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Effect of different plant density on production parameters of canola (*Brassica napus* L.)

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Abstract

The purpose of this study was to evaluate the yield and yield component of canola (*Brassica napus* L.) cultivars in different plant density. An experiment was conducted in a randomized complete block design with three replications. Main plots were four canola cultivars viz, Hyola 60, Opera, Zarfam and Sarigol sub plots consisted of three plant densities (45, 65 and 85 plants/m^2). Hyola 60 had the highest grain yield (3425.2 kg/ha) and number of pods per plant (95.4 pods). Interaction effect of cultivar x plant density affected all traits except number of pod per plant. Results showed that the highest seed yield (3751.2 kg/ha) was obtained from Hyola 60 hybrid with 65 plant/m^2.

Keywords: Canola; Plant density; Seed yield; yield component

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Introduction

Statistics indicates that canola has more annual production growth than soybean, cotton, sunflower and peanut and its higher production moved it from fifth to third order. Increasing population followed by increasing consuming vegetable in recent years has caused more than 90% consumption of oil of Iran supply via imports. Canola cultivars oil has higher nutritious value compared with other oil seeds due to its high unsaturated fatty acids. One way to increase seed yield/m^2 is using suitable cultivars compatible with climate conditions of any region in desired planting density in a manner to create minimum competition among plants.

One of the main goals in agriculture is determining best plant density to get desired yield. Desired density is obtained when a canopy has maximum leaf area to catch sunlight at the beginning of reproductive stage (Maddonni et al., 2001; Larry et al., 2002). Increasing light penetration into lower parts of canopy by changing its structure is a management practice which causes improved yield (Reta-Sanches and Fowler, 2002). Heikkinen and Auld (1991) recommended densities more than plants/m^2 for canola. James and Anderson (1994) suggested that yield increased with increasing in plant density by increasing pod/m^2. Potter et al. (2002) observed in studying rows spacing and seed rate effect on canola cultivars and found that seed yield increased significantly with increasing density to 50 plants/m^2.

Canola is the first choice to supply needed vegetable oil in the country. Canola planting is very important than other oily seeds due to its compatibility with most the country region and its higher qualitative oil. Due to importance of oil seeds and no existing data about plant density effect on seed yield and oil content of cultivars under Ilam conditions (Iran), an experiment was conducted to identify the best cultivar and also best plant density in this region.

Materials and Methods

In order to study yield and agronomy traits of canola cultivars response to different plant densities, an experiment was conducted as split plots in randomized

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complete block design in three replications during 2009-2010, in Ilam, Iran. Main plot included four hybrid and cultivars, Hyola 60 hybrid, Opera, Zarfam cultivar and Sarigol cultivar and subplot also included three plant density levels (45, 65 and 85 plants/m^2). Soil was loamy to 30cm depth and 65% mm electrical conductivity and 8 acidic reactions. Rainfall rate was 256 mm in year in which experiment was conducted. Canola seeds were planted manually on 6m long and 2.5m wide plots into 4cm depth. Plots were irrigated as plot by plot. Urea and ammonium phosphate fertilizers were used at the rate of 65 and 160 kg/ha respectively. Plots thinned up to 4-5 leave stage to obtain desired density. At the plant maturity, middle rows of plots were harvested and sent to laboratory to determine grain yield, yield components and harvest index calculated as dividing seed yield by biological yield. Oil and protein content were measured using Sockselle and Kejdhal method. Obtained data were analyzed using SPSS software and means compared employing Duncan multiple rage test.

Results and Discussion

Grain yield

Significant difference in seed yield between studied cultivars were observed (table 1). Highest seed yield was observed in Hyola 60 hybrid and lowest was in Zarfam cultivar. In general, seed yield difference of cultivars was contributed to their genetic properties, thus Hyola60 yield highest pods per plant and 1000 seed weight than other cultivars and as a result it yielded higher yield. Low seed yield of Zarfam cultivar is contributed to low pods per plant and 1000-seed weight. Significant difference was also observed between different plant densities (table1). Thus, changing plant density caused significant change in seed yield. Mean seed yield in 45, 65, 85 plants/m^2 densities were 3050.2, 3259.2 and 3150.3 kg/ha respectively (Table2). In thicker densities (85 plants/m^2), absorbed sunlight into canopy decreased photosynthetic due to increase competition among plants.

Table 3 showed seed yield in response to plant density. Highest seed yield was produced in 65 plants/m^2 density. Results of Larry et al. (2002) on soybean showed that increasing plant density caused decrease in seed yield. Other reports also pointed out that if lodging occurs when plant is metabolically active, it would cause direct reduction in seed yield (Emam and Eilkaee, 2002). Interaction of cultivar and plant density showed a significant difference in seed yield ($P<0.01$). In high densities (65 plants/m^2), total sunlight penetration into canopy increased and as a result seed yield was also improved. Other reports also show that in very thick densities, leave would fall quickly and sever competition to absorb light may slow primary growth and decrease seed yield (Fathi, 2008).

Pods per plant

In Rapeseed, pods per plant is one of the most important attributes on which seed yield is dependent, because green pods play key role in photosynthesis. The results indicated significant difference in pods per plant between studied cultivars (Table 1). In comparisons, Hyola 60 yielded on average 95.4 pods per plant and in compare with Opera, Zarfam and Sarigol cultivars, it was 7.02, 14.2 and 11.6% respectively higher, thus higher pods per plant is one of the reasons for higher seed yield in Hyola60 cultivar (Table 2). Therefore, it seems that Hyola 60hybrid cultivar profited from existing conditions due to compatibility with regional climate and this caused increase pods per plant due to more branches. Thickening plant density decreased pods per plant and this was significant ($P<0.01$) (Table 1). Amanulla and Ghnlam (1990) indicated that density thickening (85 plants/m^2) caused decrease pods per plant. But increasing plants/m^2 can be compensated by decrease in pods per plant. According to obtained results during growth season, in 85 plant/m^2 density, enough sunlight did not penetrate into canola due to massive branches and leave and thus pods per plant reduced. It has been shown in other studies that reducing capsules number in sesame due to plant density was caused by increasing inter specific competition and decreasing available nutrients, light space to any plant. On the other hand, in thicker densities, branches number and capsules and finally capsule per plant also decreased due to inter specific competition (Bahrani and Babaei, 2007).

Table 1: Analysis of variance (mean of squares) for traits under study in different plant density of rapeseed varieties

S.O.V	d.f	Seed yield (kg/ha)	Number of pods Per plant	1000-seed weight(g)	Harvest index(%)
Replication	2	ns	Ns	ns	Ns
Cultivar	3	**	**	**	**
Error a	6	3456.3	12.7	0.005	0.440
Plant density	2	**	**	**	**
Cultivar*P.D	6	**	Ns	**	*
Error b	16	1365.4	3.45	0.003	0.34
C.V (%)		15.4	8.5	7.2	7.2

Table 2: Main effect of cultivar and plant density on seed yield, number of pods per plant, 1000-seed weight, harvest index

Treatment	Seed yield (kg/ha)	Number of pods per plant	1000-seed weight(g)	Harvest index (%)
Cultivar				
Hyola 60	3425.2^{a}	95.3^{a}	4.25^{a}	35.3^{a}
Hyola 308	3234.6^{b}	91.4^{ab}	4.54^{a}	32.2^{a}
Zarfam	2979.3^{d}	88.2^{c}	4.51^{b}	31^{b}
Sarigol	3042.4^{c}	92b^{c}	4.30^{ab}	30.5^{b}
Plant density(m^2)				
40	3050.2^{a}	89.5^{a}	4.40^{b}	29.5^{a}
60	3325.4^{a}	93.6^{b}	4.20^{a}	30.7^{a}
80	3150.3^{b}	91.2^{c}	4.55^{b}	29.7^{a}

Table 3: Interaction effect of cultivar and plant density on grain yield, number of pods per plant, 1000-seed weight, harvest index

Treatment		Seed yield ($Kg.h^{-1}$)	Number of pods per plant	1000-seed weight (g)	Harvest index (%)
	45	3287^{e}	96.3^{a}	4.63^{a}	30.6^{cd}
Hyola 60	65	3751.2^{a}	90^{b}	4.66^{a}	30.6^{a}
	85	3534^{e}	83^{cd}	4.44^{b}	31.3^{c}
	45	3234^{f}	88.3^{b}	4.3^{ab}	30.3^{d}
Opera	65	3423.3^{b}	83^{cd}	4.3^{a}	32.3^{d}
	85	3123.5^{d}	81.1^{d}	4.2^{a}	30.6^{cd}
	45	2867^{d}	80.3^{f}	4.8^{c}	28^{gh}
Zarfam	65	3321^{g}	75.3^{e}	4.3^{b}	28.6^{h}
	85	3221^{h}	71.3^{f}	4.44^{a}	27.3^{h}
	45	3123^{h}	85.3^{f}	4.44^{b}	29^{f}
Sarigol	65	3456^{e}	80.3^{d}	4.46^{a}	30de
	85	3412.2^{f}	74.3^{e}	4.33^{c}	29.3^{ef}

1000-Seeds weight

Results showed a significant difference in 1000-seeds weight between studied cultivars. In comparison, Hyola 60 yielded highest seeds weight followed by Zarfam. No significant difference was observed between 65 and Opera (Table 2). Results showed that plant density levels had significant difference in 1000 seeds weight (Table1). Hyola 60 gave the best mean 1000 seed weight (3.6g) in 60 plants/m^2 and Zarfam cultivar had lowest (4.2g) 1000 seeds weight in 45 (plants/m^2). As shown, 1000 seeds weight increased with increasing density to 65 plants/m^2 and then reduced with higher density (85 plants/m^2). It seems that in very thick densities, seed weight decreased due to sever competing for photosynthesis.

Harvest index

Harvest index indicate that transforming percent of photosynthetic matters from source to sink, and thus it is important factor to improve grain yield. Cultivars had significant effect on harvest index (Table 1). Hyola 60 and Zarfam yielded highest (35.2 %) and lowest (31%) harvest index, respectively (Table 2). Difference in matters distributing pattern between cultivars caused difference in harvest index. It seemed that Hyola 60 hybrid could give better profit better from environment sources and yielded higher harvest index by transforming more photosynthetic matters to seed. Another point is that Hyola60 could be more efficiently use sunlight to producing economic yield by generating greener canopy. Based on obtained results, different plant densities effect was significant on harvest index ($P<0.01$) (Table 1). Fathi, (2008) also indicated significant plant density effect on harvest index in his experiments and he yielded highest harvest index (28.1) in 20 plants/m2 density. Danesh-Shahraki et al. (2008) also suggested that harvest index was affected significantly by plant density and thickening density increased harvest index. This is the result of effective role of nutrients in distribution, assimilation and balancing of intra specific competition and transformation of matters to seed in 65 plants/m^2 density. Increase density (85 plants/m^2) depressed harvest index due to reduced preserved matters. As productive and vegetative organs compete in taking photosynthetic matters, thickening density and increasing intra specific competition also increase. Bahrani and Babaei (2007) also indicated that increasing plant density causes increase in harvest index, but in very thick density, harvest index reduces, due to increasing shadowing and inter specific competition.

Conclusion

The results indicated that there was significant difference in all attributes except for plant density. Thus based on obtained results, it can be recommended that

Hyola60 hybrid and 65 (plants/m^2) densities are the optimum conditions for Ilam region, Iran.

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