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Optimization of Nitrogen for Increasing the Productivity of Canola

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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 28th 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 µ g 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 Pakhtun Khwa 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 m2 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 28th 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.

Biological yield (kg ha^{-1})=(Biological yield per plot)/(Row to Row distance × No.of rows × Row length)×10000

Seed yield was determined by harvesting three central rows from each plot, sun dried for 10 days and their seeds were threshed. Then seeds were weighed and then converted into kg ha^{-1} by using the formula.

Seeds yield (kg ha^{-1}) =(Seed yield per plot)/(Row to row distance × No of rows × Row length)×10000

To calculate harvest index, the seed yield was divided by biological yield and multiplied by 100 as follow,

Harvest index (%) =(Seed yield)/(Biological yield)×100

Statistical analysis

The statistix 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].

Result and Discussion

Plant height (cm)

Table 1: Effect of varieties and nitrogen levels on the yield and yield contributing components of canola.

	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 (%)
Varieties								
V1	140.49 a	5.56	211.34 a	16.87 a	4.78 a	4021.9	1173.0 a	34.18
V2	136.53 b	5.31	200.69 b	15.81 b	4.60 b	3757	1107.5 b	33.63
LSD (0.05)	1.18	0.65	2.68	0.93	0.09	343.01	274.62	2.91
Nitrogen Levels								
Control	122.20 e	3.42 d	168.18 e	13.09 d	3.43 e	2481.2 e	868 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;Control0 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}

Table 2: Interactive effect of varieties and nitrogen levels on the yield and yield contributing components of canola.

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	123.74 g	3.51 d	168.85 g	14.00 de	3.47 f	2860 e	896.3 f	31.92 b
V1×N1	135.87 e	5.73 bc	192.00 e	15.86 bcd	4.63 de	3601 d	1038.3 e	34.68 ab
V1×N2	138.93 e	5.90 bc	203.80 d	17.40 ab	4.90 cd	4081.8 c	1151.7 d	35.40 ab
V1×N3	146.33 c	6.06 ab	228.94 c	17.73 ab	5.13 bc	4608.1 ab	1342.0 b	34.36 ab
V1×N4	157.60 a	6.63 a	263.13 a	19.36 a	5.80 a	4958.8 a	1436.7 a	34.54 ab
V2×Control	120.67 g	3.33 d	167.52 g	12.18 e	3.40 f	2102.3 f	839.7 f	25.04 c
V2×N1	131.33 f	5.20 c	174.53 f	14.66 cd	4.53 e	3553.3 d	976.7 e	36.67 ab
V2×N2	136.33 e	5.83 bc	192.64 e	16.70 bc	4.80 de	3936.4 cd	1051.3 e	37.49 a
V2×N3	142.20 d	6.06 ab	224.40 c	17.56 ab	5.10 bc	4287.4 bc	1238.3 c	34.66 ab
V2×N4	152.13 b	6.13 ab	244.33 b	17.93 ab	5.20 b	4905.6 a	1431.7 a	34.27 ab
LSD (0.05)	3.38	0.57	4.73	2.14	0.27	389.62	792.9	4.79

V1 Zahoor; V2 PARC; Control0 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}

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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 pods per plant (253.73) was observed by the application of N at 125 kg ha^{-1}. However lowest number of pods (168.18) were recorded in control plot. However, application of 125 kg ha^{-1} to Zahoor produced maximum 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}) where treated with 125 kg N ha^{-1}. 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].

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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.

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