Optimization of Nitrogen for Increasing the Productivity of Canola

Umar Farooq, Shahid Iqbal*, Muhammad Zahir Afridi, Fazal Munisif, Muhammad Tauseef and Khaista Rehman

Department of Agronomy, The University Of Agriculture Peshawar, Pakistan

Submission: January 13, 2017; Published: February 03, 2017

*Corresponding author: Shahid Iqbal, Department of Agronomy, The University of Agriculture Peshawar, Amir Muhammad Khan Campus, Mardan, Pakistan, Email: shahiduali85@gmail.com

Abstract

Nitrogen has strong effect on the seed yield and quality of canola. Therefore, a field experiment was conducted at Palato Research Farm of Amir Muhammad Khan Campus Mardan, The University of Agriculture, Peshawar Pakistan during 2015-16 to optimize the nitrogen for increasing the productivity of canola. The experiment was Randomized Complete Block Design with split plots having three replications. Four nitrogen levels (50, 75, 100, 125 kg ha\(^{-1}\)) with a control and two canola varieties Zahoor and PARC were used. The seeds were sown on 28\(^{th}\) of November 2015. The varieties did not vary significantly for the seed yield. However, biological yield, seed yield and harvest index were significantly affected by the nitrogen levels. The nitrogen level of 125 kg ha\(^{-1}\) were superior to the other levels that resulted highest biological yield (4958.8 kg ha\(^{-1}\)), seed yield (1436.7 kg ha\(^{-1}\)) and harvest index (37.49%). On the other hand the interaction between N levels and varieties had also significant effect on the parameters. The application of 125 kg N ha\(^{-1}\) to both varieties resulted maximum yield. Therefore, it is concluded that 125 kg N ha\(^{-1}\) application to canola varieties Zahoor and PARC could be more effective to obtain higher yield in the agro ecological condition of Mardan.

Keywords: Canola; Nitrogen; Yield; Varieties

Introduction

Canola (Brassica napus L.) is a third important oil crop in the world [1] produces high quality oil (contains > 2% erucic acid and 36-40% quality protein) and meal (> 30 µg glucosinolates). Its oil may be used as alternative to soybean oil [2]. Pakistan meet only one third of the requirements of edible oil and remaining is met by import [3]. Canola contributes a big share of 17% to the domestic production of edible oil in Pakistan [4]. It is sown in Punjab, Sindh and Khyber Pakhtunkhwa provinces of Pakistan as second most important oilseed crop after cotton [3]. However, its production in Pakistan is subject to low yield. One of the main causes of low productivity is imbalanced and inadequate supply of nutrients. Among the major elements nitrogen is one of the most important nutrient which play key role in plant growth and yield by influencing a variety of growth parameters such as number of branches per plant, branches seed yield, seed weight, number of pods per plant and number of seeds per plant [5]. Some studies reported an average of 187-200 kg N ha\(^{-1}\) for high yield [6]. It has been also noted that increased in yield with increasing N rates up to 100 kg ha\(^{-1}\) [7]. Similarly a study concluded that yield increased with rates of N up to 213 kg ha\(^{-1}\) [8]. However, excess N can may have negative effect on seed yield and quality by increasing the lodging [7,9,10]. There is a wealth of data is present regarding the suggested N rates for increasing the canola yield in different regions of world but from Pakistan no a comprehensive study is so far reported to the best of our knowledge in this regard. Hence, the present study was conducted with the aim to optimize the nitrogen rates for increasing the productivity of canola.

Materials and Methods

Experimental materials and design

The present experiment was conducted at Palato Research Farm, The University of Agriculture Peshawar, Amir Muhammad Khan Campus Mardan during the Rabi season of 2015-16. The Randomised complete block (RCB) design was used with split plot arrangement. The experiment consisted of five nitrogen levels i.e. 0, 50, 75, 100 and 125 kg ha\(^{-1}\) and two canola varieties (Zahoor and PARC). Each plot size was 7.5 m\(^2\) having 5 plant rows with row to row distance 50 cm. Urea was used as N source.

Crop husbandry

The crop was shown on the 28\(^{th}\) of November in 2015. The soil was pulverised to a depth of 15 to 20 cm. Basal dose of DAP was applied as P source. To control the weeds hoeing was done when plant reached at 10-12 cm height. All the agronomic practices were done as required according to crop need.
Observations

For plant height, five plants per plot were selected randomly and their heights were taken and averaged. In order to count the number of branches per plant, five plants were randomly selected from each plot and their branches were counted and averaged. To observe the number of pods plant five plants from each plot were selected and their pods were counted and averaged. For number of seeds pods-1 ten pods were randomly selected, threshed, their seeds were counted and averaged. 1000-seeds weight were observed by randomly collecting seeds samples from the plot and weighed. For biological yield, three central rows in each plot were harvested, dried for 10 days and weighed. Biological yield kg ha\(^{-1}\) determined by using following formula.

\[
\text{Biological yield (kg ha}^{-1}\) = (Biological yield per plot)/(Row to row distance \times \text{No of rows} \times \text{Row length}) 	imes 10000
\]

Result and Discussion

Plant height (cm)

| Treatments | Plant Height (cm) | Number of Branches Plant\(^{-1}\) | Number of pods plant\(^{-1}\) | Number of Seeds pod\(^{-1}\) | 1000-Seeds weight (g) | Biological Yield (kg ha\(^{-1}\)) | Seed Yield (kg ha\(^{-1}\)) | Harvest Index (%) |
|------------|------------------|----------------------------------|-----------------------------|--------------------------|------------------------|-----------------------------|---------------------|------------------|
| V1 Control | 122.20 e          | 3.42 d                            | 168.18 e                    | 13.09 d                  | 3.43 e                 | 2481.2 e                    | 868.6 e             | 28.48 b          |
| N1         | 133.60 d          | 5.46 c                            | 183.27 d                    | 15.26 c                  | 4.58 d                 | 3577.2 d                    | 1007.5 d            | 35.68 a          |
| N2         | 137.63 c          | 5.86 bc                           | 198.22 c                    | 17.05 b                  | 4.85 c                 | 4009.1 c                    | 1101.5 c            | 36.45 a          |
| N3         | 144.27 b          | 6.06 ab                           | 226.67 b                    | 17.65 ab                 | 5.11 b                 | 4447.8 b                    | 1290.2 b            | 34.51 a          |
| N4         | 154.87 a          | 6.63 a                            | 253.73 a                    | 18.65 a                  | 5.50 a                 | 4932.2 a                    | 1434.2 a            | 34.41 a          |
| LSD (0.05) | 2.39              | 0.4                              | 3.34                        | 1.51                     | 0.19                   | 275.5                       | 560.72              | 3.39             |

V1 Zahoor; V2 PARC; Control 0 kg N ha\(^{-1}\); N1 50 kg N ha\(^{-1}\); N2 75 kg N ha\(^{-1}\); N3 100 kg N ha\(^{-1}\); N4 125 kg N ha\(^{-1}\)

Statistical analysis

The statitix 8.1 package was implemented for the analysis of data. The data were statistically analysed using analysis of variance techniques (ANOVA) and treatments’ means were compared using LSD value at 0.05% probability level [11].
N levels and varieties had significant influence on the plant height (Table 1). The interaction between N levels and varieties was also found significant (Table 2). Zahoor gave maximum plant height (140.49 cm) as compared to PARC. In case of N levels highest plant height (154.87 cm) was observed by the application of 125 kg N ha\(^{-1}\) while lowest plant height (122.20 cm) was observed in control plot. However, application of 125 kg N ha\(^{-1}\) to Zahoor produced maximum plant height (157.60 cm). Similarly, [1] observed that highest rate of N application gave highest plant height. Our results could be largely due to the positive effect of nitrogen on the growth and development of stem and leaf area, which resulted into taller plants.

**Number of branches per plant**

N levels had significant influence on the number of branches per plant while the varieties had no significant effect on the number of branches per plant (Table 1). The interaction between N levels and varieties was found significant for the number of branches per plant (Table 2). In case of N levels highest value of the number branches per plant (6.38) was observed by the application of 125 kg N ha\(^{-1}\) and it was at par with number of branches per plant by 100 kg N ha\(^{-1}\). Whilst the lowest (3.42) was observed in control. However, application of 125 and 100 kg N ha\(^{-1}\) to both varieties produced statistically equal maximum number of branches per plant (6.63, 6.06, 6.13 and 6.06). The increase in number of branches per plant with increase in N rate may be due to the fact that N promoted vegetative growth. These results agree with those documented by [12], who stated that number of branches per plant significantly increased with N doses from 0 to 150 kg ha\(^{-1}\).

**Number of pods per Plant**

N levels and varieties and their interactions had significant influence on the number of pods per plant (Table 1&2). Zahoor produced maximum number of pods per plant (211.34) as compared to PARC. In case of N levels highest number of pods per plant (253.73) was observed by the application of N at 125 kg N ha\(^{-1}\) while lowest number of pods (168.18) were recorded in control plot. However, application of 125 kg N ha\(^{-1}\) to Zahoor produced maximum number of pods per plant (263.13). These results are in line with the study [12] who reported that higher nitrogen application resulted in more number of pods per plant.

**Number of seeds per pod**

N levels and varieties had significant influence on the number of seeds per pod (Table 1). The interaction between N levels and varieties was also found significant for the number seeds per pod (Table 2). Zahoor gave maximum number of seeds per pod (16.87) as compared to PARC (15.81). In case of N levels highest value of the number of seeds per pod (18.65) was observed by the application of 125 and 100 kg N ha\(^{-1}\). The lowest number of seeds per pod (13.09) was observed in control. In interactions, application of 125 and 100 kg N ha\(^{-1}\) to Zahoor and PARC produced maximum number of seeds per pod (19.36, 17.93, 17.73 and 17.56) [13,14]. The increase in the number of seeds per pod might be due to the fact that nitrogen enhanced the growth of the crop and produced more dry matter that resulted in more number of seeds per pod. The plants took more nitrogen and enhanced the rate of photosynthesis which resulted in more vigorous growth. Similar results are stated by another study [15].

**1000-seeds weight**

N levels and varieties had significant influence on the 1000-seed weight (Table 1). The interaction between N levels and varieties was also found significant for 1000-seeds weight (Table 2). Zahoor produced maximum 1000-seeds weight (4.78 g) as compared to PARC (4.60). In case of N levels highest value of 1000-seeds weight (5.50 g) was observed with 125 kg N ha\(^{-1}\) while lowest (3.43) was observed in control. Among interactions, 125 kg N ha\(^{-1}\) application to zahoor produced maximum 1000-seeds weight (5.80 g). Increasing nitrogen levels increased seed weight probably due to enhancement of dry matter accumulation in seeds responsible for heavier seed. A field study [15] also reported parallel results.

**Biological yield (kg ha\(^{-1}\))**

N levels had significant influence on the biological yield while the varieties had no significant effect on the biological yield (Table 1). The interaction between N levels and varieties was found significant for the biological yield (Table 2). In case of N levels highest value of the biological yield (4932.2 kg ha\(^{-1}\)) was observed with 125 kg N ha\(^{-1}\) and the lowest (2481.2 kg ha\(^{-1}\)) with control. The Zahoor and PARC produced maximum biological yield (4958.8 and 4905.6 kg ha\(^{-1}\) respectively). These results were in line with previous studies [9,16] who found that higher nitrogen application produced more biological yield.

**Seed yield (kg ha\(^{-1}\))**

Similar to other parameters N levels, varieties and their interactions had significant influence on the seed yield (Table 1&2). Zahoor produced maximum seed yield (1173 kg ha\(^{-1}\)) as compared to PARC (1107.5 kg ha\(^{-1}\)). In case of N levels the highest seed yield (1434.2 kg ha\(^{-1}\)) was attained with 125 kg N ha\(^{-1}\). While the lowest seed yield (868.0 kg ha\(^{-1}\)) was attained in the control. Among interactions, highest seed yield (1436.7 and 1431.7 kg ha\(^{-1}\)) was attained by Zahoor and PARC treated with 125 kg N ha\(^{-1}\). Increases in seed yield resulting from an increase in the number of pods [9]. The increase in N level significantly increased seed yield, mainly because of its positive increasing effect on yield components we studied. Many studies concluded that yield increased with the increase of N fertilizer rate [17-22].

**Harvest index (%)**

Varieties had non significant while N levels had significant influence on the harvest index (Table 1). The interaction between N levels and varieties was found significant for the harvest index (Table 2). Different N levels did not produced any difference in harvest index. However, harvest index in N levels were different from control. The application of all the N levels to both varieties gave equally same harvest index. A field study reported [16] similar results that the effect of N fertilizer was significant on harvest index and also the varieties Hyola-401 and Hyola-60 had no significant effect on the harvest index [23,24].
Conclusion

The results conclude that increasing the nitrogen levels increased the yield of canola varieties. However, application of highest level of 125 kg N ha⁻¹ to canola varieties i.e. Zahoor and PARC produced highest yield. The further higher level of N above than 125 kg N ha⁻¹ may be tested to increase the yield while keeping in consideration the nitrogen losses as well with this much application. However, farmers of Mardan can apply 125 kg N ha⁻¹ to get high yield of canola.

Acknowledgements

We sincerely acknowledged the technical support provided by Dr. Shahid Iqbal, Dr. Muhammad Zahir Afridi and Dr. Fazal Munsif, Agronomy Department, Amir Muhammad Khan Campus Mardan, The University of Agriculture Peshawar, Pakistan.

References

1. Elewa TA, Mekki BB, Bakry BA, El-Kramamy MF (2014) Evaluation of Some Introduced Canola (Brassica napus L.) Varieties under Different Nitrogen Fertilizer Levels in Newly Reclaimed Sandy Soil. Middle-East Journal of Scientific Research 21(5): 746-755.
2. Amin R, Khalil SK (2005) Effect of Pre- and Post-Emergence Herbicides and Row Spacing on Canola. Sarhad Journal of Agriculture 21(2): 165-170.
3. Anonymous (2014) Government of Pakistan. Pakistan Economic Survey 2013-14. Economic Advisor’s wing, Finance Division, Islamabad, USA, p. 31.
4. PARC (2001) Rapeseed Mustard Production in Pakistan. PARC, Islamabad, Pakistan.
5. Al-Hassa (2006) Irrigation Interval and Nitrogen Level Effects on Growth and Yield of Canola (Brassica napus L.). Scientific Journal of King Faisal University (Basic and Applied Sciences) 7(1): 87-103.
6. Holmes MRJ, Ainsley AM (1977) Fertilizer Requirements of Spring Oilseed Rape. Journal of Science of Food and Agriculture 28 (3): 301-311.
7. Sheppard SC, Bates TE (1980) Yield and Chemical Composition of Rape in Response to Nitrogen, Phosphorus and Potassium. Canadian Journal of Soil Science 60(2): 153-162.
8. Ibrahim AF, Abusten EO, Elmentawly MA (1989) Response of Rapeseed (Brassica napus L.) to Growth, Yield, Oil Content and its Fatty Acid to Nitrogen Rates and Application Times. Journal of Agronomy and Crop Science 162(2): 107-112.
9. Scott RK, Ogurenmi EA, Ivins JD, Mendham NJ (1973) The Effect of Fertilizers and Harvest Date on Growth and Yield of Oil Seed Rape Sown in Autumn and Spring. The Journal of Agricultural Science 81(2): 287-293.
10. Wright PR, Morgan JM, Jossop RS, Cass A (1995) Comparative Adaptation of Canola (Brassica napus L.) and Indian Mustard (B. juncea L.) to Soil Water Deficit Yield and Yield Components. Field Crops Research 42(1): 1-13.
11. Steel RGD, Torrie JH, Dickey DA (1997) Principles and procedures of statistics: a biometrical approach. McGraw Hill Book Companies, New York, USA.
12. Uddin MK, Khan MNH, Mahbub ASM, Hussain MM (1992) Growth and Yield of Rapeseeds as Affected by Nitrogen and Seed Rate. Bangladesh Journal of Scientific and Industrial Research 27: 30-38.
13. Khorshidi MG, Moradpoor S, Ranji A, Karimi B, Asri F (2013) Effect of Different Levels of Nitrogen Fertilizer and Plant Density on Yield and Yield Components of Canola. Scientific Journal of Crop Science 4(11): 2896-2900.
14. Tuset Patra, Maiti S, Mitra B (2006) Variability. Correlation and Path Analysis of the Yield Attributing Characters of Mustard (Brassica spp.). Research on Crops 7(1): 191-193.
15. Hamidi A, Asgharzadeh A, Choukan R, Dehghan Shoar M, Ghalavand A, Malakooti MJ (2007) Study on Plant Growth Promoting Rhizobacteria (PGPR) Biofertilizers Application in Maize (Zea mays L.) Cultivation by Adequate Input. Environmental Sciences 4(4): 1-19.
16. Keivanrad S, Delkhosh B, Shirani Rad AH, Zandi P, Amir Hossein (2011) The Effect of Different Rates of Nitrogen and Plant Density on Qualitative and Quantitative traits of Indian mustard. Advances in Environmental Biology 6(1): 145-152.
17. Pellet D (2002) Oilseed rape varietal response to nitrogen fertilization. GCIRC Bulletin 18.
18. Rathke GW, Christen O, Diepenbrock W (2005) Effects of Nitrogen Source and Rate on Productivity and Quality of Winter Oilseed Rape (Brassica napus L.) Grown in Different Crop Rotations. Field Crops Research 94(2-3): 103-113.
19. Sidlauskas G, Bernotas S (2003) Some Factors Affecting Seed Yield of Spring Oilseed Rape (Brassica napus L.). Agronomy Research 1(2): 229-243.
20. Söchting HP, Verret JA (2004) Effects of Different Cultivation Systems (soil management and nitrogen fertilization) on the Epidemics of Fungal Diseases in Oilseed Rape (Brassica napus L. var. napus). Journal of Plant Disease and Protection 111(1): 1-29.
21. Zhang ZH, Song HX, Liu Q, Rong XM, Peng JW, Xie GX, Zhang YP (2009) Study on Differences of Nitrogen Efficiency and Nitrogen Response in Different Oilseed Rape (Brassica napus L.) Varieties. Asian Journal Crop Science 4(1): 105-112.
22. Cheema MA, Malik MA, Hussain A, Shah SH, Basra SMA (2001) Effects of Time and Rate of Nitrogen and Phosphorus Application on the Growth and Seed Oil Yields of Canola (Brassica napus L.). Journal of Agronomy and Crop Science 186(2): 103-110.
23. Sana M, Ali A, Malik AA, Saleem MF, Rafik M (2003) Comparative Yield Potential and Oil Contents of Different Canola Cultivars (Brassica napus L.). Pakistan Journal of Agronomy 2(1): 1-7.
24. Allen EJ, Morgan DG (1972) A Quantitative Analysis of the Effects of Nitrogen on the Growth, Development and Yield of Oilseed Rape. Journal of Agricultural Sciences 78(2): 315-324.
