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EFFECT OF SOURCE AND METHOD OF NITROGEN FERTILIZER APPLICATION ON SEED YIELD AND QUALITY OF CANOLA (*Brassica Napus* L).

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A field experiment was conducted at Agronomic Research Area, University of Agriculture, Faisalabad during 2001-2003 to investigate the effect of different N source (urea, calcium ammonium nitrate and ammonium sulphate) and method of application (broadcast, drilling below seed and side placement) on seed yield and quality of canola (*Brassica napus* L). Effect of sources of N on yield and yield components was non-significant where as that of method was significant Drilling below seed and side placement increased seed yield up to 21.10 and 15.97 % and protein up to 16.45 and 15.93 % and oil yield up to16.37 and 11.37% over broadcast method, respectively.
Key Words: Nitrogen fertilizer, application methods, growth, seed yield and oil yield, canola.

INTRODUCTION

Pakistan is facing an acute shortage of edible oil and 70% of the country's requirements are met through import costing huge amount of foreign exchange as edible oil is the single largest food import item in Pakistan (Aslam *et al.,* 1996). Local contribution is 31% and remaining 69% was fulfilled through import (Anonymous, 2005-06).

Canola (*Brassica napus* L) is a specific type of rape seed associated with high quality oil and meal. It has less than 2% erucic acid and its meal has less than 30 u g of glucosinolates. It contains 40-45% oil and 36-40% protein in meal. The oil and meal are now very acceptable as alternative to soybean oil and meal (Amin and Khalil, 2005).

Newly introduced canola cultivars with low erucic acid and glucosinolates made the canola oil more popular and it is gaining more popularity among the farmer's community. Traditional brassica species like sarson, raya and taramera are being grown successfully on marginal lands and barren areas which can easily be replaced by canola type varieties as its production potential is higher than other rapeseed group.

In addition to various factors, growing of canola on marginal and infertile land is the major factor drastically affecting per unit yield. Efforts on the proper mineral nutrition from proper source, keeping in view the environmental concern, are need of the hour in order to be self sufficient in edible oil production.

Amongst the major elements N plays key role in growth of plant and it increases protein synthesis, protoplasm, greater cell size, photosynthetic activity and thus provides a huge frame on which more flowers and pods are produced (Beech and Norman, 1964). Nitrogen increases yield by influencing a variety of growth parameters such as branches, buds and flowers plant^{-1} (Allen and Morgan, 1972). Nitrogen uptake and yield was greater when N was applied as band placement than from broadcast method (Tomer and Soper, 1981). The sub-surface placement of N-fertilizer resulted in significantly higher yield and leaf N-contents due to decreased NH_4 volatilization and immobilization of surface applied N-fertilizer (Mengel *et al.*, 1982).Yields were significantly higher from ammonium nitrate than from top dressed urea N-sources (Bandel *et al.,* 1980) Rechcigl and Colon (2000) studied the influence of nitrogen sources i.e. ammonium nitrate and ammonium sulphate and sulfur fertilizer on bahigrass production and quality. Highest yields were obtained with ammonium-sulphate as compared to ammonium nitrate. Fox *et al.* (1986) concluded that side dress applications of N resulted in more efficient N fertilizer utilization with all N-sources. Cheema *et al.* (1997) investigated in his study that side drilling method approved to be better for attaining high quality seed and yield of canola. Thus the opinion of early workers is controversy and the present study was conducted to determine a suitable source and method of nitrogen application on quality and production of canola crop under agro-ecological conditions of Faisalabad (Pakistan).

MATERIALS AND METHODS

The experiment was laid out in randomized complete block design (RCBD) with split plot arrangement consisting of 3 replications, having a net plot size of

2.7m x 5m. Canola variety "Zafar-2000" was used as a test crop. The experiment consisted of three nitrogen sources i.e. urea, calcium ammonium nitrate and ammonium sulphate and three fertilizer application methods i.e. broadcast, below seed and side placement application. Sources of nitrogen fertilizer were kept in main plots and methods of fertilizer application in sub plots. N and P were applied @ 90 and 60 kg ha^{-1}, respectively. All the P and half of N were applied at sowing while remaining half N was applied at early flowering with 2nd irrigation. Canola crop was sown on 3rd October 2001 and 6th October 2002 using seed rate of 5 kg ha^{-1} in 30 cm apart rows. All agronomic practices were kept uniform and normal for all the treatments. Crop was harvested on 18th and 23rd April 2002 and 2003, respectively when about 60% of the siliqua turned brown. Later on crop was threshed manually and Oil content of seed was estimated by the NMR test (Robertson and Morrison,1979). For this purpose seed samples from each plot were taken randomly, grinded and subjected to chemical analysis by using Gunning and Hibbard's method of H_2SO_4 digestion and using micro Kjeldahl's method for distillation (AOAC, 1990). Available N % age was determined and multiplied by a constant factor of 6.25 for protein contents in the seed.

The data were statistically analyzed by MSTAT-C (Freed and Eisensmith, 1986). Analysis of variance techniques were employed to test the overall significance of the data, while the least significant difference test (LSD) at p=0.05 was used to compare the treatment's means (Steel and Torrie, 1984).

RESULTS AND DISCUSSION

Number of Siliquae plant^{-1}

Number of siliquae plant^{-1} is known as an important yield determining factor. The number of siliquae plant^{-1} was not significantly affected by source of N- fertilizer in both the seasons (Table-1). However, significant difference in the number of siliquae plant^{-1} was observed among various fertilizer application methods. Maximum number of siliquae plant^{-1} (869.7) was recorded in drilling below seed treatment followed by side placement method. It was due to less loss of N and more availability in moist root zone where as in broadcast method losses were higher which eventually reduced N fertilizer efficiency. Similarly Majeed (1991) and Shahzad (2003) observed an increase in number of siliquae plant^{-1} when nitrogen was applied at the depth of 3-4 cm.

Number of seeds siliqua^{-1}

The results (Table-1) showed that the number of seeds siliqua^{-1} was not significantly affected by different sources of N-fertilizer in both the seasons. In contrast, significant difference was recorded in the number of seeds siliqua^{-1}among various methods of N-fertilizer application. In 2001-02 season, drilling below seed technique produced significantly higher number of seeds (21.58) which was statistically at par with side placement method while the lowest seeds siliqua^{-1} (19.71) were produced by broadcast treatment Similar trend was observed in second year of study. More seeds per siliqua under below seed drilling were due to enough supply of N to healthy siliquae. These results are confirmed by Shahzad (2003) who reported similar results in his studies.

1000-seed weight (g)

The 1000-seed weight was not significantly influenced by different sources of N-fertilizer during both the seasons of study (Table-1). In contrast, significant difference was recorded in methods of N-fertilizer. In 2001-02 the highest seed weight (3.65g) was recorded in drilling below seed method, which was statistically at par with side placement method (3.63g), while the lowest seed weight (3.51g) was recorded in broadcast method. Similar results were observed in 2002-03. More 1000-seed weight in drilling below seed method was due to enough and rapid supply of N to the crop against the other methods which enhanced the seed size due to healthy siliquae. Similar results were observed by Wahid (2003) in canola.

Seed yield (kg ha^{-1})

Sources of N-fertilizer did not enhanced seed yield of canola significantly in both the seasons, however, different methods of nitrogen application had significant effect on seed yield of canola. In 2001-02 the maximum seed yield (2695 kg ha^{-1}) was attained in drilling below seed method which was statistically at par with side placement method, while the minimum seed yield (2267 kg ha^{-1}) was recorded in broadcast method. A similar trend was noted in 2002-03. The higher seed yield in drilling below seed and side placement over broadcast method was due to greater number of siliquae plant^{-1}, seeds siliqua^{-1} and heavier 1000-seed weight which eventually enhanced seed yield (Table-1).This conclusion is also supported by the early workers (Tomar and Soper, 1981 and Riedell *et al.*, 2000).

Seed protein content

Source of N-fertilizer had no significant effect on seed protein in 2002-03 but it had significant effect on seed protein during 2001-02 season. Highest seed protein (23.53%) was produced by calcium ammonium nitrate fertilizer which was statistically at par with ammonium

Table. 1. Yield and yield components of canola as effected by different sources and methods of nitrogen application

Treatment	Siliquae plant^{-1}		No. of seeds siliqua^{-1}		1000-seed weight (g)		Seed yield (kg ha^{-1})	
	2001-02	2002-03	2001-02	2002-03	2001-02	2002-03	2001-02	2002-03
S1	836.6 NS	845.6 NS	20.77NS	21.83NS	3.59 NS	3.62 NS	2528 NS	2432 NS
S2	846.0	847.5	20.80	21.96	3.59	3.60	2555	2401
S3	827.0	837.5	20.78	21.49	3.60	3.62	2501	2425
CD (P=0.05)	-	-	-	-	-	-	-	-
M1	777.0b	783.9b	19.71b	20.91b	3.51b	3.52b	2267b	2140c
M2	862.4a	879.2a	21.58a	22.69a	3.65a	3.68a	2695a	2637a
M3	870.1a	867.6ab	21.05a	22.64a	3.63ab	3.62a	2622a	2480b
CD (P=0.05)	84.74	85.63	1.22	0.49	0.13	0.06	99.81	95.54

Means followed by the same letters do not differ significantly (P< 0.05) NS = Non significant

sulphate source while the lowest (22.75%) seed protein obtained by urea fertilizer. This may be due to high volatilization of NH_3 from urea as compared to calcium ammonium nitrate and ammonium sulphate. However, the method of application had significantly affected the seed protein (Table-2). In 2001-02 maximum seed protein (24.46%) was obtained in drilling below seed method, side placement followed earlier, while the lowest seed protein (20.98%) was produced by broadcast application, respectively. These results coincide with Johnston et al (2002) who reported an increase in protein contents of canola by side drilling. In 2001-02 S_3M_3 and in 2002-03 S_2M_2 combination produced 24.86 and 24.90% seed protein (Table-3). More seed protein in drilling below seed method was due to more and prolonged availability of N to the crop seed against the other methods which enhanced the seed size due to healthy siliquae. These results coincide with the findings of Rechcigl and Colon 2000.

Seed oil contents and yield

The source of N-fertilizer did not affect the seed oil contents of canola in both the season (Table-2). Different methods of N- application had significant effect on seed oil contents. The highest oil contents were obtained by broadcast method as compared to drilling below seed or side placement application. In 2001-02 season, maximum oil contents 44.48% were produced by broadcast method while lowest oil contents (43.32 or 42.70 %) in drilling below or the side placement application. Almost similar trend was observed in 2002-03 season. This was due to low availability of N in methods other than broadcast like drilling below seed which increased oil contents and decreased protein as compared to side placement or drilling below seed method. Johnston *et al.* 2002 also observed reduction in oil contents (4%) of canola in side banded fertilizer. Source of N-fertilizer had no significant effect on oil yield in both the seasons. The oil yield is the ultimate goal of oil seed crop. It was not

Table 2. Protein, oil yield and oil content of canola as effected by different sources and methods of nitrogen application

Treatments	Protein (%)		Oil content (%)		Oil yield (Kgha^{-1})	
	2001-02	2002-03	2001-02	2002-03	2001-02	2002-03
S1	22.75b	23.46 NS	43.54 NS	43.09 NS	1057 NS	1101 NS
S2	23.53a	23.53	43.40	43.57	1043	1113
S3	23.52a	23.66	43.56	43.22	1054	1089
CD (P=0.05)	0.04	-	-	-	-	-
M1	20.98c	21.32b	44.48a	44.76a	951.8c	1015b
M2	24.46a	24.78a	43.32ab	42.55b	1142a	1147a
M3	24.38b	24.65a	42.70c	43.67b	1059b	1142a
CD (P=0.05)	0.06	0.13	0.56	0.85	41.22	43.50

Means followed by the same letters do not differ significantly (P< 0.05) NS = Non significant

Table 3. The interaction between sources and nitrogen fertilizer methods as affecting protein percentage in canola

Treatment	Protein%		Oil content(%)		Oil yield(Kgha^{-1})	
	2001-02	2002-03	2001-02	2002-03	2001-02	2002-03
S1M1	20.99e	21.43d	-	-	-	-
S1 M2	2385c	24.61b	-	-	-	-
S1 M3	23.40d	24.33c	-	-	-	-
S2 M1	20.97e	21.14e	-	-	-	-
S2 M2	24.81a	24.90a	-	-	-	-
S2 M3	24.85a	24.84a	-	-	-	-
S3 M1	20.98e	21.38d	-	-	-	-
S3 M2	24.71b	24.82ab	-	-	-	-
S3 M3	24.86a	24.79ab	-	-	-	-
CD (P=0.05	0.10	0.23	-	-	-	-

Means in the same column having different letters differ significantly at ($p \leq 0.05$)

significantly influenced by different sources in both the season. However, the methods of N-fertilizer application had significant effect on oil yield of canola In 2001-02 drilling below seed method produced highest oil yield (1142 kgha^{-1}), side placement method followed earlier, while the lowest oil yield (951.8 kgha^{-1}) was obtained by broadcast method. A similar trend was observed in 2002-03 season (Table-2). More oil yield was due to higher seed yield in these methods. These results are in line with those of Asare and Scarisbrick (1995) and Tahir (2002).

CONCLUSION

On the basis of above study it was found that drilling below seed and side placement methods showed significant effect on seed protein, seed yield and oil yield of canola while oil contents were significantly higher in broadcast method. Different sources of N-fertilizer did not show significant improvement in oil and seed yield of canola (*Brassica napus* L).

REFERENCES

Anonymous. 2005-06. Economic Survey of Pakistan. Govt. of Pakistan, Ministry of Food, Agriculture and Livestock, Finance Division, Economic Advisor's Wing, Islamabad (Pakistan). pp.19.

Amin, R. and S.K. Khalil. 2005. Effect of pre- and post emergence herbicides and row spacing on canola. Sarhad J. Agric. 21(2):165-170.

A.O.A.C. 1990. Official Methods of Analysis. Association of Official Analytical Chemists, 15th Ed. Arlington, Virginia, USA.

Asare, E. and D.H. Scarisbrick. 1995. Rate of nitrogen and sulphur fertilizers on yield, yield components and seed quality of oilseed rape (*Brassica napus*). Field Crops Research. 44:41-46.

Aslam, M., G. Raza, S.M. Shah, M.S Mirza and Naeemullah. 1996. Rapeseed Production Oilseed Programme, NARC, Islamabad, Bulletin No.5.

Allen, E.J. and D.G. Morgan. 1972. A quantitative analysis of the effects of nitrogen on the growth, development and yield of oilseed rape. J. Agric. Sci. 78:315-324.

Bandel, V.A., S. Dzienia and G. Standford. 1980. Comparison of N fertilizers for No-Till Cron. Agron. J. 72:337-341.

Beech, D.F and M.J.T. Norman. 1964. The effect of time of planting and N fertilizer on yield attributes of Brassica oil seed crops in the Ord River Valley. Australian J. Exp. Agric. and Anim. Husband., 14:206-214.

Cheema, M.A., M.A. Malik, S.M.A. Basra and S.I. Zamir. 1997. Effect of time and methods of N and P application on growth, seed yield and oil quantity of Canola. Int. J. of Agri. and Bio., 03:131-33.

Cai, G.X., G.H. Peng, Y.W. Wu, M.T. Ma, S.W. Gan and C.F. Men. 1995. Fate of urea nitrogen applied to rape grown on a red soil and efficiency of urea in raising rape yield. Pedosphere. 5:107-14.

Fox, R.H., J.M. Kern and W.P. Piekielek. 1986. Nitrogen fertilizer source, method and time of application effects on No-till corn yields and Nitrogen uptakes. Agron. J. 78:741-746.

Freed, R.D. and S.P. Eisensmith. 1986. Mstat micro computer statistically programme. Michigan State University Agri., Michigan, Lansing, USA.

Johnston, A.M., E.N. Johnson, K.J. Kirkland and F.C. Stevenson. 2002. Nitrogen fertilizer placement for fall and spring seeded Canola (*Brassica napus).* Canadian J. Plant Sci. 82:15-20. (CAB Abst. 2000/08-2002/7).

Mengel, D.B., D.W. Nelson and D.M. Huber. 1982. Placement of Nitrogen Fertilizers for No-Till and conventional Till Corn. Agron. J. 74: 515-518.

Majeed, A. 1991. Effect of varying nitrogen applications on the growth and seed yield of "Pella Raya" (*Brassica carinata*). M.Sc. (Hons.) Agri. Thesis, Deptt. of Agron., Univ. of Agri., Faisalabad.

Riedell, W.E., D.L. Beck and T.E. Schumacher. 2000. Corn response to fertilizer placement treatments in an irrigated No-Till System. Agron. J. 92: 316-320.

Rechcigl, J.E. and W. Colon. 2000. Influence of nitrogen sources and sulfurfertilizer on rahigross production and quality. Proceedings of the 35thAnnual meeting of Caribbean food crops Society. 25-31 July 1999. 83-90. (CAB abst. 2000-2002).

Robertson, J.A. and W.H. Morrison. 1979. Analysis of oil content of Sunflower seed by NMR. J. Am. Oil Chem. Soc. 56:961-964.

Shahzad, M.A. 2003. Agro physiological response of Brassica cultivars to nutrient management under saline conditions. Ph D. thesis, Deptt. Agron., Univ. Agri. Faisalabad (Pakistan).

Steel, R.G.D. and J.H. Torrie. 1984. Principles and Procedures of Statistics, 2nd Ed. McGraw Hill Book Co. Inc., Singapore.

Tomar, J.S. and R.J. Soper. 1981. Fate of tagged Urea N in the field with different methods of N and organic matter placement. Agron. J. 73: 991-995.

Tahir, M. 2002. Agro management practices for enhanced productivity on canola (*Brassica napus* L). Ph.D. thesis, Deptt. Agron., Univ. Agri., Faisalabad (Pakistan).

Wahid, M.A. 2003. Effect of different fertilizers as source of nitrogen and their methods of application on growth, seed yield and oil quality of canola (*Brassica napus* L). M.Sc. thesis, Deptt. Agron., Univ. Agri. Faisalabad (Pakistan).

Watson, D.J. 1952. The physiological basis of variation in yield. Advances in Agronomy 4:101-145.

Zaman, M. 2003. Effect of rate and time of nitrogen application on growth, seed yield and oil contents of canola (*Brassica napus* L). M.Sc. thesis, Deptt. Agron., Univ. Agri., Faisalabad (Pakistan).