workers (Munir and McNeilly. 1987; Angadi, et al. 2003). In fact the 1000-seed weight is one of the genetically controls characters.

Number of branches

The different levels of plant densities and time of nitrogen application and their interactions affect the number of branches significantly (Table 1). The number of branches decreased with increasing the number of plants per m^2 to the 100 plants m^{-2} (Table 2). Use of nitrogen at 3 times can significantly increase the number of pods per m^2 (Table 2). Use of nitrogen at the beginning of flowering in this treatment induced the plants to produce higher branches. As can be seen from Table 2, at each level of plant densities application of nitrogen at 3 times increased oil yield.

Number of pod per m^2

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 (Ozer, 2003). Significant differences in the number of pods per m^2 were observed among the different plant densities (Table 1). The number of pods per m^2 increased with increasing the number of plants per m^2 to the 100 plants m^{-2} (Table 2). These results are consistent with those reported by Angadi et al. 2003. Furthermore time of nitrogen application has significant effects on number of pods per m^2 (Table 1) and use of nitrogen at 3 times can significantly increase the number of pods per m^2. Use of nitrogen at the beginning of flowering in this treatment induced the plants to produce higher branches and greater number of pods being carried by each inflorescence. Cheema et al. (2001) also showed that the number of pods per plant increased with increasing rates of N. The interaction of treatments on number of pods per m^2 significantly influences the number of pods per m^2. The highest number of pods per m^2 was obtained from 100 plants per m^2 and use of nitrogen in 3 times (D_3T_1).

Number of seed per pod

As show in table 1, different levels of plant densities and time of nitrogen application had no significant effects on number of seed per pod. Similar results were reported by many other workers (McGregor, 1987; Angadi, et al. 2003). Means comparison of interactions by Duncan indicated that there was significant difference among different treatments. Generally the highest number of seed per pod produced at 80 and 100 plants per m^2 by use of nitrogen at 3 times (D_2T_1) and 2 times application of nitrogen in 2 stage, 1/3 at sowing date and 2/3 when stem elongation starts, (D_3T_2), respectively (Table 2).

Plant high

There were no significant differences in mean plant high among the different levels of plant densities and time of nitrogen application and their interactions (Table 1). These results are consistent with those reported by Angadi, et al. 2003.

Conclusions

Different levels of plant density affected the harvest index (HI), seed yield, oil yield and number of pod per m^2 significantly, but not affected number of seeds per pod and 1000 seed weight. Time of nitrogen application has significant effects on seed yield and number of pod per m^2.

Table 1: Summary of variance analysis of characters

S.O.V	df	Seed Yield	Harvest Index	Oil%	Oil Yield	1000-seed weight	No. of Branches	No. of Pod/m^2	No. of Seed/Pod	Plant High
R	3	$1034129.27^{n.s}$	$69.172^{n.s}$	$4.47^{n.s}$	$224584.62^{n.s}$	$0.166^{n.s}$	6.23n.s	$398268.55^{n.s}$	24.49^{*}	1927.07**
D	2	13996926.81^{**}	341.134^{*}	$6.05^{n.s}$	2531243.74^{**}	$0.073^{n.s}$	68.82**	5973002.46^{*}	$13.57^{n.s}$	190.51n.s
E(a)	6	999991.85	45.57	2.002	195886.9	0.09	3.95	1226407.8	6.66	130.48
T	2	1376610.6^{*}	$13.46^{n.s}$	$3.66^{n.s}$	$192245.35^{n.s}$	$0.038^{n.s}$	12.78**	1973859.73^{*}	$10.27^{n.s}$	18.19n.s
D*T	4	$337610.31^{n.s}$	$10.28^{n.s}$	$2.52^{n.s}$	$58532.28^{n.s}$	$0.147^{n.s}$	10.12**	1008606.21^{*}	$7.36^{n.s}$	48.83n.s
E(b)	18	424702.94	29.67	1.82	78599.99	0.058	1.45	433621.63	6.059	42.14

*.** and $^{n.s}$ significant at the 5 and 1% and Non-significant, respectively

Table 2: Means comparison of characters

Treatment	Seed Yield (kg/ha)	Harvest Index (%)	Oil%	Oil Yield (kg/ha)	1000-seed weight (gr)	No. of Branches	No. of Pod/m^2	No. of Seed/Pod	Plant High (cm)
Plant Density									
D1	2177.2b	17.5b	40.5a	886.2b	3.15a	12.4a	2794.0b	28.9a	148.9a
D2	3673.5ab	25.6a	41.9a	1544.9ab	3.14a	9.4ab	4111.6ab	29.5a	156.5a
D3	4274.4a	27.5a	41.3a	1770.0a	3.28a	6.9b	4282.8a	27.1a	157.2a
Time of nitrogen application									
T1	3762.8a	24.6a	40.6a	1545.9a	3.22a	10.8a	4181.6a	27.5a	155.0a
T2	3225.6ab	23.5a	41.4a	1338.6a	3.22a	9.6ab	3760.3ab	29.6a	152.6a
T3	3136.7b	22.5a	41.7a	1316.4a	3.12a	8.4b	3246.5b	28.4a	155.1a
Density* Time of nitrogen application									
D1T1	2530.4bc	18.6ab	38.9b	988.9bc	3.04a	14.9a	3878.8ab	24.9b	146.3a
D1T2	2182.6bc	19.0ab	41.3a	905.7bc	3.27a	12.4ab	2608.0bc	29.2ab	146.1a
D1T3	1818.4c	14.9b	41.4a	763.8c	3.15a	12.0bcd	1894.9c	27.2ab	154.4a
D2T1	4353.3a	27.2a	41.8a	1823.8a	3.08a	11.0abc	4549.8a	30.2a	159.5a
D2T2	3195.9ab	23.8ab	42.03a	1347.6ab	3.15a	9.9bcd	3912.6ab	28.8ab	153.4a
D2T3	3471.1ab	25.8a	42.05a	1463.0ab	3.18a	7.3cd	3872.1ab	29.5ab	156.7a
D3T1	4404.4a	28.0a	41.2a	1825.0a	3.35a	7.6cd	4760.0a	27.2ab	159.3a
D3T2	4298.3a	27.8a	40.9ab	1762.4a	3.25a	7.6cd	4116.0ab	30.8a	158.2a
D3T3	4120/5a	26.7a	41.7a	1722.4a	3.04a	5.6d	3972.2ab	28.6ab	154.2a

Difference of means having similar letter in each column is not significantly different (Duncan)

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