The effects of sulfur fertilizer and plant densities on seed and oil yield of Canola cultivars

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Abstract
In order to evaluate the effects of sulfur fertilizer and plant densities on seed and oil yield of new cultivars of canola, an experiment was conducted in 2004-2005 in form of split split plot design within randomized complete block design with three replications. The main plots consist of level of sulfur fertilizer (0, 125 and 150 kg/ha), sulfur fertilizer as S bentonite fertilizer (45%) was applied. By granulation of bentonite with S, stable and dust-free granules were produced. Subplots were composed of three plant densities (60, 80 and 100 plants/m^2), and sub subplots were included three kinds of canola namely, RGS003, Hyola401 and Hyola420. Sulfur application had significant effect on oil percentage. The effects of plant density on all experiment traits were not significant. Cultivars had significant effects on plant height, length of pod in main stem, seed yield, oil percentage and oil yields. Oil percentage was significantly influenced by interaction between plant density and cultivars. The highest seed yield and oil yield was related to application of 150 kg S/ha and 60 plants per m^2. Hyola401 also obtained the highest seed and oil yield. So under similar condition with this study, application of 250 kg S/ha, using Hyola401 and the plant density of 60 plants per m^2 seems appropriate.
Keywords: Sulfur fertilizer, plant density, canola, cultivars.

Introduction

Canola is a crop that demands high sulfur inputs to achieve maximum seed yield (Karamanos et al., 2007). Application of sulfate-S to canola at seeding time gives the highest increase in yield and S uptake (Malhi et al., 2005). Knowing the plant requirement of S in relation to season variations and soil S availability can provide the basis for optimum amendments decisions (Kowalenko, 2009). Plant density governs the components yield (Diepenbrock, 2000). Laaniste et al., (2008), reported that a lower plant density (47 plants per m^2) produced yields just as high as those with higher density (98 plants per m^2). In Iran, little information is a available on the response of canola to changes sulfur supply, and best plant density for producing canola. So, the aim of this study was to determine the effects of sulfur fertilization and plant density on seed yield and oil yield of canola cultivars in Iran.

Materials and Methods

To investigate the effect of sulfur fertilizer and plant densities on seed and oil yield of new cultivars of canola, an experiment was conducted in 2004-2005 in form of split split plot design within randomized complete block design with three replications. The main plots consist of level of sulfur fertilizer (0, 125 and 150 kg/ha), sulfur fertilizer as S bentonite fertilizer (45%) was applied. By granulation of bentonite with S, stable and dust-free granules were produced. Subplots were composed of three plant densities (60, 80 and 100 plants/m^2), and sub subplots were included three kinds of canola namely, RGS003, Hyola401 and Hyola420. The study was conducted at research farm, experimental research station, Gorgan city, Golestan province, Iran (latitude 36^o $45^/$ N, longitude 54^o $25^/$ E, and 55 m elevation). In this study an experiment analysis of soil was done at 0-30 cm depth. The soil type was silty loam and EC was 0.85 at 0-30 cm. These three cultivars had good potential to be planting in humid and warm environment. The soil preparation consisted of mouldboard ploughing (20-25 cm) followed by discing and smoothing with a land leveler. On the basis of soil analysis, the field was fertilized with 50 kg N per ha from urea. Top dressed urea was also applied at the rate of 50 kg N per ha at the beginning of the stem elongation stage of canola. Trifloralin (2.5 lit per ha) was used as pre-planting herbicide for control weeds. This herbicide was mixed with soil and ferilizer by low discing. The nitrogen fertilizer was used from urea (50 percent before planting and 50 percent in the beginning of reproductive phase). Sulfur fertilizer was diffused and mixed with soil based upon each treatment. Plots were 7 m long with 6 rows spaced 24 cm apart. The distance for main plots in order to fertilizer treatment were 2 m. The seeds were seeded on 15 November, and, finally thinned to one seed of canola per hole at 3-4 leaf stage in order to obtain

target density. The distance between plants in each row were 7, 5 and 4 cm to obtain 60, 80 and 100 plants per m^2, respectively. After planting, the entire field was sprinkler irrigated until seedling establishment and then relied upon precipitation for the remainder of the season. The crop was harvested manually in May when seed moisture reduced to 14%. Rows number 1 and 6 and also up to 50 cm, primer and edge lines were discarded form sampling. Oil content was determined by nuclear magnetic resonance analyzer (NMR). Analysis of variance (ANOVA) was used to determine the significant differences. The Multiple Range Test of Duncan performed the separation means. All statistics was performed with MSTAT-C program (version 2.10).

Result and Discussion

Sulfur application had significant effects on oil percentage ($P<0.05$). Seed yield and oil yield was not significantly influenced by sulfur fertilizer (Table 1). The effects of plant density on experimental traits were not significant (Table 1). The effects of cultivars on plant height, length of pod in main stem, seed yield, oil percentage and oil yield were significant (Table 1). Oil percentage was significantly influenced by interaction between plant density and cultivar ($P<0.05$) (Table 1). The highest plant height was related to Hyola420 (167.1 cm). The differences between Hyola420 and other cultivars were significant, but the difference between RGS003 and Hyola401 was not significant (Table 2). The maximum stem diameter was related to 60 plants per m^2 (11.58 mm). In high plant densities, increased in plant height and intra specific competition cause decrease in stem diameter. Hyola401 had the highest stem diameter (11.60 mm), and minimum stem diameter was related to Hyola420 (11.16 mm). There was no significant difference between Hyola401 and other cultivars (Table 2). High length of pod is a good trait to contain more seeds in pods. The maximum length of pod in main stem was related to 60 plants per m^2 (70.99 mm). The maximum length was related to Hyola401 (72.39 mm). The differences between RGS003 and other cultivars were significant. Long pods with more seeds, resulting in a greater seed yield per plant. The increase trend in seed yield was achieved from 0 to 250 kg S/ha. The difference between 250 and 0 kg S/ha was significant, but there was no significant difference between 250 and 125 kg S/ha (Table 2). A uniform distribution of plants per unit area is a prerequisite for yield stability (Diepenbrock, 2000). Hyola401 had the highest seed yield (3803 kg/ha), and the minimum seed yield was related to RGS003 (2574 kg/ha) (Table 2). The maximum oil percentage was related to no application of sulfur fertilizer (41.95%). Oil percentage was decreased from 0 to 250 kg S/ha. The highest oil percentage was related to 60 plants per m^2 (41.52%). Oil percentage was decreased from 60 to 100 plants per m^2, but this trend was not significant (Table 2). The highest oil percentage was related to Hyola420 (41.94%). The difference in oil percentage between Hyola401 and Hyola420 was not significant, but the difference between Hyola420 and RGS003 was significant. The maximum oil percentage was related to Hyola420 and 60 plants per m^2. The highest oil yield was related to 250 kg S/ha (1359 kg/ha). The oil percentage was decreased from 60 to 100 plants per m^2. Hyola401 had the highest oil yield (1580 kg/ha). Hyola401 had significant difference with RGS003, but there was no significant difference between Hyola401 and Hyola420.

Table 1- Analysis of variance for experimental characteristics.

S.O.V	d.f.	Plant height (cm)	Stem diameter (mm)	Length of pod in main stem (mm)	Seed yield (kg/ha)	Oil percentage (%)	Oil yield (kg/ha)
Replication	2	54.117	0.041	38.971	682646.89	21.864	112823.211
Sulfur	2	24.276	1.751	10.301	277901.56	16.622*	78399.575
Error (a)	4	160.502	0.859	22.990	93956.66	7.513	16636.069
Plant density	2	28.495	0.891	3.713	1612901.87	0.675	280764.622
Sulfur × plant density	4	130.170	0.859	8.027	172665.171	2.867	56942.485
Error (b)	12	230.544	2.836	6.184	352652.32	17.732	104740.349
Cultivar	2	3876.269**	1.360	130.374**	10501928.83**	15.694*	2246293.050**
Sulfur × cultivar	4	74.107	0.364	8.268	606112.93	5.663	117769.699
Plant density × cultivar	4	25.640	0.137	2.165	235403.29	10.576*	43954.788
Sulfur × plant density × cultivar	8	50.828	0.495	9.522	317104.62	1.148	59367.331
Error (c)	36	79.267	0.829	9.483	534897.83	3.982	70509.083

*significant at 0.05 significance in F-tests
**significant at 0.001 significance in F-tests

Table 2- Mean comparison for plant height (cm), stem diameter (mm), length of pod in main stem (mm), seed yield (kg/ha), oil percentage (%), and oil yield (kg/ha).

Treatment	Plant height	Stem diameter	Length of pod in main stem	Seed yield	Oil percentage	Oil yield
Sulfur fertilizer (kg/ha)						
0	152.6a	11.43a	70.05a	3132a	41.95a	1308a
125	153.0a	11.23a	70.23a	3208a	41.45ab	1336a
250	154.4a	11.16a	71.46a	3309a	40.42b	1359a
Plant density (plants/m^2)						
60	152.4a	11.58a	70.99a	3446a	41.52a	1410a
80	154.5a	11.24a	70.47a	3327ab	41.33a	1399a
100	155.8a	11.07a	70.27a	2976b	41.14a	1228a
Cultivar						
Hyola401	145.6b	11.60a	72.39a	3803a	41.50ab	1580a
Hyola420	167.1a	11.16a	71.22ab	3371b	41.94a	1430ab
RGS003	147.3b	11.27a	68.13b	2574b	40.35b	1023b

Common letters within each column do not differ significantly.

Conclusion

So under similar condition with this study, application of 250 kg S/ha, using Hyola401 and the plant density of 60 plants per m^2 seems appropriate.

References

1- Diepenbrock, W. 2000. Yield analysis of winter oilseed rape (Brassica napus L.): a review. Field Crops Research. 67: 35-49.
2- Karamanos, R. E. Goh, T. B., Flaten, D. N. 2007. Nitrogen and sulphur fertilizer management for growing canola on sulphur sufficient soils. Canadian Journal of Plant Science. 87(2): 201-210.
3- Kowalenko, C. G. 2009. Availability of single spring application of three sulphur fertilizer to grass under humid weather conditions. Canadian Journal of Soil Science. 89(4): 511-519.

4- Laaniste, P., Joudu, J., Eremeev, V., Maeorg, E. 2008. Effect of sowing rates on plant density and yield of winter oilseed rape (Brassica napus L) under Nordic climate conditions. Acta Agriculture Scandinavica Section B-Soil and Plant Science. 58(4): 330-335.
5- Malhi, S. S., Schoenau, J. J., Grant, C. A. 2005. A review of sulphur fertilizer management for optimum yield and quality of canola in the Canadian Great Plaings. Canadian Journal of Plant Science. 85(2): 297-307.