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EFFECT OF ROW SPACING AND NITROGEN MANAGEMENT OF AGRONOMIC TRAITS AND OIL QUAILITY OF CANOLA (*Brassiea napus* L.)

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In a field experiment the response of canola to different row spacings and nitrogen levels was studied at the University of Agriculture, Faisalabad. Pods m^{-2} were significantly influenced by row spacings. Nitrogen levels also significantly affected all the yield components. Maximum seed yield (3083 kg ha^{-1}) was recorded at 30 cm row spacing while more seed and oil yield were obtained when the crop was fertilized @ 135 kg N ha^{-1}. Oil contents, protein percentage and fatty acid composition were also significantly influenced by different row spacings and nitrogen levels.
Key words: agronomic traits, canola, nitrogen management, oil quality, row spacing.

INTRODUCTION

Pakistan is spending a huge amount of foreign exchange on the import of edible oil. The total requirement of edible oil for 1998-99 was 1.7 million tonnes of which 32% was met from local production and remaining 68% was imported at the cost of US$ 653 million (Anonymous, 1998-99), which is a great burden on national economy. Rapeseed and mustard are the second source of edible oil after cottonseed, but their oil is of low quality due to the presence of high concentration of erucic acid and glucosinolates. Newly introduced canola cultivars with low erucic acid and glucosinolates also known as "double zero" varieties made the canola oil more popular. Besides canola oil has the lowest level of saturated and the highest level of mono- and polyunsaturated fatty acids, which reduce cholesterol level. Therefore, canola is gaining more popularity among Pakistani farmers and consumers. Being a newly introduced crop in the country, little information is available regarding its agronomic requirements. Improved varieties of canola or hybrids are capable of higher yields when grown under optimum row spacing and fertility level. Nitrogen increases yield by influencing different growth parameters such as branches per plant and flowers per plant (Alien and Morgan, 1972; Taylor et aI., 1991) and by producing more vigorous growth and development as reflected by increase in stem length, number of flowering branches, total plant weight, leaf area index (LAI) and number and weight of pods and seeds per plant (Alien and Morgan, 1972). Rapeseed sown at narrow row spacing generally produces higher seed yield than when sown in widely spaced rows. Studies on canola in Sweden (Ohlsson, 1974), (Kondra, 1975), New Zealand (Sims, 1976) and Denmark (Nordestgaard, 1979) have demonstrated maximum yield of rapeseed with minimum row spacing. However, the information on yield dynamics of canola with respect to nitrogen and row spacing is still lacking in Pakistan. Therefore, the present study was conducted to determine the effect of different row spacings and nitrogen levels on the agronomic traits, yield and oil quality of canola under the irrigated conditions of Faisalabad.

MATERIAL AND METHODS

A field study to determine the effect of different row spacings and nitrogen levels on the yield and oil quality of a canola cultivar Hyola-401, was conducted during 1999-2000 at the University of Agriculture, Faisalabad on sandy clay loam soil with an initial fertility status of 0.042% N, 9.1 ppm P_2O_5 and 13 ppm K_2O. The row spacings were 30, 45 and 60 cm while the nitrogen rates comprised 0, 45, 90 and 135 kg N ha^{-1}. Half of N and full dose of P_2O_5 (60 kg ha^{-1}) were applied as a basal dose while the remaining half N was applied at flowering. Nitrogen and P_2O_5 were used in the form of urea and single super phosphate respectively. The crop was sown on October 14, 1999 using a seed rate of 5 kg ha^{-1} and harvested on April 6, 2000. Two hand-hoeings were given to eradicate the weeds from the field. Plant population was maintained by thinning, keeping the interplant distance of 15 cm. The crop was sprayed with methamidophas @ 1.25 L ha^{-1} for sucking pests and bethroid T.M. was applied @ 1.25 L ha^{-1} for controlling the boil worms and aphids. After harvesting the crop was left in the field for sun drying and threshed thereafter manually. The experiment was laid out in a split plot arrangement randomizing the row spacings in main plots and nitrogen rates in the subplots. The net plot size measured 1.8m x 5.0m. Observations on various agronomic traits were recorded by using standard procedures. Harvest index (HI) was computed by using the following formula:

$$HI = \frac{\text{Economic yield ha}^{-1}\text{ (seed yield)}}{\text{Biological yield ha}^{-1}} \times 100$$

Seed oil contents were determined by "Soxhlet Fat Extraction Method" (A.O.A.C., 1984). Total nitrogen in seed was estimated by Gunning and Hibard's method of H_2SO_4 and distillation was made with micro Kjeldahl apparatus (Jackson, 1962). Thereafter protein was calculated by multiplying nitrogen content with 6.25. Fatty acid composition was determined by gas chromatography (Thies, 1971). The data obtained were statistically analysed using Fisher's analysis of variance technique-and treatment

means were compared by using the least significant difference test at 0.05 P (Steel and Torrie, 1984).

RESULTS AND DISCUSSION

The data pertaining to different agronomic traits, seed oil contents and protein percentage given in Table 1 revealed that the number of plants m,2 was affected significantly by different row spacings while nitrogen rates had no significant effect.. Maximum number of plants m,2 (29.75) was recorded at a row spacing of 30 cm against the minimum of 14.50 m,2 at 60 cm row spacing. Singh et a!. (1989) also reported significant decrease in number of plants m,2 with increasing row spacing.

Different row spacings and nitrogen rates significantly affected the number of pods m". Among the row spacings, 30 cm produced more number of pods m,2 (8121.11) than those of 45 and 60 cm. Higher number of pods m,2 at closer row spacing was attributed to more number of plants m,2 which ultimately increased the total number of pods m,2 (Table 1). In general, lower population increased and higher population decreased the number of pods plant'ı. These findings are in agreement with those of Ali et al. (1996). Nitrogen applied @ 135 kg ha" resulted in the maximum number of pods m,2 (7133.58) against the minimum of 4875.35 m,2 in control.. Generally, increasing rate of N increased the number of pods m". Singh et a!. (1985) also reported significant increase in pods m,2 with increasing rate of nitrogen in Indian mustard.

Number of seeds pod"' was significantly affected by different nitrogen levels while row spacings had no significant effect.. Among the N levels, the crop fertilized @ 135 kg ha" produced significantly more number of seeds pod"' (29.27) than those of control, 45 and 90 kg N ha" which produced 24.56, 25.27 and 27.39 seeds pod" respectively. Qayyum et al. (1991) also reported an increase in number of seeds pod"' with the application of N up to 120 kg ha,l. Different nitrogen levels affected the 1000-seed weight significantly while row spacings had non-significant effect.. The maximum 1000-seed weight (4.06g) was recorded in 135 kg N ha"' against the minimum (3.25g) in control, whereas 45 kg and 90 kg N ha,l gave 3.55 and 3.73 g weight per 1000 seeds respectively.

Both the row spacings and nitrogen levels had significant effects on seed yield. Among the row spacings, 30 cm produced significantly higher seed yield (3083.50 kg ha") than 45 and 60 cm row spacings which yielded 27,27.50 kg and 2428.50 kg ha" respectively. Unlike yield attributes, the number of seeds pod"' and 1000-seed weight, the seed yield was significantly higher at 30 cm row spacing or at 29.75 plants m". It may be concluded that 29.75 plants m,2 gave substantially higher seed yield because such an optimum plant density facilitated maximum utilization of nutrients and increased dry matter production which ultimately resulted in higher seed yield ha". Among the N levels, 135 kg N ha"' produced the maximum seed yield (3299.67 kg ha"). The treatment 45 kg N ha" produced 2677.33 kg ha"'. The minimum seed yield (191 1.33 kg ha") was recorded in control plots. The maximum seed yield at 135 kg N ha"' was attributed to improvement in yield attributes such as number of pods m", seeds pod" and 1000-seed weight.. Higher seed yield with increasing rate of nitrogen was also reported by Narang et al. (1993), Wojnowska (1995) and Mankotish and Sharma (1997).

Harvest index was significantly affected by row spacings and nitrogen levels. Row spacing of 30 cm gave significantly higher harvest index (23.90%) than rest of the treatments. Regarding nitrogen rates, application of 90 and 135 kg N ha"' gave significantly higher harvest index (23.26 and 23.42% respectively) than those of control and 45 kg N ha'.

Table I. Effiect of di*a*erent row spacinas and nitroaen levels on azronomic traits, seed oil content and protein contents of canola

Treatments	Number of plants m"2	Number of pods m"2	Seeds pod"'	IOOO-seed weight (g)	Seed yield (kg ha")	Harvest index (%)	Oil contents (%)	Oil yield (kg ha")	Protein percentage
A, Row spacings (cm)									
S = 30	29.75 a	8121.11 a	26.48	3.65	3083.50a	23.90 a	46.23 a	1422.89 a	19.99 c
S = 45	19.25 b	542981 b	26.57	3.65	2727.50b	22.28 b	45.55 b	1237.75 b	20.08 b
S = 60	14.50 c	4250.92 c	26.76	3.66	2428.50c	20.82 c	44.67 c	107631 c	20.42 a
LSD (P=0.05)	1.035	730.7	NS	NS	54.07	0.46	0.20	23.93	0.01
B. Nitrogen levels (kg/ha")									
N = control	20.66	487535 d	24.56 c	3.25d	1911J3d	20.12 c	46.77 a	894.91 d	19.90 d
N = 45	20.66	548533 c	25.27 be	3.55c	267733c	22.53 b	45.97 b	1232.50 c	20.05 c
N = 90	21.33	6241.52 b	2739 ab	373 b	3097.67b	23.26 a	45.20 c	1401.77 b	20.08 b
N = 135	22.00	7133.58 a	29.27 a	4.06 a	3299.67a	2341 a	44.00 d	145346 a	20.61 a
LSD (P=0.05)	NS	5503	2.668	0.044	2735	0.050	0.16	11,73	0.01

Any two means not sharing a letter differ significantly at 0.05 P.

Oil Yield (kg ha"): Oil yield was significantly affected by both row spacinr,s and nitrogen levels. Maximum oil yield (1422.89 kg ha') was obtained at closer row spacing (30 cm), against the minimum (1076.31 kg ha") at 60 cm row spacing. Increase in oil yield ha"' at narrow row spacings was attributed to more seed yield ha" (Table 1) than the wider row spacings (60 cm). These findings are in conformity with those of Ali et al. (1996). Regarding N levels, maximum oil yield (1453 kg ha") was obtained when the crop was fertilized @ 135 kg N ha", which could be ascribed to more seed yield ha",

Seed Oil and Protein Contents: Oil and protein contents were significantly affected by different row spacings and nitrogen levels. Maximum oil contents (46.23%) were

recorded at narrow row spacing (30 cm) against the minimum (44.67%) at wider row spacing (60 cm). By contrast, increasing rate of nitrogen decreased oil contents. Protein contents were also significantly affected by row spacings and nitrogen levels. For each successive increase of N rate, there was significant increase in protein content but it negatively affected the oil contents. It appeared that protein contents increased with increasing rate of N which showed inverse relationship with oil content.. Patil and Bhargava (1989) reported similar results with N in respect of oil and protein contents of *Brassica juncea*.

Table 2. Effect of different row spacings and nitrogen levels on fatty acid composition (%) of canola

Treatments	Palmitic acid	Stearic acid	Oleic acid	Linoleic acid	Linolenic acid	Erucic acid
A. Row spacings (cm)						
S = 30	3.943 a	0.692 a	66.63 a	16.27 c	9.94 c	0.4375 a
S = 45	3.682 b	0.675 b	66.07 b	17.49 b	9.98 b	0.4175 b
S = 60	3.392 c	0.565 c	65.36 c	18.26 b	10.32 a	0.4025 c
LSD (P=0.05)	0.03	0.11	0.28	0.01	0.01	0.01
B. Nitrogen Levels (kg ha^{-1})						
N = control	3.840 a	0.670 a	67.28 a	16.78 d	9.87 d	1.047 a
N =45	3.670 b	0.650 b	65.76 b	17.28 c	10.07 c	0.220 b
N =90	3.640 c	0.630 c	65.61 b	17.43 b	10.09 b	0.210 c
N = 135	3.540 d	0.627 c	65.43 b	17.88 a	10.29 a	0.200 d
LSD (P=0.05)	0.009	0.009	0.44	0.03	0.009	0.009

Any two means not sharing a letter differ significantly at 0.05 P.

Fatty Acid Composition: The data regarding fatty acid composition presented in Table 2 showed that palmitic acid content increased significantly with increase in row spacing (Table 2). Increasing rate of N up to 135 kg ha^{-1} significantly reduced the palmitic acid content from 3.84 to 3.54%. These results corroborated with the findings of Joshi et al, (1998).

An increase in row spacing significantly decreased stearic acid content.. Increasing rate of N application up to 135 kg N ha^{-1} decreased stearic acid content from 0.67 to 0.62%. Different row spacings and nitrogen levels affected significantly oleic acid content.. Increasing row spacing up to 60 cm significantly decreased oleic acid content from 66.63 to 65.36%. Increasing rate of N application also significantly reduced oleic acid content (Table 2). Linoleic acid contents increased with an increase in row spacing. The highest percentage of linoleic acid (18.26) was recorded at 60 cm row spacing against the lowest (16.27%) at 30 cm. Increasing rate ofN application up to 135 kg ha^{-1} increased linoleic acid content (Table 2).

Increase in row spacing significantly increased linolenic acid content.. Maximum linolenic acid (10.32%) was produced at 60 cm row spacing and the minimum (9.94%) at 30 cm row spacing. Increasing rate ofN application up to 135 kg ha^{-1} also significantly increased linolenic acid content.. Erucic acid was affected significantly by different row spacings and nitrogen levels. Increase in row spacing markedly reduced the erucic acid content.. The highest erucic acid content (0.43%) was obtained at 30 cm row spacing followed by 45 cm row spacing (0.4 1%) against the lowest (0.40%) at 60 cm spacing (Table 2).

Conclusion: The canola crop should preferably be grown at 30 cm row spacing and fertilized @ 135 kg N ha^{-1} under the agroecological conditions' of Faisalabad for obtaining maximum seed yield ha^{-1}.

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