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Nitrogen Use Efficiency and Morpho-phenological Traits of Canola (*brassica napus* l.) as Influenced by Shoots Cutting and Nitrogen Levels

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Abstract

The objective of this study was to determine the effects of shoots cutting and nitrogen levels on nitrogen use efficiency and morpo-phenological traits of canola (*Brassica napus* L.). Therefore the field experiment was carried out at New Developmental Farm of The University of Agriculture, Peshawar, Pakistan during Rabi 2012-13. The experiment was laid out in randomized complete block design with split plot arrangement heaving four replications. Nitrogen levels (0, 50, 75 and 100 kg ha^{-1}) were allotted to main plots, while shoots cutting (0, 5, 10, 15 and 20 cm) above ground after 60 days of sowing were allotted to sub plots. Plots treated with 100 kg N ha^{-1} took maximum (104) days to first flowering, (160) days to maturity: produced maximum branches plant^{-1} (11), pods plant^{-1} (172) and biological yield (10310 kg ha^{-1}) as compared with control plots but maximum NUE (19.5%) was recorded when plots treated with 50 kg N ha^{-1}. Shoots cut with 20 cm had significantly maximum branches plant^{-1} (9) and biological yield (8875 kg ha^{-1}) as compared with other shoots cuts plots but no cut plots produced maximum pods plant^{-1} (142) and NUE (16.1%) but NUE statistically a par with 20 cm shoots cut plots. Interaction between nitrogen levels and shoots cutting revealed that plots treated with 100 kg N ha^{-1} either no cut or 20 cm shoots cut had maximum pods plant^{-1} and biological yield. It was concluded from present results that supplied nitrogen at the rate of 100 kg ha^{-1} either no cut or 20 cm shoots cut seems to be the best choice for canola producer in the agro-climatic condition of Peshawar valley.

Keywords: *(Brassica napus L.); Shoots cutting; Nitrogen; NUE; Phenology; Morphology*

Introduction

Canola (*Brassica napus* L.) is considered as the most important source of vegetable oil and protein-rich meal world wide. It ranks the third among the oil crops, following palm oil and Soya oil and the fifth among economically important crops, following rice, wheat, maize and cotton [1]. Canola is grown primarily for its seeds, which yield between 35% to over 45% oil. Its main use is as cooking oil, but it is also commonly used in margarine. There are increased domestic and export market opportunities for canola oil that can be realized through the development of high-oleic acid canola to replace saturated palm oil in food service applications [2]. Rapeseed is an important edible oilseed crop however its yield very low (Average < 812 kg ha^{-1}) in Pakistan [3]. While the average production in Canada is 3200 kg ha^{-1} and Australia 2000 Kg ha^{-1} [4].

In the current agriculture, nitrogen is a limiting nutrient for growth and consequently to the yield production. So, N fertilization has made an unquestionable contribution to the improvement of phenological and morphological traits of canola (Hamzei, 2011). The plants obtain the nitrogen, mainly by the application of nitrogen fertilizers, industrially synthesized from the atmospheric N_2. However, due to economic as well as environmental reasons, today's challenge lies in maximizing production using the minimum possible amount of N fertilizer [1]. Plants take in N as either nitrate (NO^{-3}) or ammonium (NH^{+4}) and generally grow best when both forms are available (Cramer and Lewis, 1993). Plants convert most of the N that they consume into amino acids, proteins and nucleic acids and typically contain 1-6%

N by weight [5]. Nitrogen is also an essential ingredient in the chemical structure of chlorophyll, the molecule responsible for converting light into the chemical energy that drives photosynthesis [6].

Thus, applications of fertilizer N are often well justified, as plants cannot function in the absence of this essential nutrient. While N is important for all crops, wherever possible this review focuses on canola (*Brassica napus* L.), a crop which has its genetic roots as an ancient oilseed crop known as rapeseed. Originally used as a fuel source for lamps, industrial use of rapeseed oil did not flourish until the development of steam power when rapeseed oil gained a reputation as one of the best lubricants of its time. Rapeseed oil began to be recognized as a potential food source by the end of World War- II if processing techniques could be improved. Nitrogen is indispensable for vegetative and reproductive growth.

Kate. (2007) [7] showed a series of trails on canola, juncea canola and reported that cutting at late flowering is a good cooperation between phenology and morphology but it some what reduces plant height, leaf area plant^{-1}, pods plant^{-1} and causes delay in maturity. Cutting after late flowering reduced hay quality and had little effect on hay quantity. The hybrid clear field cultivars produced higher hay and biological yield than the triazine tolerant cultivars. Kirkegaard., *et al.* (2008) [8] concluded that grazing canola delay 11 days flowering than control. Leaves and main stem delay flowering 10-14 days. Removal of leaves delay flowering by only 4 days. Canola is able to re-shoot from auxiliary buds. Keeping in view the above constraints this experiment were conducted to find out the effect of nitrogen and shoots cutting on morpo-phenological of canola at the agro-climatic condition of Peshawar valley.

Materials and Methods

Experimental Site, Design and Agronomic Management

The study was carried out at New Developmental Farm of The University of Agriculture, Peshawar, Pakistan during Rabi 2012-13. The site is located at (34° 00' N, 71° 30' E, 510 MASL). The experiment was laid out in randomized complete block design with split plot arrangement having four replications. Nitrogen levels (0, 50, 75 and 100 kg ha^{-1}) were allotted to main plots with split dose, ½ N at time of sowing and ½ N before days to first flowering while shoots cutting (0, 5, 10, 15 and 20 cm) above ground after 60 days of sowing were allotted to sub plots. Sub plot size of 3 m x 3 m was used. Each sub plot was consists of 6 rows having 50 cm row-to-row distance. Phosphorous were applied at the rate of 60 kg ha^{-1} in the form of SSP at the time of sowing. Crop was sown at seed rate of 4 kg ha^{-1} using canola cultivar Abasin-95.

Experimental and Data Recording Procedure

Data on days to first flowering were recorded in each subplot when first flowers appeared on plants. Number of branches plant^{-1} was counted in ten plants selected randomly in each subplot and then it was average. Pods plant^{-1} was recorded by counting pods in ten plants selected randomly in each sub plot. Data on days to maturity were recorded when more than 75% of the plants in each sub plot showed signs of physiological maturity. Data on biological yield was taken in four central rows in each subplot at harvest. Harvested crop was sun dried and weighed by using electronic balance and then converted into kg ha^{-1} by the following formula.

$$\text{Biological yield (kg ha}^{-1}\text{)} = \frac{\text{Weight of plant materials in four rows (kg)}}{\text{No. of rows x Row length x R-R}} \times 10{,}000 \text{ m}^2$$

Nitrogen use efficiency (NUE) was calculated as NUE= Seed yield / Nitrogen applied (Ali and Ahmed 2012).

Statistical Analysis

All data collected were subjected to analysis of variance (ANOVA) with the help of statistical software, Statistics 8.0 USA (2005) [9]. Upon significant F-Test, least significance difference (LSD) test was used for mean comparison to identify the significant components of the treatment means.

Results and Discussion

Days to first flowering

Statistical analysis of data showed in table 1 that nitrogen levels and shoots cutting had significant effect on days to first flowering while interaction between N x Sc were not significant. Plots supplied with nitrogen had significantly delayed days to first flowering as compared to control plots. Plots treated with 100 kg N ha^{-1} delayed flowering (104 days) as compared to control, which took early 98 days to first flowering. The possible reason should be that accessibility and uptake of nitrogen which leads to comparative prolonged days to first flowering with more vegetative growth. These results are in line with the findings of Kardgar., *et al*. (2010) [10] who reported that increasing rate of nitrogen application significantly increased delayed days to first flowering over control plots because N is involved to improve vegetative growth and delayed days to first flowering. Mean value of shoots cutting showed that delay flowering (107 days) were recorded in 5 cm shoots cut plots, while early flowering (91 days) were recorded in no cut plots. Delayed days to first flowering with the cutting confirmed the findings of Rahmat., *et al*. (2010) [11] who found that the removal of top portion of rapeseed showed positive response on days to first flowering which range from 15 to 20 days delayed days to first flowering as compared with no cut plots.

Number of Branches Plant^{-1}

Data presented in table 1 indicated that the levels of nitrogen and shoots cutting had significant effect on number of branches plant^{-1} while interaction between N x Sc were found not significant. Mean values of branches plant^{-1} indicated that plots treated with 100 kg N ha^{-1} produced maximum (11) number of branches plant^{-1}, while minimum (5) number of branches plant^{-1} in control plots. The reason could be with increasing nitrogen level so more vegetative growth as result number of branches plant^{-1} increased as compared to control plots. This agreed with the finding of Umar et at. (2012) [12] who recorded that nitrogen fertilizer application had significant effect on number of branches plant^{-1} with increase the nitrogen level branches plant^{-1} increased up to (40 %) if we compared with control plots. Mean values of shoots cutting indicated that maximum (10) number of branches plant^{-1} were recorded in 15 cm shoots cut plots but statistically at par with 20 cm shoots cut plots, while minimum (6) number of branches plant^{-1} were noted when crop was cut at 5 cm. These results are in line with the findings of Khan., *et al*. (2004) [13] who reported that the removal of secondary branches at the initial flowering of rapeseed ultimately effect number of branches plant^{-1}.

Number of Pods Plant^{-1}

Statistical analysis of the data indicated in table 1 that nitrogen levels and shoots cutting had significant effect on number of pods plant^{-1}. Number of pods plant^{-1} was increased with increase in nitrogen levels. Mean value of the nitrogen level indicated that plot treated with 100 kg ha^{-1} produced maximum (172) number of pods plant^{-1} while the lowest (79) pods plant^{-1} was recorded in control plots. Similar notations were reported by Kardgar., *et al*. (2010) [10] that significant differences in number of pods plant^{-1} were recorded among nitrogen levels. Less (69) number of pods plant^{-1} were noted in control plots when nitrogen levels were enhanced from 0 to 120 kg ha^{-1}, number of pods increased from 69 to 158 plant^{-1}. Mean value of shoots cutting showed that maximum (142) number of pods plant^{-1} noted in no cut plots, while minimum (99) number of pods plant^{-1} were noted when crop was cut at 5 cm. These results are in line with those of Kate. (2007) [7] who reported that cutting at late flowering reduces pods plant^{-1}. Interaction between N x Sc indicated in figure 1 that on all shoots cutting increased number of pods plant^{-1} with increasing in nitrogen levels. However linearly and maximum increased was produced for number of pods plant^{-1} when supplied nitrogen at the rate of 100 kg ha^{-1} with no shoots cut plots.

Days to Maturity

Mean value of nitrogen levels indicated in table 1 that plots treated with 100 kg ha^{-1} delayed maturity (162 days) as compared to control, which took early 155 days to maturity. The possible reason should be that accessibility and uptake of nitrogen which leads to comparative prolonged days to maturity with more vegetative growth. This agreed with the finding delay in maturity with increase nitrogen level as compared to control plots has been reported by Bahrani (2009) [14]. Mean values of shoots cutting indicated that delay maturity (161 days) were recorded in 5 cm shoots cut plots, while early maturity (154 days) were recorded in no cut plots. This could be due to less regenerative power of brassica cultivar no-cut treatment produced significantly early maturity as compared to cut treatment delayed days to maturity has been reported by Rahmat., *et al.* (2010) [11].

Biological Yield (Kg Ha^{-1})

Mean value of nitrogen levels indicated in table 1 that plots treated with 100 kg ha^{-1} produced maximum (10310 kg ha^{-1}) biological yield while minimum (6725 kg ha^{-1}) biological yield was recorded in control plots. Nitrogen fertilizer delay physiological maturity due to this extended the vegetative period of the crop, plant attained maximum branches plant^{-1} and plant height thus increase biological yield. These results confirm the findings of Ali., *et al.* (2003) [15] who reported that increasing rate of nitrogen application up to 120 kg N ha^{-1} significantly and linearly enhanced biological yield as compared to control plots. Mean values of shoots cutting indicated that maximum (9025 kg ha^{-1}) biological yield were recorded in 15 cm shoots cut plots but statistically at par with 20 cm shoots cut plots, while minimum (7325 kg ha^{-1}) biological yield were recorded when crop was cut at 5 cm. These results are similar to Clarke. (1978) [16] who studied that maximum (8841kg ha^{-1}) biological yield was recorded when canola shoots was cut at 14 cm height as compared with no cut plots. Shoots cut at the start of flowering reduced biological yield but at the end of flowering did not affect yield or its components therefore highest biological yield was recorded in 15 cm shoots cut plots. Interaction between N x Sc indicated in figure 2 that on all shoots cutting increased biological yield with increasing in nitrogen levels. However linearly and maximum increased was produced for biological yield when supplied nitrogen at the rate of 100 kg ha^{-1} with 15 cm shoots cut plots.

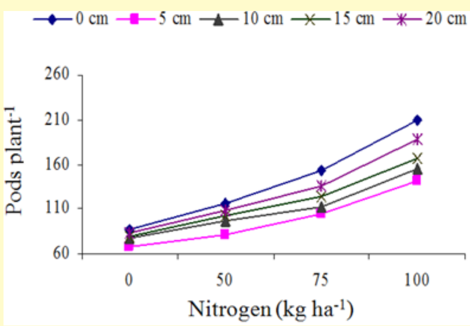

Figure 1: *Pods plant^{-1} of canola is affected By shoots cutting and nitrogen levels.*

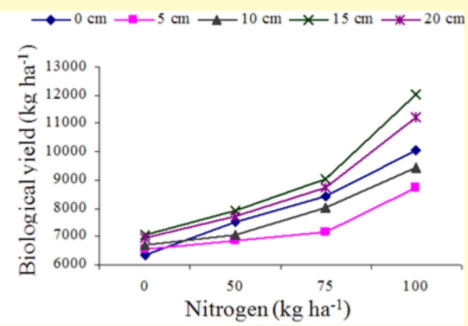

Figure 2: *Biological yield of canola is affected By shoots cutting and nitrogen levels.*

Nitrogen Use Efficiency (%)

Statistical analysis of NUE showed in table 1 that nitrogen levels and shoot cutting had significant effect on NUE while the interaction between N x Sc were not significant. Increasing nitrogen fertilizer rates decreased nitrogen use efficiency. The maximum nitrogen use efficiency (19.5%) was obtained from the low rate of nitrogen fertilizer (50 kg ha^{-1}) while the lowest values (11.7%) were obtained from the highest nitrogen level (100 kg ha^{-1}). These results are in agreement with the findings of Ali and Ahmed. (2012) [17] who reported that Nitrogen use efficiency was decreased by increasing nitrogen fertilizer rates. The maximum nitrogen use efficiency means values (21%) were obtained from the low rate of nitrogen fertilizer (45 kg ha^{-1}), while the lowest values (9.8%) were obtained from the highest nitrogen fertilizer rate (120 kg ha^{-1}). Mean value of shoots cutting showed that maximum (16.1 %) NUE were noted in no cut plots but statistically at par with 20 cm shoots cut plots, while minimum (14.2 %) NUE were noted in 5 cm shoots cut plots. Shoots was cut more closely toward the ground reduced NUE as compared with no cut plots these result confirmed the findings of Rahmat., *et al.* (2010) [11] who found that the removal of top portion of rapeseed showed negative response on NUE.

Treatment	Days to first flowering	Branches plant^{-1}	Pods plant^{-1}	Days to maturity	Biological yield (kg ha^{-1})	NUF
Nitrogen (kg ha^{-1})						
0	98d	5d	79d	155c	6725d	-
50	101c	6c	101bc	157c	7420c	19.5a
75	103b	9b	126b	159b	8290b	13.9b
100	104a	11a	172a	162a	10310a	11.7c
LSD (0.05)	0.25	0.52	12.7	2.34	151	0.65
Shoots cutting (cm)						
0	91e	8bc	142a	154e	8094c	16.1a
5	107a	6de	99e	161a	7325e	14.2c
10	105b	7cd	111d	160b	7813d	14.3bc
15	103c	10a	118c	158c	9025a	14.8b
20	102d	9ab	129b	157d	8875ab	15.9a
LSD (0.05)	0.49	1.0	3.23	0.93	151	0.42
Interaction						
N x Sc	ns	ns	*	ns	*	ns

Means in the same category followed by different letters are significantly different at $P \leq 0.05$ levels.

*ns = non-significant * = significant.*

Table 1: *Days to first flowering, branches plant^{-1}, pods plant^{-1}, days to maturity, biological yield (kg ha^{-1}) and nitrogen use efficiency (%) of canola as affected by nitrogen levels and shoots cutting.*

Conclusions

The results obtained from the present study indicated that supplied nitrogen at the rate of 100 kg ha^{-1} either no cut or 20 cm shoots cut produced maximum branches plant^{-1}, pods plant^{-1}, biological yield and nitrogen use efficiency (%) significantly and therefore, it is recommended that canola should be treated with 100 kg N ha^{-1} either on cut or 20 cm shoots cut for improved biomass productivity and nitrogen use efficiency (%) in agro-climatic condition of Peshawar valley [18-20].

Bibliography

1. Sharifi RS. “Study of yield, yield attribute and dry matter accumulation of canola (*brassica napus* l.) Cultivars in relation to nitrogen fertilizer”. *International Journal of Agriculture and Crop Sciences* 4.7 (2012): 409-415.
2. Spector AA. “Essentiality of fatty acids”. *Journal of the American Oil Chemists’ Society* 34.S1-3 (1999): 51- 53.
3. MINFA. “Agriculture statistic of Pakistan, Ministry of food, agriculture and Livestock,Govt. of Pakistan, Islamabad (2011).
4. Rashid R., *et al*. “Response of rapeseed (*brassica campestris* l.) To different nitrogen doses and number of weeding”. *Middle-east journal of scientific research* 2.3-4 (2007): 146-145.
5. Campbell NA and JB Reece. “Biology. 6th edition. Pearson Education, Inc., publishing as Benjamin Cummings”. *San Francisco, CA* (2002).
6. Havlin JL., *et al*. “Soil Fertility and Fertilizers: An introduction to nutrient management”. 7th edition. Upper Saddle River, NJ: Pearson Prentice Hall (2005): 503.
7. Kate M. “Canola hay & silage – cutting time and feed quality”. *John Stuchbery and Associates, Donald, Victoria* (2007).
8. Kirkegaard JA., *et al.* “Dual-purpose canola a new opportunity in mixed farming systems”. *Australian Journal of Agricultural Research* 59.2 (2008): 291-302.

9. AOAC. Association of Official Agricultural Chemists, Official and Tentative Methods of Analysis, 11th Ed., Washington, D.C., USA 1980.
10. Kardgar v., *et al*. "Effects of nitrogen and plant density on yield of field mustard (*Brassica campestris*)". *Plant Ecophysiology* 2 (2010): 157-164.
11. Rahmat UK., *et al*. "Impact of Rapeseed (*Brassica napus* .L) on the economic returne under odh kohi condition". *Pakistan Journal of Biological Sciences* 10.16 (2010): 2740- 2743.
12. Umar UA., *et al*. "Effect of nitrogen fertilizer level and intra row spacing on growth and yield of sesame (*sesamum indicun* L.) varieties". *Technical Journal of Engineering and Applied Sciences* 2.1 (2012): 22-27.
13. Khan AH., *et al*. "Nutritional yield and oil quality of canola cultivars grown in NWFP". *Sarhad Journal of Agriculture* 20.2 (2004): 287- 290.
14. Ahmad M and MJ Bahrani. "Yield and Yield Components of Rapeseed as Influenced by Water Stress at Different Growth Stages and Nitrogen Levels". *American-Eurasian Journal of Agricultheral & Environmental Science* 5.6 (2009): 755-761.
15. Ali A., *et al.* "Effect of different irrigation and Nitrogen Levels on the seed and oil yield of Canola (*Brassica napus* L.)". *Pakistan Journal of Agricultural Sciences* 40.3 (2002): 3-4.
16. Clarke JM. "The effects of leaf removal on yield and yield components of Brassica napus". *Canadian Journal of Plant Science* 58.4 (1978): 1103-1105.
17. Ali EA., *et al*. "Influence of nitrogen rates and foliar spray by different concentration of copper on canola seed and oil yields as well as nitrogen use efficiency in sandy soil". *Research journal of agriculture and biological sciences* 8.2 (2012): 174-178.
18. Holmes MRJ. "In Nutrition of the oilseed rape crop. Applied Sci. Pub. Barking Essex, England". *Nitrogen* (1980): 21-67.
19. Jan MT., *et al*. "Agriculture Research: Design and Analysis, A monograph". The University of Agriculture, Peshawar-Pakistan.
20. Shehu EH., *et al*. "Nitrogen, phosphorus and potassium nutrition of Canola (*Brassica napus* L.)". *New York Science Journal* 3.12 (2010): 21-27.

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