Asian Journal of Plant Sciences

ISSN 1682-3974

Asian Journal of Plant Sciences 7 (5): 500-504, 2008
ISSN 1682-3974

Canola (*Brassica napus* L.) Cultivation in Rotation after Rice under Different Levels of Nitrogen and Plant Densities

[1]S. Ghadicolaei Morteza, [2]D. Jahan Far, [3]Y. Esmaeil, [4]N. Morteza and [5]M. Saedeh
[1]Islamic Azad University, Takestan Branch, Iran
[2]Breeding and Preparation of Seed and Seedling Institute, Karaj, Iran
[3]University of Payam Nour, Iran
[4]Rice Research Institute, Amol, Iran
[5]Organization of Jihade-Agriculture of Mazandaran, Iran

Abstract: To investigate the effects of different levels of nitrogen and plant densities on agronomical traits of canola a split plot experimental design was carried out during 2005-2006 cropping season in Mazandaran rice researches institute. The canola was grown in rotation after rice in paddy field. The main plot were consisting of 4 levels of nitrogen fertilizer application i.e., 0 (control), 46, 92 and 138 kg nitrogen and the sub plot comprising 3 different levels of plant densities viz., 65, 80 and 95 plants m^{-2}. The results showed that increasing the levels of nitrogen resulted in increased canola seed yield and yield components and maximum number of pods of main stem in m^2, number of pods in sub-branch, total number of pods in m^2, number of seeds per pod, oil yield and finally seed yield was obtained with the application of maximum level of nitrogen. The results also showed that an increase in plant density from 65 to 95 plants m^{-2} resulted in increased number of days to stem initiation and plant growth period. The maximum number of days to stem initiation and plant growth period were obtained at maximum number of plant density. This result indicated that the application of 138 kg ha^{-1} nitrogen at 80 plants m^{-2} density was optimum for maximum yield of canola in rotation after rice.

Key words: Agronomical trait, canola, nitrogen fertilizer, plant density, seed yield

INTRODUCTION

Canola (*Brassica napus* L.) production after soy bean and palm is the third largest oilseed crop, producing as much as 14.7% of total vegetable edible oil in the world (Yasari *et al*., 2008). Total demand for vegetable edible oil in Iran based on 13.5 each person consumption with 70 million population reaches to 945 thousand tones per year, giving a huge drain to the economy (Yasari *et al*., 2007). Canola cultivation after rice in rotation system causes in decreasing soil erosion during winter season and absorbing the additional nitrate in the soil and decreases leaching during winter heavy rains. Canola roots penetration in paddy field causes in depletion the organic acids in the soil and changes soil phosphorous to the solution form. Canola cultivation in paddy field causes also in decreasing the possibility of infection to sclerotinia stem rot disease by breaking the life cycle of the fungi.

Canola is nitrogen demanding crop plant. Nitrogen plays vital role in its healthy growth and is one of the main precursors of protein which absorbs in the form of mineral, ammonium or nitrate by canola plant like the other crops (Hopkins and Hünter, 2004). The seed yield, total dry matter and harvest index in some genotypes of *Brassica napus* and *Brassica juncea* has been found to improve with higher rates of N (Sharma *et al*., 1997; Kumar *et al*., 2001; Cheema *et al*., 2001; Miller *et al*., 2003; Kopsell *et al*., 2004). Canola has the ability of producing branches and in low densities compensates the less numbers of plant stands by producing more branches which was reported also by Kimber and Mc Gregor (1995). Producing an acceptable seed yield however, requires certain density of the plant. Choosing an appropriate plant density in winter canola helps in efficient use of available resources such as water, light and soil nutrients. In the study of effects of sowing time and nitrogen fertilizer on canola yield, Hocking and Strapper (2001) reported a linear correlation in increasing seed and oil yield with an increased level of nutrient availability. Ali *et al*. (1990) observed that the number of pods in sub-branch and total number of pods in plant showed an increasing trend with increased in levels of nitrogen. The previous research works conducted in the area were mostly related to the dry land fields and there are rarely works investigating the canola plant density and

Corresponding Author: S. Ghadicolaei Morteza, Islamic Azad University, Takestan Branch, Iran

response to nitrogen application in rotation after rice. Therefore, the present research was carried out to evaluate the effects of different nitrogen levels and plant density in rice-canola rotation system at Mazandaran province, Iran.

MATERIALS AND METHODS

The study was carried out in paddy field in Mazandaran rice researches institute, during 2005-2006 where the latitude is 39-28 N and longitude 52-22 E with an elevation of 19.5 m above the sea level. Mean precipitation per month was 48 mm and total precipitation during the experiment was 387 mm. The experimental soil was silty-loam textually with pH of 7.51 which was slightly alkaline. The experimental design was split-plot based on randomized completely block design in three replications. The factors examined were four levels of nitrogen (0, 46, 92 and 138 kg ha^{-1} nitrogen) equal to the application of 0, 100, 200 and 300 kg ha^{-1} of urea, as main plot, respectively. Three levels of plant density at 65, 80 and 95 plants m^{-2} comprised the sub plot factors.

The area of each main plot was 5×8.2 m and that of sub plot was 5×2.4 m. There was a 3 m distance between two adjacent main plots in order for nitrogen fertilizer to prevent moving to the next plot. There was a 50 cm distance between two adjacent sub plots as well. There were 12 plots in each block and the treatments were allocated randomly to each plot. Total amount of recommended doses of P (150 kg ha^{-1}), K (100 kg ha^{-1}) and S (100 kg ha^{-1}) fertilizers based on soil physico-chemical test result was broadcasted and incorporated to the experimental soil prior to canola cultivation. Nitrogen fertilizer but was added in three splits: 1/3rd at cultivation time as basal fertilization, 1/3rd at stem initiation stage and the remaining 1/3rd was applied at bud initiation before flowering stage in accordance with the treatment variables. Data were analyzed following the analysis of variance technique (ANOVA) and the mean differences were adjudged by Duncan's Multiple Range Test (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Effects of different levels of nitrogen: The results derived from the experiment clearly showed that nitrogen is important factors in canola growth, seed yield and yield components improvement in canola plantation in rotation after rice in paddy field. It was observed that (Table 1) the number of sub-branches per plant, number of seeds per pod, number of pods in sub branch, number of pods in main stem, total number of pods in plant, oil yield and seed yield were all affected by the application of different levels of nitrogen significantly (at 0.01 level). Plant growth period also differed significantly (at 0.05 level) due to application of different levels of nitrogen. Numbers of days to stem initiation and oil percent but were not influenced significantly by the nitrogen application (Table 1). The mean comparison showed (Table 2) that increasing the levels of nitrogen application resulted in increased canola seed yield and yield components and maximum number of branches (3), number of pods in main stem m^{-2} (2600), number of pods in sub-branch (4460), total number of pods in m^{2} (7060), number of seeds per

Table 1: Analysis of variation for the studied traits

Source of variation	df	Oil yield (kg ha^{-1})	Oil (%)	No. of seeds per pod	Total No. of pod (m^{2})	No. of pods in sub-branch (m^{2})	No. of pods in main stem (m^{2})	No. of sub-branch	Plant growth period (days)	No. of days to stem initiation	Seed yield (kg ha^{-1})
Replication	2	3.17560^{ns}	71.10^{ns}	971.10^{ns}	92.193423^{ns}	92.205797^{ns}	56.24675^{ns}	36.00^{ns}	33.10^{ns}	25.75^{ns}	9.40732^{ns}
Nitrogen	3	6.2239833**	3.90^{ns}	978.38**	29.46901725**	69.27505487**	59.26369**	73.30**	77.210*	2.1030^{ns}	6.11088506**
Error	6	31.8113	3.30	337.00	72.734139	95.206544	68.261471	23.00	66.42	2.377	9.33567
Plant density	2	6.460847**	37.10^{ns}	983.30*	64.323281^{ns}	12.279072^{ns}	20.518948**	46.10**	33.241**	58.418**	7.2180413**
*Nitrogen plant density	6	7.13108**	35.00^{ns}	889.20*	7.2415895**	19.1779137**	62.87577^{ns}	16.00*	66.10^{ns}	139.11^{ns}	67.76297**
Error	16	44.810	41.00	921.00	24.256192	35.193437	40.40151	6.00	70.20	95.32	72.7895
CV (%)		16.20	36.10	48.30	61.10	69.16	39.90	60.10	78.00	96.80	18.30

**Significant at 0.01 level, *Significant at 0.05 level and ns: Non significant

Table 2: Effects of Different levels of nitrogen and plant density on the studied traits

Plant density	Nitrogen (kg ha^{-1})	Oil yield (kg ha^{-1})	Oil (%)	No. of seeds per Pod	Total No. of pod (m^{2})	No. of pods in sub-branch (m^{2})	No. of pods in main stem (m^{2})	No. of sub -branch	Plant growth period (days)	No. of days to stem initiation	Seed yield (kg ha^{-1})
	0	8.752d	4.48a	6.24d	2001c	0.571d	1430b	6.1c	0.217a	8.77a	1553d
	46	1093c	3.48a	5.27c	3869b	1877c	1992ab	1.2b	8.214a	8.65ab	2262c
	92	1553b	1.47a	5.28b	6153a	3635b	2517a	7.2a	8.208b	0.60ab	3304b
	138	1885a	3.46a	4.29a	7060a	4460a	2600a	0.3a	8.206c	5.52b	4065a
95		1099c	6.47ab	9.26b	4779a	2463a	2316a	0.2c	8.216a	6.70a	2317c
80		1469a	1.47b	6.27ab	4931a	2750a	2181a	4.2b	5.210b	3.62b	3134a
65		1394b	8.47a	0.28a	4603a	2695a	1908b	7.2a	2.208c	2.59b	2936b

Values with different letter(s) indicated significant differences from each other at 0.05 levels pod (29.4), oil yield (1885 kg ha^{-1}) and finally seed yield (4065 kg ha^{-1}) was obtained with the application of maximum level of nitrogen (138 kg ha^{-1}). The minimum value of the above mentioned characters, i.e., the minimum number of branches (1.6), the minimum number of pods in main stem (1430), the minimum number of pods in sub-branch (571), the minimum total number of pods in plant (2001), minimum number of seeds per pod (24.67), minimum oil yield (752.8 kg ha^{-1}) and finally the minimum seed yield (1553 kg ha^{-1}) resulted with no nitrogen treatment control plots. Favorable reports exist on canola seed yield by application of N fertilizer (Ozer, 2003; Hocking *et al*., 2003) and N being a structural component of nucleic acid, protein and nucleoprotein its application does favor significantly the seed yield, LAI and TDM in canola and other *Brassica* species (Lickfett *et al*., 1999). The results obtained from the present study are in conformity with those observed by Santonoceto *et al.* (2002). Behrens and Diepenbrock (2006) concluded that higher doses of nitrogen accompanied with more number of sub-branch per plant, having positive correlation with seed yield. In an investigation, Khan *et al.* (2002) suggested that the maximum number of pods in main stem resulted with maximum doses of nitrogen. Shukla *et al.* (2002) also reported that application of nitrogen fertilizer resulted significantly in higher number of seeds per siliquae, TDM, branches per plant and the length of siliquae in Indian mustard.

The results obtained from this research work however showed that increasing the level of nitrogen shortened the canola growth period whereas the maximum growth period (217 days) resulted in non-nitrogen application plots and the minimum (206 days) was observed at the maximum nitrogen level (138 kg ha^{-1}). Similarly it was observed that an increase in the levels of nitrogen accompanied by decreasing the number of days to stem initiation. The maximum number of days to stem initiation (77.8 days) was obtained at non-nitrogen fertilizer application control plots and the minimum number of days to stem initiation (52.5 days) observed at 138 kg ha^{-1} nitrogen application.

Effects of different plant density: The results in Table 1 showed that the number of sub-branches per plant, number of seeds per pod was significantly affected by the different levels of plant density (at 0.05 levels). It was further observed that the number of pods in sub-branch, total number of pods in plant, oil yield and seed yield were all significantly (at 0.01 level) influenced by the different levels of plant density. The number of pods in main stem, number of days to stem initiation, plant growth period and oil percent, however weren't affected significantly under different levels of plant density (Table 1).

The results indicated that an increase in the number of plant stand (plant density) from 65 to 95 plants m^{-2} accompanied with increased number of days to stem initiation and plant growth period (Table 2), where the maximum number of days to stem initiation (70.6 days) and plant growth period (216.8 days) were obtained at maximum number of plant density (95 plants m^{-2}). Shirani Rad and Ahmadi (2004) suggested that number of days to stem initiation increased with an increase in plant density. Yousaf and Ahmad (2002) showed that minimum number of sub-branches obtained at 10 cm row spacing where the maximum plant density was designed. They also added that maximum number of sub-branches observed at 30 cm row spacing with minimum density. Kohansal (2001) suggested that the number of pods in main stem increased with an increase in plant density but number of pods in sub-branches decreased with increased plant density, which can be related to allocation of more assimilates to the main stem rather than to the sub-stem in competitive situation. He also suggested that oil yield decreased with increase in plant density mainly because of decrease in seed yield. In the present study it was observed that the number of pods in plant, sub-branches and seed yield increased with an increase in the plant density. The maximum (4931, 2750 and 3134 kg ha^{-1}, respectively) obtained at the density of 80 plants m^{-2}, after which these values decreased with more density of plant per meter at 95 plants m^{-2}. The similar observation where also made by Masoud *et al*. (2003).

Seed oil percentage however was not significantly affected by any of the treatments at all and the changes in oil yield were mainly due to an increase in seed yield rather than an increase in oil percentage.

Interaction effects of nitrogen and plant density: The results obtained showed that the interaction effects of nitrogen and plant density were significant for the number of sub-branch, number of pods in sub stem in unit area of land, total number of pods per unit area of land, number of seeds per pod, seed and oil yield (Table 3). The maximum number of sub-branches (3.5) and number of seeds in pod (29.88) resulted with 138 kg ha^{-1} nitrogen at the density of 65 plants m^{-2}. The minimum number of these traits (1.1 and 23.60, respectively) was obtained at non-nitrogen plots at the density of 95 plants m^{-2}.

The results obtained form the study showed that maximum number of pods per sub stem in m^2 (5409), total

Table 3: Interaction effects of different levels of nitrogen and plant density on the studied traits

Plant density	Nitrogen (kg ha^{-1})	Oil yield (kg ha^{-1})	Oil (%)	No. of seeds per Pod	Total No. of pods (m^2)	No. of pods in sub-branch (m^2)	No. of pods in main stem (m^2)	No. of sub -branch	Plant growth period (days)	No of days to stem initiation	Seed yield (kg ha^{-1})
95	0	2.574i	2.48abc	6.23e	1748f	.267h	1481h	1.1e	7.219a	0.84a	1191i
80	0	4.907g	1.48abc	3.24e	2245f	6.671gh	1573gh	8.1d	3.214b	6.75ab	1884g
65	0	7.776h	9.48a	2.26d	2011f	1.774fg	1237h	9.1cd	3.210cd	0.74ab	1586h
95	46	7.921g	1.48abc	6.27bcd	3372e	1266fg	2105def	9.1cd	38.210cd	3.75ab	1914g
80	46	1191ef	0.48abc	9.26cd	4617d	2626e	1991ef	2.2bcd	7.214d	3.62cd	2484ef
65	46	1166f	8.48ab	0.28bcd	3618e	1737f	1881fg	3.2bc	0.214b	0.60cd	2388f
95	92	1226e	6.47bcd	2.27cd	5557c	2908df	2649bc	4.2b	3.213b	3.66bc	2572e
80	92	1752c	6.46de	4.29a	6879b	4182bc	2698ab	1.3a	7.207de	6.58cde	3761c
65	92	1681d	0.47cde	4.28abc	6023bc	3817bc	2206def	2.3a	3.205ef	0.55de	3579d
95	138	1673d	5.46de	5.29a	6549bc	3520cd	3029a	6.2b	0.212bc	0.57cde	3592d
80	138	2028a	9.45e	3.29ab	7871a	5409a	2462bcd	4.2b	3.205ef	6.52de	4410a
65	138	1953b	5.46de	8.29ab	6760b	4452b	2307cde	5.3a	0.203f	0.48e	4192b

Values with different letter(s) indicated significant differences from each other at 0.05 level

number of pod in m^2 (7871), oil yield (2028 kg ha^{-1}) and seed yield (4410 kg ha^{-1}) resulted at the density of 95 plant m^{-2} with 80 kg ha^{-1} nitrogen application. The interaction of different levels of N and plant density on oil percentage however was not significant. Seed yield in unit area in the present study was found to have positive and significant correlation with number of pods in main stem, sub stem as well as total number of pods in unit area of land, number of seed per pod, oil and seed yield, reflecting the response of each trait on increased seed yield. Seed yield also was found to have negative significant correlation with oil percentage. It can be concluded that the application of 138 kg ha^{-1} nitrogen at the density of 80 plants m^{-2} is the most appropriate treatment for maximum canola seed yield in paddy field in rotation system of cultivation.

REFERENCES

Ali, M.H., A.M.D. Rahman and M.J. Ullah, 1990. Effects of plant population and nitrogen on yield and oil content of rape seed (*Brassica napus* L.). Indian J. Agric. Sci., 60: 347-349.

Behrens, T. and W. Diepenbrock, 2006. Using digital image analysis to describe canopies of winter oilseed rape (*Brassica napus* L.) during vegetative developmental stages. J. Agron. Crop Sci., 192: 295-302.

Cheema, M.A., M.A. Malik, A. Hussain, S.H. Shah and A.M.A. Basra, 2001. Effects of time and rate of nitrogen and phosphorus application on the growth and the seed and oil yields of canola (*Brassica napus* L.). J. Agron. Crop Sci., 186: 103-110.

Gomez, K.A. and A.A. Gomez, 1984. Statistical Procedures for Agricultural Research. 2nd Edn. John Wiley and Sons, Inc., New York, ISBN: 0-471-87931-2, pp: 704.

Hocking, P.J. and M. Strapper, 2001. Effects of sowing time and nitrogen fertilizer on canola and wheat and nitrogen fertilizer on Indian mustard dry matter production, grain yield and yield components. Aust. J. Agric. Res., 52: 635-644.

Hocking, P.J., J.A. Mead, A.J. Good and S.M. Diffey, 2003. The response of canola (*Brassica napus* L.) to tillage and fertilizer placement in contrasting environments in southern New South Wales. Aust. J. Exp. Agric., 43: 1323-1335.

Hopkins, W.G. and N.P.A. Hünter, 2004. Introduction to Plant Physiology. 3rd Edn., Wiley John Wiley and Sons Inc., New York, ISBN: 978-0-471-38915-6, pp: 576.

Khan, N., A. Jan, I.I.A. Khan and N. Khan, 2002. Response of canola to nitrogen and sulphur nutrition. Asian J. Plant Sci., 1: 516-518.

Kimber, D. and D.I. McGregor, 1995. Brassica Oilseeds: Production and Utilization. 1st Edn., CAB. International, Wallingford UK., ISBN: 0-85198-960-8, pp: 230.

Kohansal, R., 2001. Evaluation of nitrogen and plant density impact on growth, seed yield, yield components and seed quality of canola. M.Sc. Thesis, Collage of Agriculture of Sari, University of Mazandaran, pp: 155

Kopsell, D.E., D.A. Kopsell, M.G. Lefsrud and J. Curran-Celentano, 2004. Variability in elemental accumulations among leafy *Brassica oleracea* cultivars and selections. J. Plant Nutr., 27: 1813-1826.

Kumar, A., D.P. Singh, S. Bikram and Y. Yadav, 2001. Effects of nitrogen application an partitioning of biomass, seed yield and harvest index in contrasting genotype of oilseed brassicas. Indian J. Agron., 46: 162-167.

Lickfett, T., B. Matthäus, L. Velasco and C. Möllers, 1999. Seed yield, oil and phytate concentration in the seeds of two oilseed rape cultivars as affected by different phosphorus supply. Eur. J. Agron., 11: 293-299.

Masoud, M., I. Haidar and N. Khan, 2003. Impact of row spacing and fertilizer levels (Diammonium phosphate) on yield and yield components of canola. Asian J. Plant Sci., 2: 234-456.

Miller, P.R., S.V. Angadi, G.L. Androsoff, B.G. McConkey and C.L. McDonald *et al*., 2003. Comparing *Brassica* oilseed crop productivity under contrasting N fertility regimes in the semiarid northern great plains. Can. J. Plant Sci., 83: 489-497.

Ozer, H., 2003. Sowing date and nitrogen rate effects on growth, yield and yield components of two summer rapeseed cultivars. Eur. J. Agron., 19: 453-463.

Santonoceto, C., P.J. Hoching, J. Braschkat and P.J. Randall, 2002. Mineral nutrient uptake and removal by Canola, Indian Mustard and Linola in two contrasting environments and implications for carbon cycle effects on soil acidification. Aust. J. Agric. Res., 53: 459-470.

Sharma, S.K., R.M. Rao and D.P. Singh, 1997. Effects of crop geometry and nitrogen on quality and oil yield of *Brassica* species. Ind. J. Agron., 42: 357-360.

Shukla, R.K., K., Arvind, B.S. Mahapatra and K. Basanth, 2002. Integrated nutrient management practices in relation to morphological and physiological determination of seed yield in Indian mustard (*Brassica juncea*). Indian J. Agric. Sci., 72: 670-672.

Yasari, E. and A.M. Patwardhan, 2007. Effects of (*Azotobacter* and *Azospirillum*) Inoculants and chemical fertilizers on growth and productivity of canola (*Brassica napus* L.). Asian J. Plant Sci., 6: 77-82.

Yasari, E., A.M. Patwardhan, V.S. Ghole, G.C. Omid and A. Ahmad, 2008. Relationship of growth parameters and nutrients uptake with canola (*Brassica napus* L.) yield and yield contribution at different nutrients availability. Pak. J. Biol. Sci., 11: 845-853.

Yousaf, N. and A. Ahmad, 2002. Effects of different planting densities on the grain yield of canola varieties. Asian J. Plant Sci., 4: 332-333.