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Effect of Nitrogen and Boron on Canola Yield and Yield Components in Ahwaz, Iran

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Abstract: In order to study the effects of nitrogen and boron on canola yield and its components, in Ahwaz region, an experiment was conducted in 2005-2006 at Ramin Agriculture and Natural Resources University. The experimental design was a randomized completely block with three N rates (150, 200 and 250 kg ha^{-1}) and four B rates (0, 2.5, 5 and 10 kg ha^{-1}). All treatments replicated four times. Results showed that with increase of nitrogen rates, the number of siliques m^{-2}, number of seeds per silique, 1000 grain weight, seed yield, oil yield and biological yield significantly increased but Harvest Index (HI) and grain oil percentage decreased. With increase of boron rates, number of seeds per silique, grain yield, oil yield and harvest index significantly increased, but no significant effect of boron rates on the number of siliques m^{-2}, 1000 grain weight, biological yield and grain oil percentage was observed. The highest grain and oil yield (3095 and 1345 kg ha^{-1}, respectively) were obtained with 250 and 10 kg ha^{-1} N and B, respectively. Although, the interaction effect of nitrogen and boron on economical yield was not significant, 200 kg N ha^{-1} and 10 kg B ha^{-1} had equal grain and oil yield (2803 and 1265 kg ha^{-1}, respectively) to 250 kg N ha^{-1} and without B application (2640 and 1143 kg ha^{-1}, seed and oil yield, respectively). This experiment showed that B application for canola can result in less use of nitrogen fertilizers. Therefore, B application in this experiment condition is very important agronomic factor.

Key words: Boron, canola, nitrogen, seed oil, seed yield

INTRODUCTION

Efficient use of fertilizers is one of important factors in maximizing crop yield. Canola demand to nitrogen is two times rather than wheat. In addition, nitrogen absorption efficiency was lower than wheat. Crop nitrogen use efficiency is related to climate conditions, soil properties and interaction between nutrient elements. Brassica plants need also to high level of boron in soils (Stangoulis *et al*., 2000).

Malhi and Gill (2004) reported that nitrogen increased canola Grain Yield (GY) through increase silique number and 1000 grain weight. Khan *et al*. (2002) reported plots that received 120 kg N ha^{-1}, had highest branch number, silique per shrub, grain per silique, 1000 grain weight and GY. But nitrogen decreased grain oil percentage, significantly. With nitrogen increase, grain yield component increase through increased LAI and branch number (Ahmad *et al*., 2007).

Among micronutrients, boron has an important role in maximizing GY in canola. The boron deficit often occurs in calcareous soils (Goldberg, 1997). Exceeded amount of this micronutrient can be toxic for canola seeds and avoid optimum germination and seedling establishment (Dordas, 2006).

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Malhi *et al*. (2003) showed that boron application increased grain yield (GY), dry matter (DM) and boron absorption. Stangoulis *et al*. (2000) observed that boron application increased DM and branch number of canola in farm and greenhouse conditions.

In addition, increase of GY resulting from boron application was due to increase grain number per silique (Stangoulis *et al*., 2000).

Nuttal *et al*. (1987) observed that boron along with nitrogen decreased grain protein and increased grain oil, respectively. In addition, Porter (1993) reported that boron application caused to maximizing canola yield. Therefore, it seems that boron application result in canola efficient nitrogen use and maximizing oil yield. In calcareous soils of Iran, particularly Ahwaz region, no any research that evaluated nitrogen and boron application on canola yield, was not be seen. Objective of this study was identification effects of nitrogen and boron on canola in Ahwaz region, Iran.

MATERIALS AND METHODS

An experiment was conducted in 2005-2006 at Ramin Agriculture and Natural Resources University, Ahwaz, Iran. Soil properties were induced in Table 1. A factorial experiment in RCB with four replicate was used. Experimental factors included three nitrogen levels (150, 200 and 250 kg ha^{-1}) and four boron levels (0, 2.5, 5 and 10 kg ha^{-1}). Each plot was consisted eight seeding lines with 3 m length. Nitrogen fertilizer was applied in three stages (1/3 in seeding, 1/3 in stem elongation and 1/3 in early flowering). Born fertilizer (boric acid with 17% boron) was incorporated to soil before seeding. Crop density was 90 shrub m^{-2}. Thinning and cultivation of weeds were done in 3-4 leaf stages.

Cultivation of weed in plots repeated several times through growth period. Grain protein was measured by Kjeldhal procedure and grain oil was measured by NMR. Statistical analysis was done with glm procedure by SAS and graphs were dragged with Excel software.

Table 1: Physical and chemical properties of experimental soil

Sampling depth (cm)	Available N (ppm)	Available P (ppm)	Available K (ppm)	pH	EC (micro mohs cm^{-1})	Organic matter (%)	Texture
0-30	6.3	7	128	7.7	340	0.98	Clay-Loam
30-60	5.8	3	73	7.8	300	0.42	Silty-Clay

RESULTS AND DISCUSSION

Yield and Yield Component

Results showed that nitrogen and boron had significant effects on GY, oil yield and yield components of canola (Table 2, 3).

With nitrogen increase, silique number and 1000 grain weight increased, significantly. But grain per silique decreased following nitrogen increase (Fig. 1). However, nitrogen caused to GY increase, significantly (Fig. 1). Application 250 kg N ha^{-1} result in highest GY and oil yield in comparison to other nitrogen levels. These results agree with Ahmad *et al*. (2007) and Starner *et al*. (1999).

Table 2: Analysis of variance of grain, protein and oil yield

		Mean squared					
SOV	df	DW	GY	Oil yield	HI	Grain oil	Grain protein
Block	3	72.15**	0.48**	96316.90**	0.02**	0.000056	0.0002
Boron	3	2.45	0.27**	53833.11**	0.0025	0.0000076	0.0008
Nitrogen	2	379.42**	2.25**	265986.15**	0.011**	0.0041**	0.0158**
B*N	6	3.43	0.46	10170.602	0.0019	0.000016	0.0002
Error	33	3.97	0.03	5841.5112	0.00145	0.0000112	0.0004
CV (%)	-	10.47	6.67	6.7	20.21	0.454	3.76

**Significant in 1% of probability

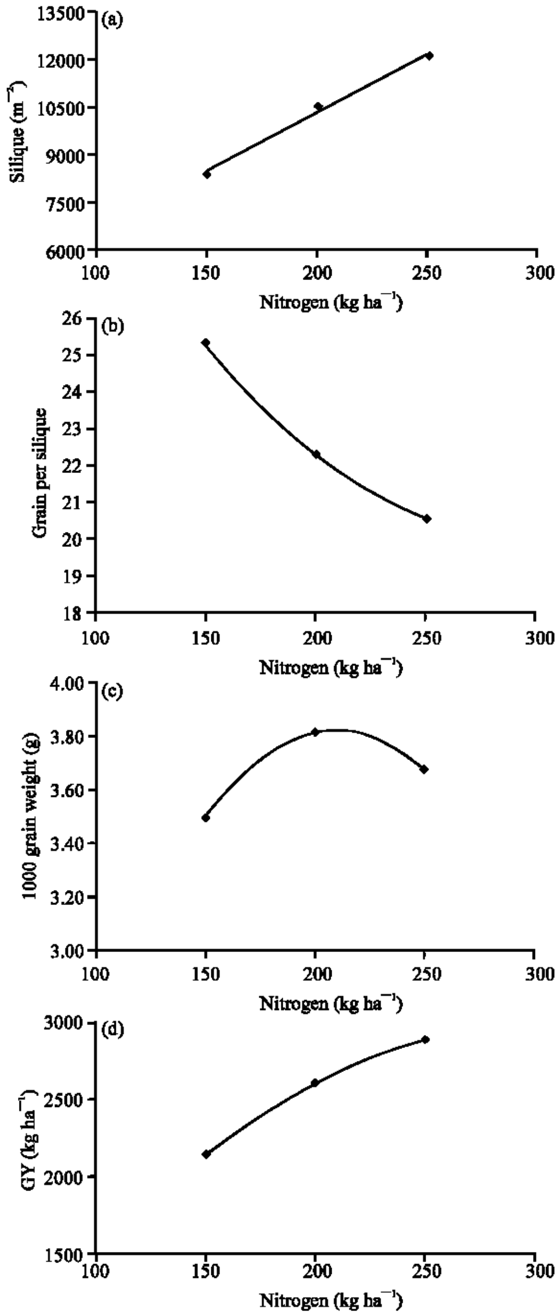

Fig. 1: Effect of nitrogen on grain yield and yield component of canola

In addition, with boron application, grain per silique increased (Fig. 2). But other yield components showed no any significant differences between Boron levels (Table 1). Application of 10 kg B ha^{-1}, produced higher GY than other levels (Fig. 2). Versus of nitrogen, application of Boron had no significant effect on dry matter of canola (Table 2). These findings agree with Dell and Huang

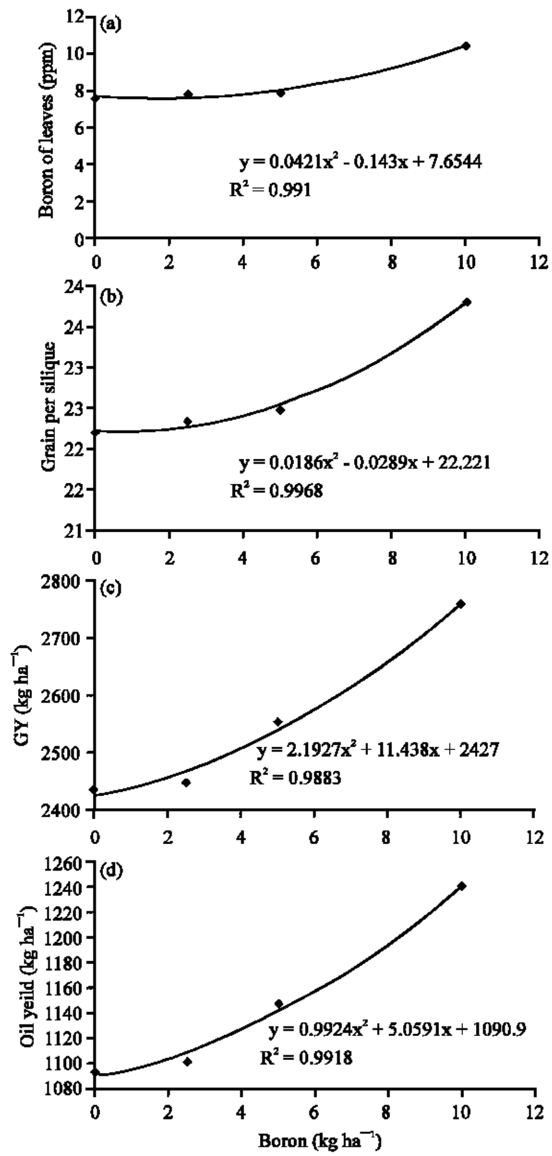

Fig. 2: Effect of boron on, (a) boron of leaves, (b) grain per silique, (c) GY and (d) oil yield of canola

(1997) that showed boron application affected GY of canola without significant effect on dry matter production. These results as well as report of Stangoulis *et al*. (2000) underline the role of boron in pollination and seed formation in canola.

Branching, Height, DW and Boron of Leaves

Results showed that nitrogen had significant effects on dry matter weight (DW), Branch number and plant height (Table 3). With nitrogen increase, branch number increased significantly (Fig. 3). With nitrogen increase, branching will be stimulated and following silique number increased to maximize grain yield (Ahmad *et al*., 2007; Thakur *et al*., 2003).

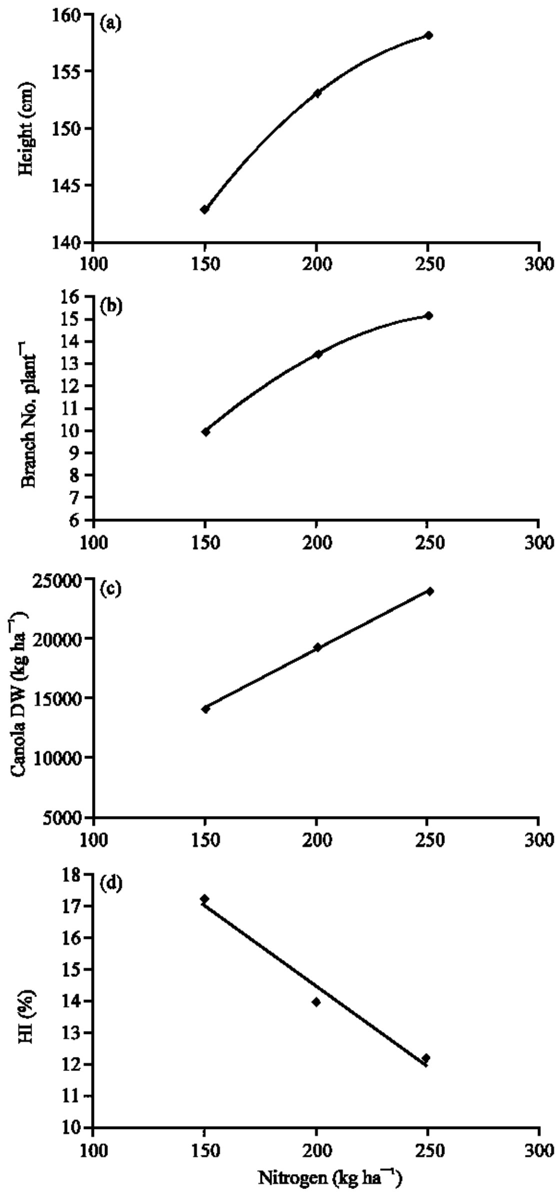

Fig. 3: Effect of nitrogen on: (a) height, (b) branch number, (c) DW and (d) HI of canola

Table 3: Analysis of variance of yield components, height, branch number and boron of leaves

		Mean squared					
SOV	df	Silique No.	Grain per silique	1000 grain weight	Height	Branch No.	Boron of leaves
Block	3	6823413.02**	0.82	0.12	0.026**	2.14	2.55
Boron	3	2360668.6	6.65**	0.03	0.001	2.54	22.47**
Nitrogen	2	54969957.8**	90.87**	0.29	0.089**	110.705**	0.077
B*N	6	3561184.2	1.10	0.05	0.001	0.051	0.93
Error	33	1262385.74	1.05	0.045	0.002	3.29	0.33
CV (%)	-	10.88	4.52	5.38	3.27	14.16	6.82

**Significant in 1% of probability

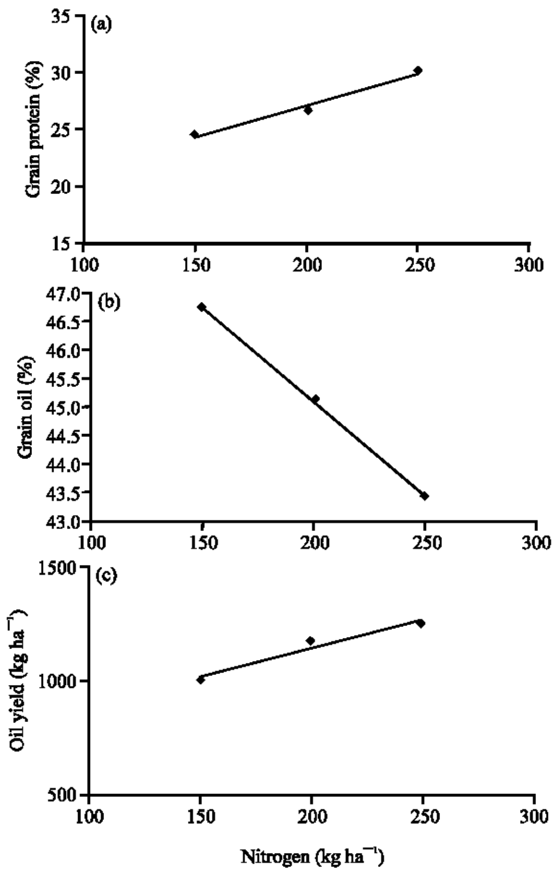

Fig. 4: Effect of nitrogen on: (a) grain oil, (b) grain protein and (c) oil yield of canola

Effects of nitrogen on plant height and DW, were be reported by Ahmad *et al*. (2007) and Takur *et al*. (2003).

Boron application had no significant effect on height, DW and branching of canola. It agrees with Stangoulis *et al*. (2000) that showed non-significant effect of boron on vegetative growth. But, boron of leaves increased by boron application (Fig. 2).

Grain Oil, Protein and Oil Yield

Grain oil and protein decreased and increased with nitrogen application, respectively (Fig. 4). It seems that effect of nitrogen on grain protein and oil percentage can be related to delayed maturity of grain that reported with Mason and Brenan (1998).

Boron application had no significant effect on grain oil and protein (Table 1). Karamanos *et al*. (2003) showed no any significant effect of boron on grain oil and protein percentage. But, boron application increased oil yield through GY that was be increased by grain number per silique (Fig. 2).

Interaction between nitrogen and boron on grain oil and protein was not significant (Table 3). It is inconsistent with Nuttal *et al*. (1987) that showed interaction between nitrogen and boron caused to increase grain oil content.

Table 4: Mean comparison of grain and oil yield of canola affected by experimental

Treatments	Grain yield (kg ha^{-1})	Oil yield (kg ha^{-1})
B0N150	2100g	978.84fg
B0N200	2560de	1159.99bcd
B0N250	2640de	1143.02cde
B2.5N150	1932g	902.21g
B2.5N200	2460e	1119.08ed
B2.5N250	2940ab	1284.06a
B5N150	2180fg	1026.33ef
B5N200	2600de	1163.20bcd
B5N250	2880abc	1251.64abc
B10N150	2380ef	1108.49ed
B10N200	2800bcd	1265.13ab
B10N250	3100a	1345.71a

Similar letter(s) in each column show non-significant differences

CONCLUSION

Results showed that effect of nitrogen on GY, DW, oil yield and yield component was significant. Generally, with nitrogen increase, grain and oil yield increased through higher silique number. Plant height and branching also increased with nitrogen application. Nitrogen levels had no effect on boron absorption from soil.

Boron application result in higher GY that was related to higher grain number per silique. But other yield component showed no any significant difference between boron levels. Although, boron application increased boron absorption from soil, plant height and branching were not affected significantly by boron levels. It seems that effect of boron on pollination and grain formation is rather than vegetative growth including branching and dry matter production.

With nitrogen increase, grain oil percentage decreased, significantly. However, grain protein decreased by nitrogen increase. It is related to nitrogen role in protein formation. In addition, delayed maturity resulting from exceeded nitrogen can be a rationale reason for lower grain oil percentage.

Simultaneous nitrogen and boron had no effect on yield or quality of grain. However, 200 kg nitrogen companion with 10 kg boron produced equal to 250 kg nitrogen without boron application (Table 4). It shows that nitrogen use can be decreased without yield loss. Lesser use of nitrogen without yield loss can be helpful in term of farm economy. In addition, environmental risks including subterranean water pollution could be decreased by lesser nitrogen use.

In this study, against to expectation, nitrogen and boron had no simultaneously effects on grain oil and yield of canola.

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