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EFFECT OF DIFFERENT LEVELS OF NITROGEN ON DRY MATTER AND GRAIN YIELD OF FABA BEAN (*VICIA FABA* L.)

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Abstract

Faba bean is widely used in the Mediterranean region as source of protein in both human and animal nutrition. A legume member so fixes atmospheric nitrogen but with the assumption that nitrogen application to crops often results in yield improvement, a field experiment with N rates was conducted for two consecutive years. In the experiment 12 faba bean genotypes (KITIKI-2003, ERESEN-87, FİLİZ-99, SEVİL, SAKIZ, 95 ETA 225, 95 ETA 249, 95 ETA 276, 97 ETA 718, 97 ETA 727, 98 ETA 296 and 98 ETA 329) at 5 N rates (0, 50, 100, 150, and 200 kg ha^{-1}) were evaluated for dry matter production and grain yield. Genotypes showed significant variation in grain yield and shoot dry weight. Genotype FİLİZ-99 was the highest yielding, whereas genotype SEVİL was the lowest yielding and the remaining genotypes were intermediate in grain yielding potential. Grain yield and shoot dry weight indicated significant quadratic relation with the increasing N rates between 0 and 200 kg ha^{-1}.

Introduction

Faba bean (*Vicia faba* L.) is one of the major winter-sown legume crops grown in the Mediterranean region, and has considerable importance as a low-cost food rich in proteins and carbohydrates (Sepetoğlu, 2002). Nitrogen, a plant nutrient is required by plants in comparatively larger amounts than other elements. Nitrogen is essential component of many compounds of plant, such as chlorophyll, nucleotides, proteins, alkaloids, enzymes, hormones and vitamins (Marschner, 1995). For an optimal yield, the N supply must be available according to the needs of the plant. Nitrogen deficiency generally results in stunted growth, chlorotic leaves because lack of N limits the synthesis of proteins and chlorophyll. This leads to poor assimilate formation and results in premature flowering and shortening of the growth cycle. The presence of N in excess promotes development of the above ground organs with relatively poor root growth. Synthesis of proteins and formation of new tissues are stimulated, resulting in abundant dark green (high chlorophyll) tissues of soft consistency. This increases the risk of lodging and reduces the plants resistance to harsh climatic conditions and to foliar diseases (Lincoln, 2006).

Biological nitrogen fixation has often been reported insufficient in many studies (Vikman & Vessey, 1993; Kailerova, 1984; Ruszkowska *et al*., 1991; Zinkiewicz *et al*., 1992). This raises a question whether we should apply some amount of nitrogen in addition to symbiotic nitrogen fixation of the crop to meet the needs for potential crop production or not? Many authors showed a beneficial effect of Ammonium nitrate on the seed yield of lucerne (Ruszkowska *et al*., 1992), faba bean (Bochniarz *et al*., 1987; Pizto *et al*., 1991) and other legume plants (Wojcieska *et al*., 1994; Premaratne & Oertli 1994).

Literature on nitrogen application to faba bean was not found so other legumes that originated idea for the present study have been presented here. Research on addition of N fertilizer to *Phaseolus vulgaris* L., in North Dakota showed increasing plant growth with successive N fertilizer applications but significant yield increases were not found with N fertilizer rates above 44.81 kg N ha^{-1} (Deibert & Utter, 1997). Evans *et al.*, (1989) reported that pea received on average 61% of the total N (80 kg N ha^{-1}) from biological nitrogen fixation.

Grain legume crops has an advantage over non legume grain crops that root nodules fix atmospheric nitrogen (N) for plant use and the plant and root residues contribute to soil nitrogen for the following crop. The amount of N fixed by grain legumes can vary by crop, residual soil N levels, plant growth, management practices and climatic conditions. The present study with different nitrogen level on faba bean was conducted with the assumption that N fixation contributes only a portion of the grain legume plant requirements, the plant must rely on residual soil N or applied N fertilizer for maximum growth and yield. Furthermore, the trial was conducted with 12 genotype to get more comprehensive results.

Materials and Methods

A field experiment was conducted at Ege University, Bornova Turkey during 2005-2006 and 2006-2007 crop seasons to evaluate 12 faba bean genotypes responses to nitrogen fertilization. Average climatic conditions during the experiment are shown in Fig. 1. Soil of the experimental site was clay loam (37.44 % sand, 33.28 % silt and 29.28 % clay) and soil properties at 0-30 cm soil depth were: pH 7.5; organic matter 2.86 g 100 g^{-1}; total N, 0.106 g 100 g^{-1}; available phosphorus (P), 1.6 m kg^{-1}; potassium (K), 300 mg 100 g^{-1}; copper (Cu) 1.77 mg 100 g^{-1}; zinc (Zn) 2.72 mg 100 g^{-1}; iron (Fe) 54.4 mg 100 g^{-1} and manganese (Mn) 11.8 mg 100 g^{-1}.

Sand, silt and clay fractions of the soil (Soil texture) were determined by Bouyoucos hydrometer method as reported by Gee & Bauder (1986). Soil pH was determined in soil saturation extract as described by Thomas (1996). Total N in soil samples was determined by Kjeldahl method of Bremner (1996). Soil P, K, Cu, Zn, Fe and Mn were determined by AB-DTPA extractant solution as described by Soltanpour & Schawab (1977). Organic matter was determined by the method described by Nelson & Sommers (1996). Treatments consisted of 12 genotypes and five N rates. The genotypes tested were KITIKI-2003, ERESEN-87, FİLİZ-99, SEVİL, SAKIZ, 95 ETA 225, 95 ETA 249, 95 ETA 276, 97 ETA 718, 97 ETA 727, 98 ETA 296 and 98 ETA 329. The nitrogen rates were 0, 50, 100, 150 and 200 kg ha^{-1} that applied through urea. Half of the N was applied at sowing and the remaining was top dressed at start of flowering (95 days after sowing).

The N rates were in the main plots and genotypes in the subplot. Treatments were replicated three times in a randomized block design. Plot size was 4 lines of each genotype with 6 m length and spacing of 35 cm between each row. The experimental area received 68 kg P ha^{-1} from triple super phosphate and 98 kg K ha^{-1} from potassium chloride as basal fertilizers at the time of sowing each year. Irrigation and weeding were done uniform as per requirement. Two central rows of 4 m each were harvested for grain yield determination. Two meter of the rows was harvested for shoot dry matter determination.

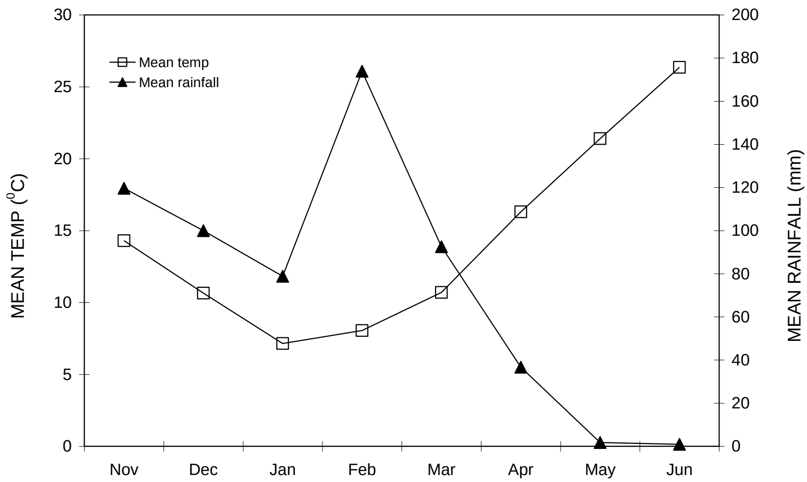

Fig. 1. Mean temp (^{0}C) and rainfall for the two consecutive experimental seasons.

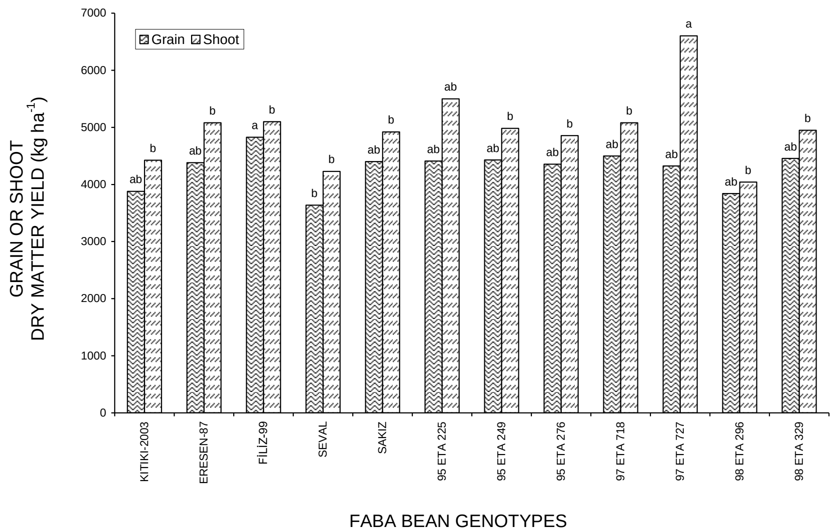

Fig. 2. Grain or shoot dry weight of 12 faba bean genotypes. Value with different letter are statistically significant at 5% probability

All the data were analyzed by analysis of variance and regression analysis was used to check treatment effects. Appropriate regression equations were selected on the basis of higher R^2 values and probability level significance. LSD test (at 5 % probability level) was used for comparison of treatment means (Steel & Torrie, 1980).

Results and Discussion

In the experiment, genotypes showed significant variability in grain yield and shoot dry weight (Fig. 2). Shoot dry weight varied from 6602 kg ha^{-1} for genotype 97 ETA 727 to 4041 kg ha^{-1} for genotype 98 ETA 296, with an average value of 4980 kg ha^{-1}. Similarly, variation in grain yield was from 4828 kg ha^{-1} for genotype FİLİZ-99 to 3638 kg ha^{-1} for genotype SEVİL, with an average value of 4287 kg ha^{-1}. Pekşen *et al*., (2006) have reported differences in shoot and grain yield of faba bean genotypes. Variation in shoot dry weight and grain yield among genotypes may be associated with differences in genetic make-up that may exist for radiation use efficiency, and grain harvest index or plant adaptation to target environments (Berger *et al*., 2002).

Regression analysis was performed to determine association between nitrogen rates (X) and grain yield (Y). The N fertilization significantly increased grain yield and shoot dry weight of 12 genotypes (Tables 1 and 2). The variation in grain yield with nitrogen fertilization varied from 66 to 93% depending on genotypes (Table 1). Similarly, the variation in shoot dry weight with the application of nitrogen fertilizer varied from 54 to 78%, depending on genotypes (Table 2). This means N requirement was higher for grain yield compared to shoot dry matter production. Schulze *et al*., (1999) also reported similar results for lupins that predominant portion of the N fertilizer went into the seeds.

Genotypes were having linear and quadratic responses to applied nitrogen in relation to grain yield and shoot dry matter. Across 12 genotypes, the genotypic response to applied N in the range of 0 to 200 kg ha^{-1} was quadratic for grain yield as well as shoot dry matter production (Figs. 3 and 4). These findings are in agreement with conclusions from Bochniarz *et al*., (1987) and Deibert & Utter (1997) experiments.

Conclusions

Faba bean genotypes differed significantly in grain and shoot dry weight productions and this difference may be related to difference in genotypes. Grain and dry matter yields were significantly increased with N fertilization. However, responses varied from genotypes to genotypes. It could be concluded that application of adequate N rate is one of the possible strategies to improve shoot dry weight and grain yield.

Table 1. Relationship between nitrogen rate (X) and grain yield (Y) of 12 faba bean genotypes. Values are averages of two years.

Genotype	Regression equation	R2
KITIKI-2003	$Y = 1899.03 + 19.40X$	0.77^{**}
ERESEN-87	$Y = 2642.53 + 17.01X$	0.74^{**}
FİLİZ-99	$Y = 2797.53 + 20.30X$	0.92^{**}
SEVİL	$Y = 1816.19 + 18.21X$	0.88^{**}
SAKIZ	$Y = 2630.31 + 26.79X - 0.0611X^2$	0.70^{**}
95 ETA 225	$Y = 2511.89 + 29.09X - 0.0703X^2$	0.77^{**}
95 ETA 249	$Y = 2213.08 + 39.69X - 0.1131X^2$	0.87^{**}
95 ETA 276	$Y = 2430.88 + 32.92X - 0.0848X^2$	0.83^{**}
97 ETA 718	$Y = 2516.87 + 28.93X - 0.0669X^2$	0.84^{**}
97 ETA 727	$Y = 2590.43 + 24.28X - 0.631X^2$	0.82^{**}
98 ETA 296	$Y = 2912.43 + 18.17X$	0.66^{**}
98 ETA 329	$Y = 1814.42 + 19.83X$	0.93^{**}

**Significant at the 1% probability level.

Table 2. Relationship between nitrogen rate (X) and shoot dry weight (Y) of 12 faba bean genotypes. Values are averages of two years.

Genotype	Regression equation	R2
KITIKI-2003	$Y = 2442.44 + 29.21X - 0.0595X^2$	0.5812^{**}
ERESEN-87	$Y = 2978.50 + 31.49X - 0.0759X^2$	0.5401^{**}
FİLİZ-99	$Y = 2550.09 + 43.56X - 0.1267X^2$	0.7213^{**}
SEVİL	$Y = 2577.11 + 25.69X - 0.0566X^2$	0.7837^{**}
SAKIZ	$Y = 3467.83 + 20.25X$	0.7832^{**}
95 ETA 225	$Y = 2860.37 + 31.59X - 0.0759X^2$	0.7365^{**}
95 ETA 249	$Y = 3047.00 + 34.45X - 0.1054X^2$	0.6641^{**}
95 ETA 276	$Y = 2876.00 + 34.49X - 0.1013X^2$	0.6548^{**}
97 ETA 718	$Y = 2513.42 + 41.25X - 0.1044X^2$	0.7380^{**}
97 ETA 727	$Y = 3726.67 + 28.76X$	0.7464^{**}
98 ETA 296	$Y = 2886.66 + 23.62X$	0.7191^{**}
98 ETA 329	$Y = 2174.00 + 18.67X$	0.6496^{**}

**Significant at the 1% probability level.

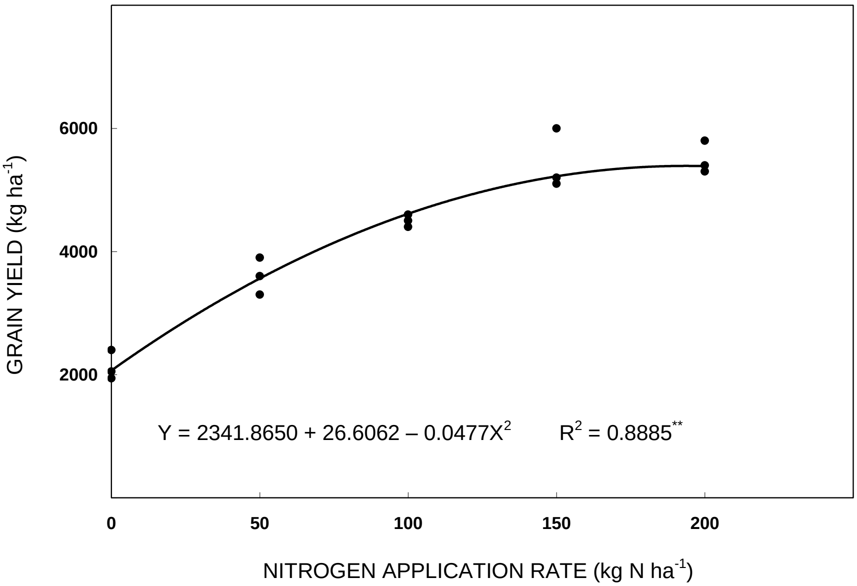

Fig. 3. Grain yield of faba bean as influenced by nitrogen application rate. Values are average of 12 genotypes and 2 years field trial.

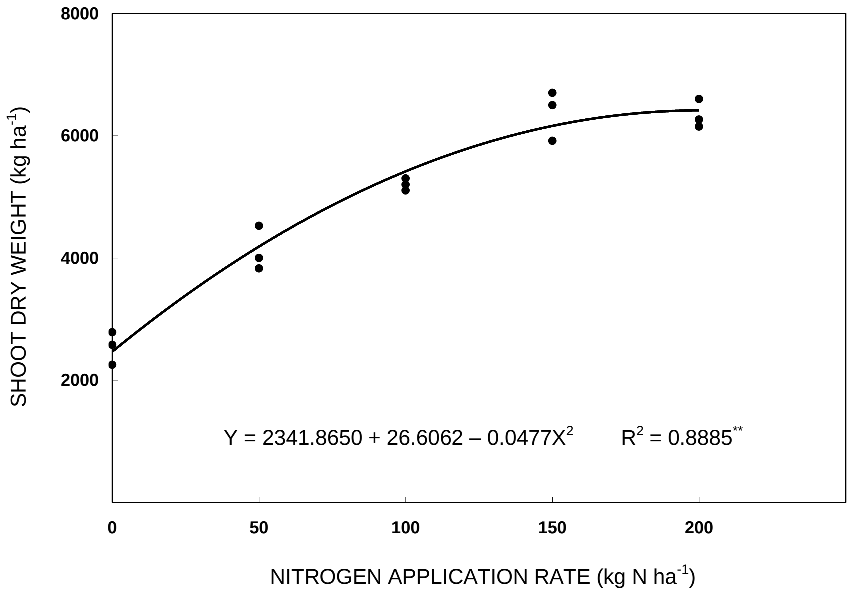

Fig. 4. Relationship between nitrogen application rate and shoot dry weight of faba bean. Values are average of 12 genotypes and 2 years field trial.

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