Research Article

Nitrogen levels and shoots cutting influenced on oil contents, yield and yield attributes of Canola

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Abstract

The performance of canola (*Brassica napus* L.) was evaluated using various nitrogen levels and shoots cutting 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 (RCBD) with split plot arrangement having four replications each. Nitrogen levels @ 0, 50, 75 and 100 kg ha^{-1} were allotted to main plots, while shoots cutting i.e. 0, 5, 10, 15 and 20 cm were allotted to sub plots. Results showed that nitrogen application had significantly affected all studied parameters. Plots treated with 100 kg N ha^{-1} produced maximum seeds pod^{-1} (23), 1000 seeds weight (3.59g), seed yield (1169 kg ha^{-1}), oil contents (49%), oil yield (600 kg ha^{-1}) and harvest index (14%) as compared with control plots. Shoots cutting had significantly affected all the parameters except harvest index. Shoots cut with 20 cm had significantly maximum oil content (50%), seed yield (1092 kg ha^{-1}) and oil yield (568 kg ha^{-1}) as compared with other shoots cuts, but no cut plots produced maximum seeds pod^{-1} (21), 1000 seeds weight (3.3g) and seed yield is statistically at par with 20 cm shoots cut plots. Interaction between nitrogen levels and shoots cutting revealed that plots treated with 100 kg N ha^{-1} with no cut or 20 cm shoots cut had maximum seeds pod^{-1}, 1000 seed weight, oil content (%), seed yield and oil yield. It was concluded from the present results that supplied nitrogen @ 100 kg ha^{-1} with no cut or 20 cm shoots cut seems to be the best choice for canola producer in the agro-climatic condition of Peshawar valley.

Key words: *Brassica napus* L.; shoots-cutting; nitrogen; oil yield

Introduction

Canola (*Brassica napus* L.) is considered as the most important source of vegetable oil and protein-rich meal worldwide. It ranks the third among the oil crops, following palm oil and Soybean 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 is 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 yield and quality of crops [5]. 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 [6]. Plants convert most of the N that they consume into amino acids, proteins and nucleic acids and typically contain 1– 6% N by weight [7]. 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 [8].
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. [9] showed a series of trails on canola, juncea canola and reported that cutting at late flowering is a good cooperation between quality and quantity, but it somewhat reduces plant height, leaf area $plant^{-1}$, seed pod^{-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 seed yield than the triazine tolerant cultivars. [10] 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 mainly conducted to find out the effect of nitrogen and shoots cutting on canola yield at the agro-climatic condition of Peshawar valley.

Materials and Methods

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 (RCBD) 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, ½N at time of sowing and ½N before days to first flowering, while shoots cutting i.e. 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.Seed pod^{-1} was recorded by counting seed in ten pods selected randomly in each sub plot. After threshing data on thousand seeds weight (g) were recorded from three seed lot and weighted with the help of electronic balance. Four central rows in each sub plot were harvested, sun dried and threshed. Seed weight was taken with the help of electronic balance and then converted into kg ha^{-1} by the following formula.

Seed yield (kg ha^{-1}) =

$$\frac{\text{Seeds weight in four rows (kg)}}{\text{No of rows x Row length x R-R}} \times 10{,}000\ m^2$$

Seed oil content (%) was determined by using Soxhlet apparatus and petroleum ether (60ºC) as an extraction solvent according to [11].

Oil yield can be calculated by the following formula.

Oil yield (kg ha^{-1}) =

$$\frac{\text{oil content \% x seed yield (kg ha}^{-1}\text{)}}{100}$$

Harvest index was calculated by using the following formula.

Harvest Index (%) =

$$\frac{\text{Seed yield (kg ha}^{-1}\text{)}}{\text{Biological yield (kg ha}^{-1}\text{)}} \times 100$$

Data collected was analyzed statistically according to the procedure relevant to RCB design. Upon significant F-Test, least significance difference (LSD) test was used for mean comparison to identify the significant components of the treatment means [12].

Results and Discussions

Number of seeds pod^{-1}

Statistical analysis of the data indicated in Table 1 that nitrogen levels and shoots cutting (Sc) had significant effect on number of seeds pod^{-1} while interaction between N x Sc were found not significant. Seeds pod^{-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 seeds pod^{-1} (23) while the lowest seeds pod^{-1} (15) was recorded in control plots. Similar notations were reported by [10] that significant differences in number of seeds pod^{-1} were recorded among nitrogen levels. Less seeds pod^{-1} (14) were noted in control plots when nitrogen levels were enhanced from 0 to 120 kg ha^{-1}, number of seeds increased from 20 to 30 pod^{-1}. Mean value of shoots cutting showed that maximum seed pod^{-1}(22) noted in no cut plots, while minimum seed pod^{-1} (16) were noted when crop was cut at 5 cm. These results are in line with those of [9] who reported that cutting at late flowering reduces seed pod^{-1}.

Thousand seeds weight (g)

Data presented in Table 1 indicated that the levels of nitrogen and shoots cutting had significant effect on thousand seeds weight. Mean values of thousand seed weight indicated that plots treated with 100 kg N ha^{-1} produced maximum seed weight (3.59g), while minimum seed weight (2.41 g) in control plots. The reason could be with increasing nitrogen level so more vegetative growth as result days to maturity is delay and seed filling duration is extended which collected assimilates toward reproductive units which make heavier, bigger and well-filled seeds as compared to control plots. This agreed with the finding of [13] who studied that increasing nitrogen application significantly increased in 1000 seed weight. Mean values of shoots cutting indicated that maximum (3.3 g) seeds weight were recorded in no cut or 20 cm shoots cut plots, while minimum (3 g) seeds weight were noted when crop was cut at 5 cm. These results are in line with the findings of [14] who reported that the removal of secondary branches at the initial flowering of rapeseed did not generally affect thousand seed weight and ultimately seed yield. Interaction between N x Sc indicated in (Fig. 1) that on all shoots cutting increased seeds weight up to 50 kg N ha^{-1} further increase in nitrogen levels slightly increased was produced in seeds weight. However linear increased was recorded for seeds weight when supplied

Table-1, Number of seeds pod^{-1}, thousand seeds weight (g), oil content (%), seed yield(kg ha^{-1}), oil yield (kg ha^{-1}) and harvest index (%) of canola as affected by nitrogen levels and shoots cutting.

Treatment	No. of seeds pod^{-1}	1000 seeds weight (g)	Oil content (%)	Seed yield (kg ha^{-1})	Oil yield (kg ha^{-1})	H.I %
Nitrogen (kg ha^{-1})						
0	15 d	2.41 d	44 d	923 d	401 d	11 c
50	18 c	3.14 c	45 c	970 c	436 c	13 b
75	21 b	3.37 b	57 b	1043 b	519 b	13 b
100	23 a	3.59 a	49 a	1169 a	600 a	14 a
LSD (0.05)	0.68	0.05	0.99	44	29	0.44
Shoots cutting (cm)						
0	22 a	3.3 a	45 e	1099 a	481 bc	13
5	16 e	3.0 d	46 d	958 c	434 d	12
10	18 d	3.1 c	48 c	982 b	470 c	12
15	19 c	3.1 c	49 b	1000 b	494 b	13
20	21 b	3.3 a	50 a	1092 a	568 a	13
LSD (0.05)	0.60	0.02	0.97	23	16	ns
Interaction						
N x Sc	ns	*	*	*	*	ns

Means in the same category followed by different letters are significantly different at P ≤0.05 levels.
ns = non-significant

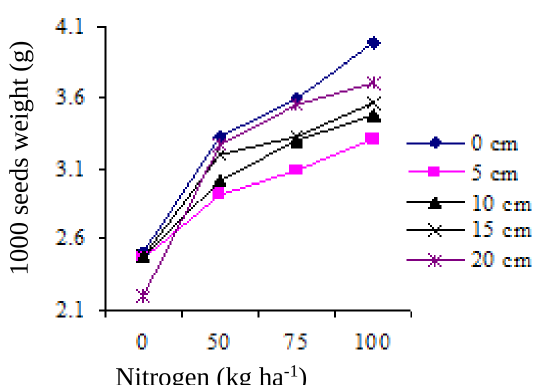

Fig. 1. 1000 seed weight of canola as affected by shoots cutting and nitrogen levels.

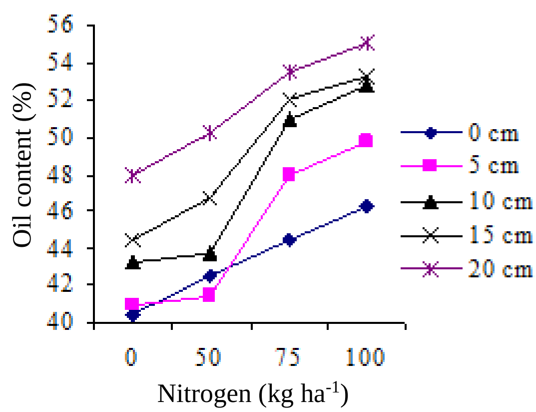

Fig. 2. Oil content (%) of canola as affected by shoots cutting and nitrogen levels.

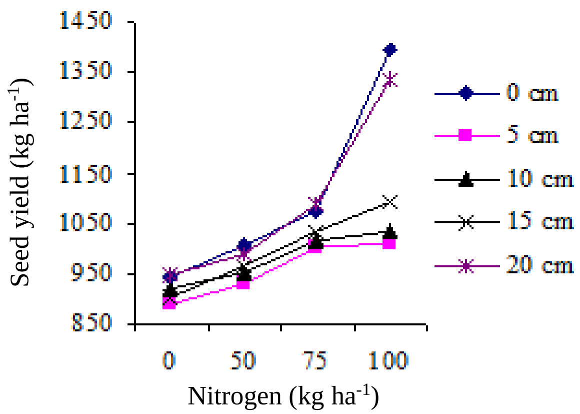

Fig. 3. Seed yield of canola as affected by shoots cutting and nitrogen levels.

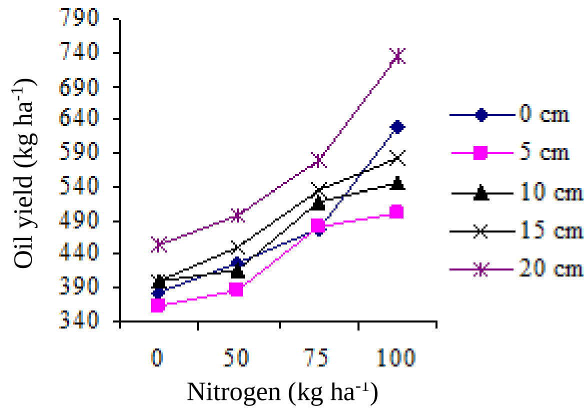

Fig. 4. Oil yield of canola as affected by shoots cutting and nitrogen levels.

nitrogen at the rate of 100 kg ha^{-1} with no shoots cut plots.

Oil contents (%)

Statistical analysis of data showed in Table 1 that nitrogen levels and shoots cutting had significant effect on oil content. Plots supplied with nitrogen had significantly higher oil content as compared to control plots. With increase of nitrogen level oil content increase significantly and therefore the highest level of nitrogen (100 kg ha^{-1}) produced maximum oil content (49 %) while lowest oil content (44 %) was recorded in control plots. These results are in line with the findings of **[10]** who reported that increasing rate of nitrogen application significantly increased oil content over control plots because N is involved in the synthesis of oil. Mean value of shoots cutting showed that maximum oil content (50%) were noted in 20 cm shoots cut plots, while minimum oil content (45%) were recorded in no cut plots. The increase in oil content with the cutting confirmed the findings of **[15]** who found that the removal of top portion of rapeseed showed positive response on oil content which range from 43.9-48%. Interaction between N x Sc indicated in (Fig. 2) that on all shoots cutting increased oil content (%) with increasing in nitrogen levels. However, linear increased was recorded for seed oil content (%) when supplied nitrogen at the rate of 100 kg ha^{-1} with 20 cm shoots cut plots.

Seed yield (kg ha^{-1})

Mean value of nitrogen levels indicated in Table 1 that plots treated with 100 kg ha^{-1}produced maximum seed yield (1169 kg ha^{-1}) while minimum seed yield (923 kg ha^{-1}) was recorded in control plots. This agreed with the finding of **[16]** who reported that yield increased with the increase in N level at 120 kg ha^{-1} as compared with control plots. This could be due to increase the nitrogen level so more branches $plant^{-1}$, pods $plant^{-1}$, seed pod^{-1}, and 1000 grain weight as result seed yield increased. Mean values of shoots cutting indicated that maximum seed yield (1099 kg ha^{-1}) were recorded in no cut plots but statistically a par with 20 cm shoots cut plots, while minimum seed yield (958 kg ha^{-1}) were recorded when crop was cut at 5 cm. This could be due to less regenerative power of brassica cultivar no-cut treatment produced significantly higher seed yield as compared to cut treatment. Similar results were reported by **[15]** who reported that defoliation up to 14 days before anthesis led to reduced seed yield. Interaction between N x Sc indicated in (Fig. 3) that on all shoots cutting increased seed yield with increasing in nitrogen levels. However, linear and maximum increased was recorded for seed yield when supplied nitrogen at the rate of 100 kg ha^{-1} with no cut or 20 cm shoots cut plots.

Oil yield (kg ha^{-1})

Mean value of nitrogen levels indicated in Table 1 that plots treated with 100 kg ha^{-1} produced maximum oil yield (600 kg ha^{-1}) while minimum oil yield (401 kg ha^{-1}) was recorded in control plots. These results confirm the findings of **[17]** who reported that increasing rate of nitrogen application up to 120 kg ha^{-1} significantly and linearly enhanced oil yield as compared to control plots. Mean values of shoots cutting indicated that maximum oil yield (568 kg ha^{-1}) were recorded in 20 cm shoots cut plots, while minimum oil yield (434 kg ha^{-1}) were recorded when crop was cut at 5 cm. These results are similar to **[18, 19]** studied that Leaf removal at the start of flowering reduced the number of pods plant^{-1}, increased seed weight, and reduced seed yield. Leaf removal at the end of flowering did not affect yield or its components therefore highest oil yield was recorded in 20 cm shoots cut plots. Interaction between N x Sc indicated in (Fig. 4) that on all shoots cutting increased oil yield with increasing in nitrogen levels. However linear and maximum increased was produced for oil yield when supplied nitrogen at the rate of 100 kg ha^{-1} with 20 cm shoots cut plots.

Harvest index (%)

Statistical analysis of harvest index data showed in Table 1 that nitrogen had significant effect on harvest index while shoot cutting and the interaction between N x Sc had found not significant. Plots supplied with nitrogen had significantly higher harvest index as compared to control plots. With increase of nitrogen level harvest index increase significantly and therefore the highest level of nitrogen (100 kg ha^{-1}) produced maximum harvest index (14%) while lowest harvest index (11%) was recorded in control plots. These results are in line with the findings of **[20]** who reported that increasing rate of nitrogen application significantly increased harvest index over control plots.

Conclusion and Recommendations

It was concluded from present research work that application of nitrogen at the rate of 100 kg ha^{-1} with no cut or 20 cm shoots cut produced maximum seeds pod^{-1}, 1000 seeds weight, seed oil content (%), seed yield, oil yield and harvest index. It is recommended that canola should be sown under the Peshawar valley condition with the application of nitrogen 100 kg ha^{-1} with on cut or 20 cm shoots cut for higher seed oil content and yield.

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