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Study on Effect of Plant Density and Nitrogen on Yield and Yield Components of *Visia faba* (Faba Bean)

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Abstract

In order to study on effect of plant density and nitrogen on yield and yield components of *Visia faba* (faba bean), the experimental design was implemented by randomized complete block with three replications at 2010-2011 in Lahijan. The experimental factors were three plant density (25×25 cm, 35×35 cm and 45×45 cm) and four nitrogen fertilizer (0, 20, 40, 60 kg ha^{-1}). In this experiment, features such as seed yield, weight of 100 seeds, the number of pod per plant and harvesting index were measured. The results showed that the effect of plant density and nitrogen were significant on seed yield but were not significant on weight of 100 seeds and the no. of pod per plant. The highest seed yield was obtained in 25 × 25 cm plant density. Also with increasing of N up to 60 kg ha^{-1}, harvesting index increased. The interaction effect of plant density and nitrogen on seed yield was significant and 25 × 25 cm plant density and 40 kg ha^{-1} nitrogen had shown the most effective on seed yield. But the interaction effect of plant density and nitrogen on other features hadn't significant.

Keywords: Faba bean, Nitrogen, Plant density, *Vicia faba*, Yield.

INTRODUCTION

Faba bean (*Vicia faba* L.) is considered as a rich source of protein and carbohydrate (Dour *et al.,* 2008). Faba bean (Fabaceae) has several benefits: It is important for soil fertility, animal feeding and industry aims (Sharran *et al*., 2002). Cultivation area for faba bean in the world is 2.9 million ha (Turpin *et al.,* 2002) and in the Iran is 98920 ha (FAO, 2009).

The obtained results showed that seed yield, harvesting index and number of pods per plant increased significantly with N application but the effect of biological yield, branches per plant and the weight of 100 seeds was not significant (Golabi and Lak, 2005).

Bruin and Pederson (2008) observed that soybean yield planted in 38 cm row spacing had 248 kg ha^{-1} greater than 76 cm. Gan *et al.*, (2007) have also shown increase of grain yield at higher plant density in chickpea.

Reduction in plant density increased the number of nodes per plant, the weight of 100 seeds, the fresh weight of the plant, the number of plant branches and the pods per plant; but did not any significant effect on the plant length, percent of dry seed, percent of seed nitrogen, yield and number of seed per pod (Hashemabadi and Sedaghathoor, 2006).

Dahmardeh *et al.*, (2010) found that some characters were markedly affected by plant density, except plant height, height of lowest pods, 100 seeds weight, number of pods per plant and number of seeds per pod. Increasing of plant density from 12.5 to 20 plants m^{-2} significantly increased economical yield and biological yield of faba bean. Increasing plant spacing increased the number of pods per plant, but a decrease in the number of seed/pod consequently gave the highest seed yield (Dahmardeh *et al.,* 2010).

The effect of planting density on number of seeds per pod, 100 seeds weight and grain protein wasn't significant. Interaction effects of N and planting density on grain yield and harvesting index was significant and maximum yield was obtained from application of 90 kg ha^{-1} N and the highest level of density (Golabi and Lak, 2005).

Filek *et al.* (2008) found that increased plant density as well as the high level of nitrogen, inhibited the growth and development of root nodules and limited their nitrogenase activity in two cultivars.

Application of 30 kg ha^{-1} N at the start of flowering, increased seed yield only at the lowest plant density at 1986, but 60 kg ha^{-1} N increased seed yield by 135 % in 3 years. The highest rate of N resulted in higher yields in all plant densities (Aguileradiaz, 1995).

Therefore by considering that nitrogen and plant density are effective on yield and yield components of different cultivar of beans, so it aimed to determine the most appropriate amount of using nitrogen and plant density and their interaction on growth, yield and yield components of *Vicia faba*.

MATERIALS AND METHODS

This experiment has been implemented during 2010-2011 at 37º 10́ northern latitude and 50º 2́ eastern longitude in 40 m above from free sea. This study carried out in factorial experiment, based on randomized complete design with 3 replications. Three levels of plant density (25 × 25, 35 × 35 and 45 × 45 cm) and four levels of nitrogen (0, 20, 40, 60 kg ha^{-1} N) from urea were studied.

In order to land preparation leveling and fertilizing were done and for killing of weeds, herbicide was used. Area of each experimental plot was 10 m2. Sowing date of *Vicia faba* was at 6th of Nov. 2010. Before sowing, the seed were disinfected by fungicide (2/1000) also seeds were put into water for 24 hrs and then sowed in square arrangement in mentioned densities. The distance between replications was 1.5 m and the distance between plots was 1 m. In each hole 2 seeds were planted in depth of 5 cm. Seeds emerged after 2 weeks. Plant thinning was done in 3-4 leaves stage. Weed controlling was done in 2 stages: 4th Feb. and 4th Apr. 2011. Pesticide was applied in 2 stages.

In the center of each plot, 10 plants were labeled for sampling and measurement of characteristics.

Measurement of features

In order to measurement the weight of 100 seeds, 60 matured pods harvested from each plot and 100 seeds were selected randomly and weighted by digital scale (0.01 g). For measurement of seed yield, experimental Crete, after separating sheath from harvest area, the seed have been went off and weighted by scale. For calculating harvest index the following formula is used: harvest index = seed yield/biological yield × 100.

For measuring the number of pod in each plant, 10 plants were selected and the sum of pods in each plant counted and the pod of these 10 plants was considered as a mean of pods.

Data Analyzing

Statistical analysis of data carried out by MSTATC, means were compared using Duncan and diagrams were drawn with excel software.

RESULS AND DISCUSSIONS

Seed yield

The results of ANOVA showed that plant density, N and interaction between them had significant effect on seed yield of faba bean at 5%, 1% and 1% respectively (Table 1). With increasing of plant density, seed yield increased so that the most seed yield (4313.5 kg ha^{-1}) has been observed at 16 plants/m^2 (25 ×25 cm) (Table 2). This result was obtained due to increasing of plant density in unit area. With increasing of plant density, the yield of single plant decreases but yield in unit area increases. The 45 × 45 cm (5 plants/m2) had the least seed yield (Fig. 1). Singh *et al*., (1992) mentioned that low plant density increases the yield of single plant but the yield at unit area decreases. Ghanbari Birgani *et al*., (2003) expressed that the highest and lowest seed yield of Vcia faba obtained in 20 × 20 and 30 × 30 cm plant distance, respectively. Dehmardeh (2010) showed that by increasing the plant density from 12.5 to 20 plants/m^2, economical and biological yield of faba bean increased.

With increasing of nitrogen application up to 60 kg ha^{-1}, the seed yield of faba bean increased (Table 2). Golabi and Lak (2005) said that when the N nutrition increases, the seed yield of faba bean will increase. Stuzel (1994) showed that application of 60 kg ha^{-1} nitrogen in 3 years, increased seed yield of faba bean up to 135%.

The highest seed yield was obtained in A_3B_4 (16 plants/m2 + 60 kg ha^{-1} N) and A_3B_3 (16 plant/m^2 + 40 kg ha^{-1} N) with 5763 and 5517 kg ha^{-1}, respectively. While lowest seed yield was obtained in control plants (5 plants/m2 + 0 kg ha^{-1} N) with 2387 kg ha^{-1}. Since the difference between A_3B_4 and A_3B_3 is not significant, we recommended A_3B_3 as better treatment. Golabi and Lak (2005) showed that interaction effect of N fertilizer and plant density lead to the increase of seed yield. Aguileradiaz (1995) showed that using 60 kg ha^{-1} N in least density (10 plant/m^2) increased the yield of faba bean.

Harvesting index

The results of ANOVA showed that only effect of N fertilizer on harvest index of *Vicia faba* was significant ($p \leq 0.05$) (Table 1). The highest and lowest harvesting index were observed in B_4 (60 kg ha^{-1} N) and control plant (B0 = 60 kg ha^{-1} N) with 34.73 and 27.6, respectively (Table 2; Fig. 2). It seems that nitrogen promoted growth of plant and increased the harvesting index. Our results are agreed with Golabi and Lak (2005).

Weight of 100 seeds

The effect of plant density on weight of 100 seeds wasn't significant (Table 1). Although, the most weight of 100 seeds (1579.5 g) obtained in A1 (45 × 45 cm) (Table 2). It agrees to result of Golabi and Lak (2005). They told that increasing of plant density doesn't effect on weight of

100 seeds. Also, the effect of nitrogen on weight of 100 seeds was not significant (Table 1). Hatami (2009) said that the weight of seed has been influenced by the species (Hatami *et al.*, 2009) and it also adjusts to results of Golabi and Lak (2005) that by the increasing of nitrogen fertilizer, the weight of 100 seeds hasn't changed significantly.

Number of pods per plant

The effect of different levels of N and plant density, were not significant on number of pod per plant (Table 1). Also, the interaction between plant density and nitrogen hadn't significant effect on the pod number of Visia faba (Table 1, 2).

CONCLUSION

According to results of this study, the best plant density and N fertilization for *Vicia faba* is 16 plants/m^2 (25 × 25 cm) and 40 kg ha^{-1} N, respectively.

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Tables

Table 1- ANOVA of effect of plant density and nitrogen on the measured traits.

	df	Mean Square			
		Seed yield	100 seeds weight	number of pods	harvest index
Replication (R)	2	46531.55	25138.77	0.0019	17.174
Plant Density (A)	2	945823.79*	25138.77^{ns}	0.0836^{ns}	49.705^{ns}
Nitrogen (B)	3	2041686.1**	16342.54^{ns}	0.102^{ns}	89.113*
A × B	6	4358900.53**	11260.99^{ns}	0.0407^{ns}	21.477 ^{ns}
Errors	22	3152.2	12667.53	0.0714	20.001
(CV)(%)	-	13.96	7.21	8.83	14.34

**: significant in 1%
*: significant in 5%
ns: Non significant

Table 2. Effect of nitrogen fertilizer and plant density on the seed yield, 100 seeds weight, number of pods and harvesting index.

Treatments	Seed yield (kg/ha)	100 seeds weight (g)	number of pods per plant	harvesting index
A^1 (45 × 45 cm = 5 plants m^{-2})	3754.2 b	1579.5 a	2.94 a	30 a
A^2 (35 × 35 cm = 9 plants m^{-2})	3990.3 ab	1538.42 a	3.11 a	30.1 a
A^3 (25 × 25 cm = 16 plants m^{-2})	4313.5 a	1559.5 a	3.02 a	33.11 a
B^1 (0 kg ha^{-1} N)	3605.9 b	1581.33 a	3.05 a	27.60 c
B^2 (20 kg ha^{-1} N)	3707.9 b	16058.56 a	3.03 a	29.70 bc
B^3 (40 kg ha^{-1} N)	41.8 ab	1509.89 a	2.97 a	32.63 ab
B^4 (60 kg ha^{-1} N)	4655 a	1539.78 a	3.03 a	34.73 a

In a vertical column values having same letter (s) do not significantly at 5% level of probability using DMRT.

Figures

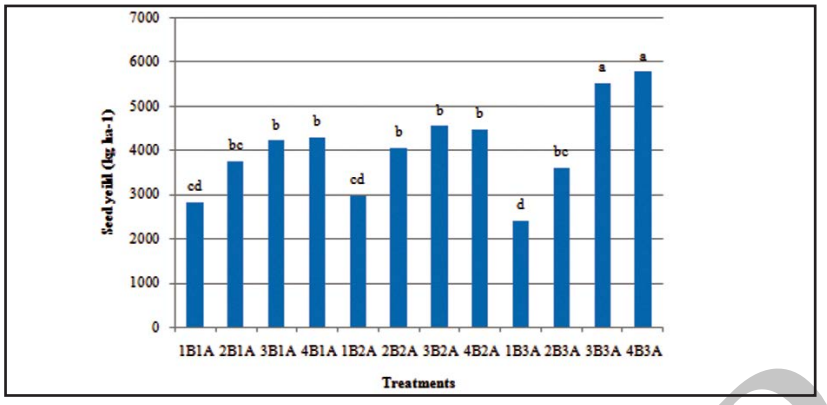

Fig. 1. Effect of nitrogen fertilizer + plant density on seed yield.

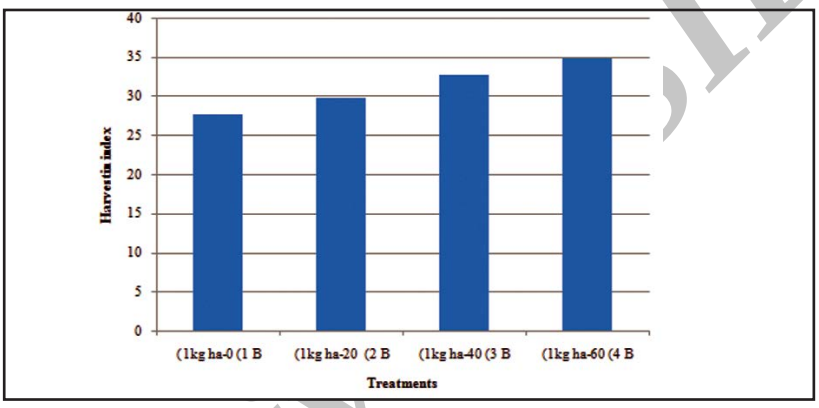

Fig. 2. Effect of N fertilization on harvesting index.