Asian Journal of Plant Sciences

ISSN 1682-3974

Asian Journal of Plant Sciences
Volume 1 Number 5: 516-518, 2002

Response of Canola to Nitrogen and Sulphur Nutrition

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Abstract: The research work was conducted to study the effect of nitrogen (0, 40, 80 and 120kg ha^{-1}) and sulphur (0, 30, 60 and 90kg ha^{-1}) on the yield and oil contents of canola variety Dunkled. Data were recorded on number of branch plant^{-1}, pods plant^{-1}, seeds pod^{-1}, 1000 grain weight, grain yield (kg ha^{-1}) and oil content. The effect of nitrogen was significant on all the parameters. Plots that received highest dose of N (120 kg ha^{-1}) had maximum number of branches plant^{-1} (14), pods plant^{-1} (760), seeds pod^{-1} (28.04), thousand grain weight (3.15 g) and grain yield (2653 kg ha^{-1}), while minimum oil content (42.1%). Different doses of sulphur had significantly increased number of branches plant^{-1} (12), pods plant^{-1} (582), grain yield (1683 kg ha^{-1}) and oil content (44%), but had not significantly affected seeds pod^{-1} and 1000 grain weight. Grain yield was significantly higher at the highest levels of both the nutrients applied.

Key words: Canola, N, S, branch plant^{-1}, pod plant^{-1}, grain yield, oil content

Introduction

Pakistan is chronically deficient in the production of edible oil and 70% of the country's requirements are meet through imports costing huge amount of foreign exchange, as edible oil is the single largest food import item in Pakistan (Aslam *et al.*, 1996). In addition to the various factors, growing of canola on marginal and infertile land is the major factor drastically effecting per unit yield. Efforts on the proper mineral nutrition keeping in view the environmental concern are need of the hour in order to be self sufficient in edible oil production.

Nitrogen increases protein formation, protoplasm, greater cell size, photosynthetic activity and thus provide a large frame on which more flowers and pods are produced (Beech and Norman, 1964). Nitrogen increased number of branch plant^{-1}, pods plant^{-1}, seeds pod^{-1} and grain yield kg ha^{-1} (Qayyum *et al.*, 1998), 1000 seeds weight (Basak *et al.*, 1990). Sulphur deficiency often inhibits the synthesis of protein and consistently results in a reduction in the relative amount of the sulphur - containing amino acids and these both factors may reduce the nutritional value of rapeseed meal as a livestock feed (Eaton, 1942). Sulphur increased number of branches plant^{-1}, pods plant^{-1} (Rathor and Manohar, 1989) and grain yield kg ha^{-1} (Nepalia and Sarhoa, 1992 and Withers, 1992).

Materials and Methods

Experiment to study the effect of nitrogen and sulphur on the yield and oil content of canola was conducted at Agriculture Research Farm, NWFP Agricultural University, Peshawar, during the year 1999-2000.

Treatments consisted of four nitrogen levels (0, 40, 80 and 120 kg ha^{-1}) and four sulphur levels (0, 30, 60 and 90 kg ha^{-1}) applied as a whole at the time of sowing. The experiment laid out in a randomized complete block (RCB) design. There were 16 subplots in one replications. The size of the subplot was 4x4 m^2. Each subplot had 10 rows with row to row distance 40 cm. The plant to plant distance was maintained at 15 cm within the row. Before sowing randomized samples of soil were taken from the plot and analysed at Soil Science Laboratory, Agricultural Research Institute, Tarnab, Peshawar.

At the time of sowing K_2SO_4 was used as sulphur source. In case of zero sulphur KCl was used in order to balance K in all the plot. Urea was used as nitrogen source. A basal dose of phosphorus (60 kg ha^{-1}) was applied at the time of sowing. The Dunkled variety of canola was seeded at the rate of 5 kg ha^{-1}. The parameters recorded during the course of experiment were number of branches per plant, number of pods per plant, number of seeds per pod, 1000-grains weight (g) and grain yield kg ha^{-1}. Statistical analysis were performed by the method given by Gomez and Gomez (1976). LSD test was applied at 5% level of probability for statistical interpretation.

Results and Discussion

Number of branches plant^{-1} were significantly affected by different doses of nitrogen and sulphur (Table 1). Maximum of 14.04 branches plant^{-1} were recorded in those plots, which received maximum nitrogen (120 kg ha^{-1}), while minimum number (8.38) of branches plant^{-1} were recorded in those plots, which received no nitrogen. The increase in number of branches plant^{-1} with increase in nitrogen level may be due to the fact that the nitrogen promoted the vegetative growth and branching of the inflorescence. These results are in agreement with those documented by Uddin *et al.* (1992), who stated that number of branches plant^{-1} significantly increased with increased in nitrogen doses from 0 to 150 kg ha^{-1}. Qayyum *et al.* (1998) observed increasing trends in number of branches plant^{-1} in canola with increase in nitrogen levels. The mean values for sulphur showed significant differences in branch plant^{-1} with application of sulphur doses. Highest dose of sulphur (90 kg ha^{-1}) had the highest number of branches plant^{-1} (11.73) although it was at par with 60 kg S ha^{-1}. While the minimum number of branches plant^{-1} were recorded in those plot which either received 30 kg S ha^{-1} or received no sulphur. The possible reason may be that rapeseed contains relatively large quantity of sulphur containing amino acids, methionine, and cystein, which might have increased protoplasm of the cell and ultimately cell size.

Number of pods plant^{-1} were significantly affected by different does of nitrogen and sulphur. Data showed that maximum of 760 pods plant^{-1} were recorded in those plots which received maximum nitrogen (120 kg ha^{-1}) while minimum of 358 pods plant^{-1} were produced by those plot which received no nitrogen (control plots). Number of pods plant^{-1} increased with increase in nitrogen and it is expected as N increase number of pods in rapeseed. These results are confirmed by Gulzar *et al.* (1989) and Qayyum *et al.* (1998).

Mean values for sulphur showed that effect of sulphur on number of pods plant^{-1} was also significant (Table 2). The maximum of 582 pods plant^{-1} were recorded in those plots which received maximum sulphur (90 kg S ha^{-1}), while minimum of 472 pods plant^{-1} were recorded in those plots which received no sulphur. The increase in number of pods plant^{-1} with increase in sulphur level upto 60 kg ha^{-1} may be due to the deficiency of sulphur for rapeseeds at lower levels non availability of sulphur. So in case of higher sulphur the requirement of the crop for sulphur were probably satisfied which resulted in maximum number of pods plant^{-1}. These results are also confirmed by Rathore and Manohar (1989), who stated that increasing sulphur levels from 0 to 160 kg ha^{-1} significantly increased number of pods plant^{-1} in mustard (*Brassica juncea*).

Mean value for number of seeds pod^{-1} showed that different doses of nitrogen had significantly affected the number of seeds pod^{-1}. Maximum of 28.04 seeds pod^{-1} were recorded in those

Table 1: Number of branches plant^{-1} as affected by different doses of nitrogen and sulphur

Nitrogen (kg ha^{-1})	Sulphur (kg ha^{-1}) Control	30	60	90	Mean
Control	08.60	08.35	08.00	08.58	08.38d
40	10.28	10.28	10.53	10.43	10.38c
80	11.95	12.38	11.90	13.35	12.39b
120	13.38	13.75	14.50	14.55	14.04a
Mean	11.05b	11.19b	11.23ab	11.73a	

LSD for nitrogen and sulphur = 0.5005

Means of each category followed by different letters are significantly different at P≤0.05

Table 2: Number of pods plant^{-1} as affected by different doses of nitrogen and sulphur

Nitrogen (kg ha^{-1})	Sulphur (kg ha^{-1}) Control	30	60	90	Mean
Control	287	328	398	419	358d
40	384	427	498	503	453c
80	516	536	593	601	561b
120	701	736	798	806	760a
Mean	472c	507b	572a	582a	

LSD for nitrogen and sulphur = 78

Means of each category followed by different letters are significantly different at P≤0.05

Table 3: Number of seeds pod^{-1} as affected by different doses of nitrogen and sulphur

Nitrogen (kg ha^{-1})	Sulphur (kg ha^{-1}) Control	30	60	90	Mean
Control	21.50	20.75	22.68	22.68	21.90c
40	23.88	25.50	25.68	24.55	24.90b
80	26.80	27.75	27.18	27.78	27.38a
120	26.20	28.00	27.75	28.20	28.04a
Mean	25.09	25.50	25.82	25.80	

LSD for nitrogen = 0.9153 Sulphur non significant

Means of each category followed by different letters are significantly different at P≤0.05

Table 4: Thousand grain weight (g) as affected by different doses of nitrogen and sulphur

Nitrogen (kg ha^{-1})	Sulphur (kg ha^{-1}) Control	30	60	90	Mean
Control	2.717	2.560	2.650	3.090	2.754b
40	2.558	2.498	2.650	3.270	2.744b
80	3.335	3.103	3.257	2.993	3.122a
120	3.027	3.260	3.170	3.145	3.151a
Mean	2.909	2.855	2.932	3.124	

LSD for nitrogen = 0.2970 Sulphur non significant

Means of each category followed by different letters are significantly different at P≤0.05

Table 5: Grain yield (kg ha^{-1}) as affected by different doses of nitrogen and sulphur

Nitrogen (kg ha^{-1})	Sulphur (kg ha^{-1}) Control	30	60	90	Mean
Control	559	572	635	958	681d
40	923	1101	1231	1333	1147c
80	1541	1657	1763	1710	1668b
120	2481	2655	2745	2731	2653a
Mean	1376c	1496b	1593b	1683a	

LSD for nitrogen and sulphur = 93

Means of each category followed by different letters are significantly different at P≤0.05

Table 6: Oil contents (%) as affected by different doses of nitrogen and sulphur

Nitrogen (kg ha^{-1})	Sulphur (kg ha^{-1}) Control	30	60	90	Mean
Control	40.85	42.67	44.72	43.32	42.89a
40	40.04	43.03	44.67	43.26	42.75a
80	40.19	43.46	43.45	43.38	42.62a
120	39.68	42.77	43.17	42.78	42.10b
Mean	40.19c	42.75b	44.00a	43.19b	

LSD for nitrogen and sulphur = 0.3055

Means of each category followed by different letters are significantly different at P≤0.05

plots which received maximum nitrogen (120 kg N ha^{-1}). While minimum number of 21.90 seeds pod^{-1} were recorded in control plots (Table 3). The results are in agreement with Qayyum *et al.* (1998), who stated that increasing nitrogen level from 0 to 120 kg ha^{-1} significantly increased the number of seeds pod^{-1}. The effect of sulphur on the number of seeds pod^{-1} was statistically not significant. These results are in line with those reported by Basak *et al.* (1990), who stated that there was no significant effect of sulphur application on the number of seeds pod^{-1} in *Brassica napus* and *Brassica compestris* in their studies.

Mean value for 1000 grains weight showed that the effect of nitrogen on 1000 grains weight was significant (Table 4). The effect of nitrogen on 1000 grains weight became visible when nitrogen was increased to 80 kg ha^{-1} but no significant increased in 1000 grain weight was noticed when nitrogen was increased beyond 80 kg ha^{-1}. The increase in 1000 grain weight may be due to the sufficient availability of nitrogen to the plants. These results are in line with those reported by Hamid *et al.* (1986), who stated that maximum 1000 grains weight was obtained when nitrogen was applied at the rate of 100 kg ha^{-1}. While Uddin *et al.* (1992) observed that 1000 grains weight increased significantly when nitrogen was increased from 0-150 kg ha^{-1}. Mean value of the data for 1000 grains (Table 4) showed that the effect of sulphur on 1000 grains weight was not significant although there was a small increase in 1000 grains weight with increase in sulphur doses. These results are in line with those reported by Basak *et al.* (1990) who stated that there was no significant effect of sulphur on 1000 grain weight.

Mean value of grain yield revealed that both nitrogen and sulphur had significantly affected grain yield (Table 5) and maximum grain yield of 2653 was produced by those plots which received maximum nitrogen (120 kg ha^{-1}) while minimum grain yield of 681 kg ha^{-1} was produced by those plots which received no nitrogen (control). Grain yield increased significantly with increase in nitrogen levels. Maximum yield at the highest nitrogen levels might be due to the fact that the yield components i.e., number of branches plant^{-1}, number of pods plant^{-1}, number of seeds pod^{-1} and 1000 grains weight were all increased with increase in nitrogen. As a result there was increase in grain yield. These results are in agreement with those reported by Rathor and Manohar (1989), Uddin *et al.* (1992), who found that grain yield increased significantly when nitrogen dose increased from 0 to 150 kg ha^{-1}.

Mean value for sulphur (Table 5) showed that sulphur had also significant effect on grain yield. Maximum grain yield of 1683 kg ha^{-1} was produced by those plots which received maximum sulphur i.e. 90 kg S ha^{-1} while minimum grain yield of 1376 kg ha^{-1} was produced by those plots which received no sulphur (control plots). The increase in grain yield with increase in sulphur may be due to the fact that sulphur is also necessary for the growth and development of seed as a food nutrient. As the sulphur had also affected significantly the yield components like number of branches/plant and number of pods plant^{-1} as a result there was increase in grain yield with increase in sulphur. These results are in agreement with those reported by Nepalia and Sarhoa (1992), who found that highest yield of 1.27t ha^{-1} was obtained when sulphur was applied at rate of 250kg ha^{-1}.

Data regarding percentage of oil contents revealed that different levels of nitrogen and sulphur had significantly affected the percentage of oil contents of the seed (Table 6). The mean value of the data showed that the application of nitrogen upto (0-80 kg N ha^{-1}) had no significant effect on the oil content but oil content decreased significantly (42.62-42.10%) when the level of nitrogen increased to (120 kg N ha^{-1}). The possible reason for the decrease in oil content with increase in nitrogen may be due to the fact that nitrogen is the major constituent of protein so it might be increased the percentage of protein of the seed as a result there might be a decrease in the percentage of oil content as it has inverse relationship with protein. The results are in agreement with those documented by Augustinussen *et al.* (1983) who reported that seed oil content decreased from 46.3% with PK alone to 42.5 percent with 130 kg N ha^{-1} and 41.7% with 260 Kg N ha^{-1}. Zhao *et al.* (1993), reported decreasing trends in oil contents with increase in nitrogen rate. The data regarding effect of sulphur showed that sulphur had significantly increased percentage of oil contents (Table 6). Maximum oil percentage (44%) was recorded in those plots which received 60 kg S ha^{-1} while minimum of 40.19% was recorded in those plots which received no sulphur (control plots). The data also showed that there was a decreased in oil percent (43.19%) with increase in sulphur level beyond 60 kg S ha^{-1}. The maximum oil contents at 60 kg S ha^{-1} are in agreement with Chaudhary *et al.* (1992) who reported that seed oil contents increased from 41.05 to 43.49% with increase in sulphur rates from 0-50 kg S ha^{-1}.

Although the inverse relationship between grain yield and oil content was observed with increase in nitrogen levels, grain yield increased many fold than reduction in oil contents at 120 kg N ha^{-1}. Increase in oil contents was more than reduction in grain yield when sulphur was applied at rate of 60 kg S ha^{-1}. These results indicated that 120 kg N ha^{-1} and 60 kg S ha^{-1} would be a better combination for higher grain yield and oil contents.

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