Changes of yield and yield components of canola cultivars under different plant densities and application of sulfur fertilization

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Abstract

In order to evaluate the effects of sulfur fertilizer and plant density of new cultivars of canola under climatic condition of Gorgan and its suburb, 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. Sulfur application had significant effect on the number of pod per plant, biological yield and harvest index. None of the experimental parameters were influenced by plant density, but cultivar had significant effects on seed yield, a thousand seed weight, biological yield and harvest index. The maximum seed yield, a thousand seed weight and harvest index was obtained by Hyola401. So, Cultivation of Hyola401 combine with application of 250 kg S/ha and 60 plants per m^2 was recommended to Isfahan farmers, to achieving high economic benefits.

Keywords: Canola, cultivars, plant density, sulfur, yield and yield components, Gorgan.

Introduction

Sulfur (S) plays a vital role in plant metabolism (Cregut et al., 2009), and canola requires relatively large amount of sulfur (S) per yield unit compared to most grain crops (Singh et al., 2006). Applying the proper rates of fertilizer, particularly N and S, increase seed yield. Jackson (2000), concluded that for an optimum level of canola seed yield and oil, 20 and 200 kg/ha of S and N is required, respectively. To produce high seed yield, it is necessary to manage both selecting good varieties and environmental parameters such as planting density and sulfur utilization. The biological yield of winter oilseed rape is the product of the growth rate and duration of vegetative period (Diepenbrock, 2000). The harvest index of modern cultivars of winter wheat showed a 45-50% increase, while that of winter oilseed rape increased by about 25-30% (Diepenbrock, 2000). The aim of this study was to determine the suitable plant density and sulfur fertilizer for new cultivars under climatic condition of Gorgan and its suburb.

Materials and Methods

In order to evaluate the effects of sulfur fertilizer and plant density of new cultivars of canola under climatic condition of Gorgan and its suburb, 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. Long term average precipitation was 650 mm. The soil type was silty loam and EC was 0.85 at 0-30 cm. 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. 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 row spaced 24 cm apart. 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. Harvest index was computed as the ration of the seed yield to aboveground dry matter at harvest (Equation 1). 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).

$$1) \quad HI = \frac{\text{Seed yield}}{\text{Biological yield}} \times 100$$

Table 1- Mean temperatures and annual precipitation from planting to harvesting.

Month	Minimum temperature (^oC)	Maximum temperature (^oC)	Average of temperature (^oC)	Precipitation (mm)
23 Oct- 21 Nov	11.7	22.3	17	49.5
22 Nov- 21 Dec	4	14.7	9.3	107.8
22 Dec- 20 Jan	3.9	12.4	8.1	103.4
21 Jan- 19 Feb	2.5	10	6.2	54
20 Feb- 20 Mar	7.1	17.5	12.3	71.7
21 Mar- 20 Apr	7.9	19.5	13.7	58.9
21 Apr- 21 May	14.8	24.8	19.8	76.3

Result and Discussion

The influence of sulfur was significant on number of pod in plant ($P<0.05$) (Table 2). The highest number of pod was obtained by application of 250 kg S/ha (171.37). An increase trend was found from application of 0 to 250 kg S/ha, but it was not significant (Table 3). Momoh and Zhou (2001) also reported that, the average number of seeds per pod was significantly lower for high density plants. The sulfur fertilizer and plant density had no significant influence on number of seed per plant (Table 2). The highest seed number was related to application of 250 kg S/ha (4472). Cultivar had significant effect on number of seed per plant (Table 2). Hyola401 had the highest number of seed (4260), and the minimum one was related to RGS003 (3927). Hyola401 can not achieve significant differences with other cultivars (Table 3). Sulfur and plant density had no significant effect on seed yield (Table 2). The highest seed yield was related to 250 kg S/ha (3309 kg/ha), and the lowest seed yield was obtained by 0 kg S/ha (3132 kg/ha). There was a decrease trend in seed yield from 60 to 100 plants per m^2. Momeh et al. (2004), reported the increased of 16.0% and 13.3% in seed yield respectively with increasing plant density from 67500 to 97500 plants per ha and from 97500 to 127500 plants per ha. A uniform distribution of plants per unit area is a prerequisite for yield stability (Diepenbrock, 2000). Cultivar had significant effect on seed yield ($P<0.01$) (Table 8). Hyola401 had the highest seed yield (3803 kg/ha) (Table 3). The sulfur fertilizer and plant density had no significant effect on 1000 seed weight (Table 2). The maximum 1000 seed weight was related to application of 250 kg S/ha (3.017 g). Low plant population (60 plants per m^2), provide suitable environment for plant growth and development. Cultivar had significant effect on 1000 seed weight ($P<0.01$) (Table 2). The highest seed weight was related to Hyola401 (3.224 g), and the minimum one was achieved in RGS003 (2.835 g). Sulfur fertilizer had significant effect on biological yield ($P<0.05$) (Table 2). Biological yield was increased significantly from 0 to 250 kg S/ha. Although, application of sulfur, cause an increase in dry matter accumulation and improved photosynthetic process. Cultivar had significant influence on biological yield ($P<0.01$) (Table 2). Hyola401 was achieved the maximum biological yield (26280 kg/ha). There was no significant difference between Hyola420 and RGS003, but Hyola401 had significant differences with Hyola401 and RGS003 (Table 3). Sulfur fertilizer had significant effect on harvest index ($P<0.05$) (Table 2). The maximum harvest index was related to application of 250 kg S/ha. Harvest index was increased significantly from 0 to 250 kg S/ha. Application of 250 kg S/ha had significant difference with 0 and 125 kg S/ha. There was a decrease trend from 60 to 100 plants per m^2. The minimum harvest index was related to 100 plants per m^2 (13.17%). Cultivar had significant effect on harvest index ($P<0.01$) (Table 2). Hyola401 had the highest harvest index (17.41%). The harvest index in Hyola420 was 14.54%. Hyola401 had significant differences with Hyola420 and RGS003, and also the difference between Hyola420 and RGS003 was significant (Table 3). Increasing the harvest index at given biomass is promising agronomical goal.

Table 2- Analysis of variance for experimental characteristics.

S.O.V	d.f.	The number of pod per plant	The number of seed per plant	Seed yield	A thousand seed weight	Biological yield	Harvest index
Replication	2	2416.344	3199098.4	682646.89	0.100	64135030.83	48.328
Sulfur	2	1827.206*	2099855.3	277901.56	0.059	1250706790*	46.227*
Error (a)	4	517.474	1057885.7	93956.66	0.257	6722993.82	4.215
Plant density	2	650.392	554228.3	1612901.87	0.172	31574845.679	21.346
Sulfur×Plant density	4	273.270	495276.6	172665.171	0.164	1328708.64	19.448
Error (b)	12	2034.590	1569429.5	352652.32	0.070	23322145.06	14.601
Cultivar	2	459.910	1470070.5	10501928.83**	0.661**	120834104.93**	406.183**
Sulfur×Cultivar	4	690.933	519058.8	606112.93	0.065	20699845.67	5.889
Plant density×Cultivar	4	364.855	503695.6	235403.29	0.025	28758873.45	5.893
Sulfur×Plant density×Cultivar	8	674.976	897554.2	317104.62	0.032	19680169.75	7.401
Error (c)	36	674.575	818405.8	534897.83	0.066	18922839.50	5.997

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

Table 3- Mean comparison for experimental characteristics.

Treatment	The number of pod per plant	The number of seed per plant	Seed yield	A thousand seed weight	Biological yield	Harvest index
Sulfur fertilizer (kg/ha)						
0	38.60a	3936b	3132a	2.925a	22690b	12.19b
125	41.72a	4073b	3208a	2.986a	24050a	14.12a
250	42.96a	4472a	3309a	3.017a	25440a	15.08a
Plant density						
60	42.90a	4258s	3446a	3.147a	25300a	14.89a
80	40.77a	4238a	3327ab	2.982a	23580b	13.64a
100	39.60a	3995a	2976b	2.889a	23300b	13.17a
Cultivar						
Hyola401	41.00ab	4260a	3803a	3.244a	26280a	17.41a
Hyola420	44.27a	4194a	3371b	2.948b	23830b	14.54a
RGS003	38.01b	3927a	2574b	2.835b	22060b	9.73b

Common letters within each column do not differ significantly.

Conclusion

Cultivation of Hyola401 combine with application of 250 kg S/ha and 60 plants per m^2 was recommended to Isfahan farmers, to achieving high economic benefits.

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