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Agro-Economic Assessment of Canola Planted under Different Levels of Nitrogen and Row Spacing

MUHAMMAD SALEEM, MUMTAZ AKHTAR CHEEMA AND M. ASGHAR MALIK
Department of Agronomy, University of Agriculture, Faisalabad–38040, Pakistan

ABSTRACT

A field experiment was carried out to determine the agro-economic response of canola to different levels of nitrogen and row spacing. The experimental treatments comprised of three row spacings viz., 30, 45 and 60 cm and four nitrogen levels i.e. 0, 45, 90 and 135 kg ha^{-1}. The yield and yield attributes were significantly influenced both by row spacing and nitrogen levels. The maximum net income of Rs. 30055.31 ha^{-1} with benefit-cost ratio of 2.68 was obtained when the crop was fertilized @ 135 kg N ha^{-1}.

Key Words: Agro-economic assessment; Canola; Nitrogen; 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 tons of which 32% came from local production and remaining 68% was imported at the cost of 653 million US$ (Anonymous, 1999). This imposes a severe threat to national economy. Rapeseed and mustards are the second source of edible oil after cotton seed (Anonymous, 1999), 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, it has the lowest level of saturated and highest level of mono and polyunsaturated fatty acids, which reduce cholesterol level. Therefore, canola is gaining more popularity among Pakistani farmers. Being a newly introduced crop in the country, meager information on its agronomic aspects is available. Improved varieties of canola or hybrids are capable of yielding higher when grown under optimum row spacing and fertility level. Nitrogen is one of the important nutrient elements affecting the yield attributes and yield of Indian mustard (Saini *et al.*, 1989). Nitrogen increases yield by influencing a variety of growth parameters such as branches $plant^{-1}$, flowers $plant^{-1}$ (Allen & Morgan, 1972; Taylor *et al.,* 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 $plant^{-1}$ (Allen & Morgan, 1972). Rapeseeds sown at narrow row spacing generally produces higher seed yields than when sown in more widely spaced rows. Studies in Alberta (Kondra, 1975), Denmark (Nordestgaard, 1979), Sweden (Ohlsson, 1974) and New Zealand (Sims, 1976) have demonstrated maximum yields of rapeseed with minimum row spacing. However, not much information is available on spacing pattern and nitrogen requirement of canola in Pakistan. The present study was, therefore, designed to develop proper row spacing and optimum nitrogen rate for successful cultivation of canola under the agro-ecological conditions of Faisalabad.

MATERIALS AND METHODS

A field study to determine the effect of different row spacing and nitrogen levels on the agronomic traits of canola cultivar Hyola-401 was conducted at the University of Agriculture, Faisalabad on sandy clay loam soil with 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}. The experiment was laid out in a split plot arrangement randomizing the row spacings in main plots and nitrogen rates in the sub-plots. The net plot size measured 1.8 m x 5.0 m. Half N and full P_2O_5 (60 kg ha^{-1}) were applied as a basal dose and remaining half N was applied at flowering. N and P_2O_5 were used in the form of urea and single super phosphate. The crop was sown on Oct. 14, 1999 using a seed rate of 5 kg ha^{-1} and harvested on April 6, 2000. Two hoeings were given to keep the crop free of weeds. Plant population was maintained by thinning, maintaining an 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 bollworms and aphids. After harvesting, the plants were left in the field for sun drying for about a week then threshed manually. Observations on various yield and yield parameters were recorded by using standard procedures. Harvest index (HI) was computed by using the following formula:

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

Biological yield ha^{-1}

Seed oil contents were determined by Soxhlet Fat Extraction Methods (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 with 6.25.

The experimental data were analyzed by using the methodology described in CIMMYT (1988). Net benefits were calculated by subtracting the total variable cost from the total benefits for each treatment. Input and output cost for each treatment was converted to Rs. ha^{-1}. The data obtained were statistically analyzed using Fisher's analysis of variance technique and treatment means were compared by using the least significant difference test at 0.5% P (Steel & Torrie, 1984).

RESULTS AND DISCUSSION

The data pertaining to different agronomic traits, seed oil and protein contents are given in Table I. The number of plants m^{-2} was affected significantly by different row spacings while nitrogen rates had non-significant effect. Maximum number of plants m^{-2} (29.75) was recorded at narrow row spacing of 30 cm row against the minimum (14.50) at 60 cm row spacing, and 9.25 at 45 cm. Singh *et al.* (1989) also reported significant decrease in number of plant m^{-2} with increasing row spacings.

Number of pods m^{-2}. The different row spacings and nitrogen rates significantly affected the number of pods m^{-2}. Among the row spacings, 30 cm produced more number of pods m^{-2} (8121.11) than that of 45 and 60 cm. More number of pods m^{-2} at closer row spacing was attributed due to more number of plants m^{-2}, which ultimately increased the total number of pods m^{-2} (Table I). These findings are in agreement with those of Ali *et al.* (1996).

Nitrogen applied @ 135 kg ha^{-1} resulted in maximum number of pods m^{-2} (7133.58) against the minimum (4875.35) in control. Generally increasing rate of N increased the number of pods m^{-2}. Singh *et al.* (1985) also reported an increase in pods m^{-2} with increasing nitrogen rates in Indian mustard.

Number of seeds pod^{-1}. Number of seeds pod^{-1} was also affected significantly by different nitrogen levels. While row spacings were found to be non-significant. Among the N levels, the crop fertilized @ 135 kg ha^{-1} produced significantly more number of seeds pod^{-1} than that of control, 45 and 90 kg ha^{-1} producing 29, 24, 25 and 27 number of seeds pod^{-1}, respectively. Qayyum *et al.* (1991) also recorded a linear increase in number of seeds pod^{-1} with the application of N up to 120 kg ha^{-1}.

1000-seed weight. 1000-seed weight was significantly affected by different nitrogen levels, while row spacings had no significant effects. Maximum 1000-seed weight (4.06 g) was recorded at 135 kg N ha^{-1} against the minimum (3.25 g) at control. Whereas, 45 and 90 kg N ha^{-1} gave 3.55 and 3.73 g per 1000-seeds, respectively. Similar results were reported by Sharma and Kumar (1990).

Seed yield ha^{-1}. Row spacings and nitrogen levels had significant effects on seed yield ha^{-1}. Among the row spacings, 30 cm produced significantly higher seed yield (3083.50 kg ha^{-1}) while 45 and 60 cm row spacings gave 2727 and 2428 kg ha^{-1}, respectively. Unlike yield attributes like number of seeds pod^{-1} and 1000-seed weight, the seed yield was significantly higher at 30 cm row spacing or at 29 plants m^{-2}. It may be concluded that 29 plants m^{-2} or 222222 plants ha^{-1} is an optimum plant density which made maximum utilization of nutrients, increased dry matter production and these resulted in higher seed yield ha^{-1}. These results are similar to the findings of Sharif *et al.* (1990) who observed significant increase in yield at higher plant density. Among the N levels, 135 kg N ha^{-1} produced maximum seed yield (3299.67 kg ha^{-1}) followed by 90 kg N ha^{-1} that gave 3097.67kg ha^{-1} against the minimum of 1911.33 kg ha^{-1} in control. Maximum seed yield at 135 kg N ha^{-1} was attributed to improvement in yield attributes, such as number of pods m^{-2}, seeds pod^{-1}, 1000-seed weight.

Table I. Effect of different row spacings and nitrogen levels on yield attributes, seed yield, oil and protein contents of canola

Treatment	Number of plant m^{-2}	Number of pods m^{-2}	Seeds pod^{-1}	1000-seed weight (g)	Seed yield (kg ha^{-1})	Harvest index (%)	Oil contents(%)	Oil yield (kg ha^{-1})	Protein percentage
A. ROW SPACINGS (cm)									
S_1 = 30	29.75 a	8121.11 a	26.48	3.653	3083.50a	23.90 a	46.23 a	1422.89 a	19.99 c
S_2 = 45	19.25 b	5429.81 b	26.57	3.65	2727.50b	22.28 b	45.55 b	1237.75 b	20.08 b
S_3 = 60	14.50 c	4250.92 c	26.76	3.66	2428.50c	20.82 c	44.67 c	1076.31 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^{-1})									
N_0=control	20.66	4875.35 d	24.56 c	3.25 d	1911.33d	20.12 c	46.77 a	894.91 d	19.90 d
N_1= 45	20.66	5485.33 c	25.27bc	3.55 c	2677.33c	22.53 b	45.97 b	1232.50 c	20.05 c
N_2 =90	21.33	6241.52 b	27.39 ab	3.73 b	3097.67b	23.26 a	45.20 c	1401.77 b	20.08 b
N_3 = 135	22.00	7133.58 a	29.27 a	4.06 a	3299.67a	23.42 a	44.00 d	1453.46 a	20.61 a
LSD (P=0.05)	NS	550.3	2.668	0.044	27.35	0.050	0.16	11.73	0.01

Means in a column having different letter differ significantly at ($P \leq 0.05$)

Increase in seed yield with increasing level of nitrogen was also observed by Narang *et al.* (1993), Wojnowska (1995) and Mankotish and Sharma (1997).

Harvest index. HI was significantly affected by row spacings and nitrogen levels. The row spacing of 30 cm gave significantly higher HI (23.90%) than rest of the treatments. Regarding nitrogen rates, application of 90 and 135 kg N ha^{-1} gave significantly higher HI (23.26 and 23.42%, respectively) than that of 45 kg N ha^{-1} and control.

Oil yield (kg ha^{-1}). Oil yield was also significantly affected by both row spacings and nitrogen levels. Maximum oil yield (1422.89 kg ha^{-1}) was obtained at closer row spacing (30 cm), against the minimum of 1076.31 kg ha^{-1} at 60 cm row spacing. Increase of oil yield ha^{-1} at narrow row spacings was attributed to increased seed yield (Table I) over the wider row spacing (60 cm). These findings are in conformity with those of Ali *et al.* (1996). Similarly, maximum oil yield (1453 kg ha^{-1}) was obtained when the crop was fertilized @ 135 kg N ha^{-1}.

Seed oil and protein contents. Seed oil and protein contents were significantly affected by row spacings and different 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). Similarly, increasing rate of nitrogen decreased oil contents. Protein contents were also significantly affected by row spacings and nitrogen levels. Maximum protein contents (20.42%) were recorded at 60 cm row spacings while 30 cm row spacings produced minimum (19.91%). For each successive increase of N rate, there was significant increase in protein content but it negatively affected the oil contents. Higher and lower protein contents of (20.61%) and (19.90%) were recorded at N_{135} and N_0 kg ha^{-1}, respectively. Thus, it appeared that protein content increased with increasing N inputs, which showed inverse relationship with oil content. Patil and Bhargava (1989) obtained similar results with N in respect of oil and protein content of *Brassica juncea*.

Economic analysis

The economic analysis (Table II) indicated the maximum net income (Rs. 20055.31 ha^{-1}) in N_4 treatment (135 kg N) with benefit-cost ratio of 2.68. Cheema (1999) also reported higher benefit-cost ratio at 90 kg N ha^{-1}.

Table II. Economic analysis of canola as affected by different nitrogen levels during 1999-2000

Treatments	GI Rs. ha^{-1}	Total expenditure	Net income (Rs. ha^{-1})	BCR
N_0	23891.62	9136.22	14755.40	1.62
N_1	33466.62	9821.00	23645.62	2.41
N_2	38720.88	10505.78	28215.10	2.68
N_3	41245.88	11190.57	30055.31	2.68

N_0 (control; N_1 (45 kg N ha^{-1}); N_2 (90 kg N ha^{-1}); N_3 (135 kg N ha^{-1}); GI= Gross income; BCR= Benefit-cost ratio

REFERENCES

A.O.A.C., 1984. *Official Methods of Analysis.* Association of Official Agricultural Chemists, 14th Ed. Arlington, Virginia, USA.

Ali, M.H., S.M.H. Zaman and S.M.A. Hussain, 1996. Variation in yield, oil and protein content of rapeseed (*Brassica compestris* L.) in relation to levels of nitrogen, sulphur and plant density. *Indian J. Agron.,* 41: 290–95.

Allen, E.J. and D.G. Morgan, 1972. A quantitative analysis of the effect of nitrogen on the growth, development and yield of oilseed rape. *J. Agri. Sci., Cambridge,* 78: 315–24.

Andersson, B. and A. Bengtsson, 1992. Influenced of row spacing, tractor hoeing and herbicide treatment on weeds and yield in winter oil seed rape (*Brassica napus* L.). *Swedish J. Agric. Res.*, 4 22: 19–27.

Anonymous, 1999. *Economic Survey of Pakistan, 1998-99.* Ministry of Food, Agriculture and Livestock, Finance division, Economic Advisor's Wing, Islamabad, Pakistan. pp. 11–2.

Cheema, M.A., 1999. Production efficiency of canola (*Brassica napus* L.) cv. Shiralee under different agro-management practices. *Ph.D. Thesis,* Univ. Agric., Faisalabad.

CIMMYT, 1998. *From Agronomic Data to Farmer Recommendation: An Economic Training Manual.* Mexico. D.F. 25–33.

Jackson, M.C., 1962. *Soil Chemical Analysis.* Constable & Co. Ltd., London. pp. 183–92.

Kondra, Z., 1975. Effects of row spacing and seeding rate on rapeseed. *Canadian J. Plant Sci.,* 55: 339–41.

Mankotish, B.S. and H.L. Sharma, 1997. Yield attributes and yield of gobhi sarson (*Brassica napus* L.) and toria (*Brassica rapa*) under different levels of nitrogen, phosphorus and farm yard manure in mid-hills of north-western Himalayas. *Indian J. Agri. Sci.,* 67: 106–9.

Narang, R.S., S.S. Mahal and M.S. Gill, 1993. Nitrogen, phosphorus and sulphur utilization in Toria (*Brassica compestris* L.) as affected by moisture availability. *Fertilizer News,* 58: 27-29. (Field Crop Absts., 48(8): 770; 1995).

Nordestgaard, A., 1979. Different sowing rates and row spacings for spring rape. *Field Crop Absts.,* 9303-1983.

Ohlsson, I., 1974. Row spaces in spring sown oilseed crops. *Proc. Int. Rapskongress,* 4, Crissen, West Germany. 212-15.

Patil, B.N. and S.C. Bhargava, 1989. Seed quality studies in rapeseed mustard in relation to nitrogen nutrition. *Ann. Pl. Phys.,* 1: 81–7.

Qayyum, S.M., A.H. Ansari, M.I. Sohu, N.S. Arain and M.A. Avain, 1991. Influence of nitrogen levels on the growth and yield of rape (*Brassica napus* L.). *J. Agric. Res., Lahore,* 29: 473–80.

Saiw, J.S., T.S. Sahota and A.S. Dhillon, 1989. Agronomy of rapeseed and mustard and their place in new and emerging cropping systems. *J. Oilseeds Res.,* 6: 220–67.

Sharma, D.K. and A. Kumar, 1990. Effect of N on yield, uptake, recovery and nitrogen use efficiency of mustard under different irrigation schedulings. *J. Indian Soc. Soil Sci.,* 38: 229–32.

Sharif, S.A.,R. Shabana, A.F.Ibrahim and G. Geisler, 1990. Variation in seed yield and quality characters of four spring rapeseed cultivars as influenced by population arrangements and densities. *J. Agron. Crop Sci.,* 165: 103–9.

Sims, R.E.H., 1976. Effect of planting pattern and sowing method on the seed yield of safflower, oilseed rape and Lupin. New Zealand J. *Exp. Agric.,* 4: 185–9.

Singh, D., J.S. Deol, P. Singh, D. Singh, P. Singh, G.S. Dhaliwal, A. Arora , N.S. Randhawa and A.K. Dhawan, 1998. Effect of nitrogen and spacing on growth, yield and quality of transplanted gobhi sarson (*Brassica napus* L.). Ecological agriculture and sustainable development, Volume 1. *Proceedings of an International Conference on Ecological Agriculture, Towards Sustainable Development,* Chandigarh, India, 15-17 November, 1997, 387-93.

Singh, R.P., Y. Singh, J.P. Singh and Y. Singh, 1989. Effect of varieties row spacings and plant densities on growth and yield of mustard under dryland conditions. *J. Oilseeds Res.,* 6: 349–52.

Singh, S.M., D.R. Dahiya and R.P. Singh, 1985. Effect of varying rectangularies, nitrogen and varieties on the yield and yield attributes of mustard. *Indian J. Agron.,* 31: 76–83.

Singh, T.P. and H.P. Singh, 1984. Response of Indian rape (*Brassica campestris* L.) var. Toria to planting density, nitrogen and sulphur. *Indian J. Agron.,* 29: 539–42.

Steel, R.G.D. and J.H. Torrie, 1984. *Principles and Procedures of Statistics.* McGraw Hill Book Co. Inc. Singapore. pp. 172–7.

Toylar, A.J., C.J. Smith and I.B. Witson, 1991. Effect of irrigation and nitrogen fertilizer on yield, oil content, nitrogen accumulation and water use of canola (*Brassica napus* L.). *Fertilizer Res.,* 29: 249–60.

Wojnowska, T., H. Panak and S. Sienkiewicz, 1995. Reaction of winter oilseed rape to increasing levels of nitrogen fertilizer application under conditions of ketrzyn chernozem. *Rosling Oleiste, Poland,* 16: 173–80.

Wright, G.C., C.J. Smith and M.R. Woodroofe, 1988. The effect of the irrigation and nitrogen fertilizer on rapeseed (*Brassica napus* L.) production in south easter Australia. Growth and seed yield. *Irrigation Science,* 9: 1–13.

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