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Effects of Tillage Systems and Nitrogen Fertilizer on Yield and Yield Components of Faba Bean

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Abstract: Field experiment in split plot format based on randomized complete block design was conducted during 2009 farming year at the Langroud Township in Guilan province (north of Iran), to study the effect of tillage systems and nitrogen fertilizer on yield and yield components of Faba Bean (*Vicia faba* L.). Main factor of experiment consists of two tillage systems (t_1: conventional tillage and t_2: minimum tillage) and sub factor consists of six nitrogen fertilizer levels (n_1: control, n_2: 25 kg/ha nitrogen, n_3: 50 kg/ha nitrogen, n_4: nitroxin biofertilizer inoculation, n_5: 25 kg/ha nitrogen+ nitroxin inoculation, n_6: 50 kg/ha nitrogen+ nitroxin inoculation). Seed yield, straw yield, biological yield, harvest index, plant height, 100 seed weight, number of pod per plant and number of seed per pod were measured. Results showed Tillage had significant effect on seed yield, biological yield, harvest index, plant height and 100 seeds weight was significant in 5% probability level. But on straw yield, number of pod per plant and number of seed per pod was non significant. Also, effect of nitrogen fertilization treatment on all measured traits had significant differences in 1% probability level. Interaction effect on seed yield, harvest index, 100 seeds weight and number of seed per pod had significant differences in 1% and on straw yield and number of pods per plant in 5% probability level. Also on biological yield and plant height was non significant. In general high seed yield was obtained by t_1n_5 treatment (conventional tillage along with 25 kg/ha nitrogen+ nitroxin inoculation) with 4869 kg/ha.

Key words: Faba Bean · Tillage Systems · Nitrogen Fertilizer · Seed Yield

INTRODUCTION

Legumes are the major direct source of proteins for both man and livestock, especially in poor countries, where animal protein is expensive [1]. 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 [2]. The tillage systems are applied in order to modify soil characteristics and to control the vegetation factors (water, air, heat, nutritive elements and biological activity), thus facilitating optimal conditions for the growth of plants. The classic system of soil tillage practiced even since the 11th century, that predominantly in usage today is definitely characterized by classical ploughing (with the use of which the soil is turned) and the preparation of the germinal layer. The necessity of the decreasing the number of tillage and also the elaboration of soil tillage system has appeared ever since the 50's and the 60's. Thus new systems of soil tillage have developed (unconventional ones, alternative systems and system of preserving the soil) with several options: working with disc harrow, rotary harrow, chisel and par plow, the system of working with protecting layer, the system of working with strips, direct sowing etc [3]. The implementation of a tillage system should be done in accordance with all the aspects which can influence that system, thus it assumes the knowledge in detail of all the elements which contribute to the increase of the soil fertility. An insufficient analysis of the way in which the soil interacts to these high requirements can have negative consequences, which are the degradation processes or even the destruction of the production capacity [4]. Responses of faba bean growth to tillage operation were evaluated in some researches. EL-Douby and Mohamed (2002) [5] and Nawar and Khalil (2004) [6] observed a tendency for increase in seed yield, 100-seed weight and number of pods/plant of faba bean with tillage, compared to no tillage systems. Nitrogen is required by plants in comparatively larger amounts than other elements [7]. For an optimal yield, the N supply must be available according to the needs of the plant. Nitrogen

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deficiency generally results in stunted growth and chlorotic leaves caused by poor assimilate formation that leads to premature flowering and shortening of the growth cycle. The presence of N in excess promotes development of the above ground organs with abundant dark green (high chlorophyll) tissues of soft consistency and relatively poor root growth. This increases the risk of lodging and reduces the plants resistance to harsh climatic conditions and to foliar diseases [8]. Excessive application of fertilizer nitrogen can result in a high soil nitrate concentration after crop harvest [9, 10, 11]. This situation can lead to an increase in the level of nitrate contamination of potable water, because nitrate remaining in the soil profile may leach to groundwater [12]. A good way to solve these problems is usage of biological nitrogen fixation. The utilization of biological nitrogen fixation method can decrease the use of chemical nitrogen fertilizer (urea), prevent the depletion of soil organic matter and reduce environmental pollution to a considerable extent [13]. Some bacteria that are associated with the roots of crop plants can induce beneficial effects on their hosts and often are collectively referred to as PGPR (Plant Growth Promoting Rhizobacteria) [14]. The biological fixation of nitrogen produced by these organisms can constitute a significant and ecologically favorable contribution to soil fertility [15]. Nitroxin is a biologic nitrogen fertilizer that containing Azospirillum and Azotobacter. Azospirillum belongs to family Spirilaceae, heterotrophic and associative in nature. In addition to their nitrogen fixing ability of about 20-40 kg/ha, they also produce growth regulating substances. Although there are many species under this genus like, A.amazonense, A.halopraeferens, A.brasilense, but, worldwide distribution and benefits of inoculation have been proved mainly with the A.lipoferum and A.brasilense. Azotobacter belongs to family Azotobacteriaceae, aerobic, free living and heterotrophic in nature. Azotobacters are present in neutral or alkaline soils and *A.* chroococcum is the most commonly occurring species in arable soils. A. vinelandii, A. beijerinckii, A. insignis and A. macrocytogenes are other reported species. The number of Azotobacter rarely exceeds of 10^4 to 10^5 g^{-1} of soil due to lack of organic matter and presence of antagonistic microorganisms in soil. The bacterium produces anti-fungal antibiotics which inhibits the growth of several pathogenic fungi in the root region thereby preventing seedling mortality to a certain extent. The isolated culture of Azotobacter fixes about 10 mg nitrogen g^{-1} of carbon source under invitro conditions. Azotobacter also to known to synthesize biologically active growth promoting substances such as vitamins of B group, indole acetic acid (IAA) and gibberellins. Many strains of Azotobacter also exhibited fungi static properties against plant pathogens such as Fusarium, Alternaria and Helminthosporium [16]. The Current study aimed is investigated the influence of Tillage Systems and different nitrogen fertilizer levels on yield and yield components of Faba bean.

MATERIALS AND METHODS

In order to study effect of different tillage systems and nitrogen fertilizer on yield and yield components of Faba bean (*Vicia faba* L.) an experiment in split plot format based on randomized complete block design with three replications in Langroud township situated on Guilan province (north of Iran), with 37°11' N latitude and 50°0' E longitude and 20 m above sea level in 2009 was conducted. The main factor of experiment consists of two tillage systems (t_1: conventional tillage and t_2: minimum tillage) and the sub factor consists of six nitrogen fertilization levels (n_1: control, n_2: 25 kg/ha nitrogen, n_3: 50 kg/ha nitrogen, n_4: nitroxin inoculation, n_5: 25 kg/ha nitrogen+ nitroxin inoculation, n_6: 50 kg/ha nitrogen+ nitroxin inoculation). Pure nitrogen prepared from source of urea (46%). The soil texture was loam clay and pH 7.1 (Table 1). Conventional tillage perform with classic plough + rotary harrow + mutual disc and minimum tillage with cultivation of the soil upper layer using a rotary mower was carry out. Inoculation seeds with nitroxin biofertilizer in a dish contain water and nitroxin bio-fertilizer (Azospirillum bacteria and Azotobacter) before cultivation to main field was carried out. Seeds of faba bean were planted on 25 November. Plant spacing of 20×40 cm was used and seeds were planted in depth of 4-5 cm. The normal agricultural practices required for control of weeds and pests were applied as commonly followed in the farm. In maturity time, Seed yield, straw yield, biological yield, harvest index, plant height, 100 seed weight, number of pod per plant and number of seed per pod were measured.

Table 1: Physical and chemical analysis of the tested soil

Soil texture	Loam clay
Clay (%)	46.580
Silt (%)	29.970
Sand (%)	23.450
E.C.(mmhos/cm)	1.310
pH	7.100
Total nitrogen (%)	0.193
P (ppm)	9.100
K (ppm)	197.000

The yield and yield components were analyzed by using MSTATC software. The Duncan's multiple range tests was used to compare the means at %5 of significant.

RESULTS AND DISCUSSION

Effect of Tillage Systems: With attention to results of variance analysis (Table 2), the effect of tillage systems on seed yield, biological yield, harvest index, plant height and 100 seeds weight was showed significant differences in 5% probability level. Also, on straw yield, number of pod per plant and number of seed per pod was non significant. Comparison of mean between tillage systems treatments show that (Table 3), the highest seed yield with 3596.6 kg/ha, biological yield with 11493.1 kg/ha, harvest index with 30.9 %, plant height with 119.6 cm and 100 seeds weight with 252.4 g was obtained from conventional tillage system. The lowest amount of this traits were recorded from minimum tillage system respectively with 3229.9 kg/ha, 10991.1 kg/ha, 28.9 %, 118.4 cm and 246.3 g. similar results were reported by Herridge and Holland [17], Gomma and El Naggar [19], El-Douby and Mohamed [5] and Nawar *et al.* [18].

Effect of Nitrogen Fertilization: The analysis of variance presented in Table 2. Showed significant effect of nitrogen fertilizer levels on all measured traits in 1% probability level. Comparison of mean between nitrogen fertilizer levels show that (Table 3), The highest seed yield, biological yield, harvest index, number of pods per plant and number of seeds per pod respectively with 4747 kg/ha, 12830 kg/ha, 36.99 %, 18.74 pods per plant and 5.97 seeds per pod was obtained from n_5 treatment (25 kg/ha nitrogen + nitroxin inoculation). The n_6 treatment with 12740 kg/ha biological yield placed in same statistically level with n_5 treatment. Also, the lowest seed yield with 2304 kg/ha, biological yield with 9412 kg/ha, harvest index with 24.44 %, number of pods per plant with 7.25 and number of seeds per pod with 4.32 was found from n_1 treatment (control). The maximum values of straw yield, plant height and 100 seeds weight was recorded from n_6 treatment (50 kg/ha nitrogen +nitroxin inoculation) respectively with 8465 kg/ha, 121.6 cm and 260.6 g. The lowest Straw yield with 7108 kg/ha, plant height with 116.1 cm and 100 seeds weight with 240.4 g was recorded from n_1 treatment (control). Similar results were reported by Kavimndan [20], Rizk *et al.* [21]. Ahmed *et al.* [22]. El-Bassiony, [23] and Susheela and Singh [24].

Table 2: Analysis of variance studied traits of faba bean under different levels of tillage systems and nitrogen fertilization

Source of variance	DF	Seed yield (kg/ha)	Straw yield (kg/ha)	Biological yield (kg/ha)	Harvest index (%)	Plant height (cm)	100 seeds weight (g)	No.of pod per plant	No.of seed per pod
				MS					
Main factor (T)	1	1210000*	164700.694ns	22675534.028*	34.869*	12.948*	334.768*	26.591ns	2.862ns
Error T	2	63653.583	10102.778	121002.194	1.752	0.448	17.810	6.192	0.488
Sub factor (N)	5	5330476.444**	1412852.628**	10937636.317**	141.326**	18.735**	263.994**	95.935**	1.969**
T×N	5	55223.400**	61597.828*	63877.828ns	4.172**	2.076ns	46.376**	1.065*	0.253**
Error N	20	5576.939	19639.944	33008.406	0.231	1.417	10.922	0.391	0.030

Ns, ** and * respectively: non significant, significant in 1% and 5% area

Table 3: Comparison of mean effect of tillage systems and nitrogen fertilization levels on studied traits

Treatment	Seed yield (kg/ha)	Straw yield (kg/ha)	Biological yield (kg/ha)	Harvest index (%)	Plant height (cm)	100 seeds weight (g)	No.of pod per plant	No.of seed per pod
Tillage								
Conventional	3596.6 a	7896.4 a	11493.1 a	30.9 a	119.6 a	252.4 a	15.7 a	5.4 a
Minimum	3229.9 b	7761.2 a	10991.1 b	28.9 b	118.4 b	246.3 b	14 a	4.8 a
Fertilizer								
Control	2304 e	7108 e	9412 e	24.44 f	116.1 c	240.4 d	7.25 d	4.32 e
25 kg/ha nitrogen	3260 c	7467 d	10730 c	30.30 c	118.8 b	248.2 bc	14.74 c	4.83 d
50 kg/ha nitrogen	3286 c	8066 b	11350 b	28.93 d	119.1 b	249.7 bc	16.48 b	5.14 c
Nitroxin	2608 d	7785 c	10390 d	25.07 e	118.5 b	246.4 c	14.82 c	4.82 d
25 kg/ha nitrogen +nitroxin	4747 a	8083 b	12830 a	36.99 a	119.7 b	251.1 b	18.74 a	5.97 a
50 kg/ha nitrogen +nitroxin	4276 b	8465 a	12740 a	33.54 b	121.6 a	260.6 a	16.96 b	5.45 b

Within each column, means followed by the same letter do not differ significantly at P<0.05

Table 4: the interaction effect of tillage systems and nitrogen fertilization on studied traits

Treatment	Seed yield (kg/ha)	Straw yield (kg/ha)	Harvest index (%)	100 seed weight (g)	No.of pod per plant	No.of seed per pod
t_1n_1	2447 j	7230 e	25.28 f	244.5 c	8.5 f	4.52 f
t_1n_2	3636 e	7470 e	32.73 c	249.4 bc	14.86 de	4.92 de
t_1n_3	3462 f	8011 cd	30.17 d	250.8 bc	17.48 b	5.34 c
t_1n_4	2741 i	7810 d	25.97 f	248.2 bc	15.69 cd	5.03 cde
t_1n_5	4869 a	8316 ab	36.92 a	252.8 b	19.97 a	6.64 a
t_1n_6	4425 c	8542 a	34.11 b	268.9 a	17.65 b	5.78 b
t_2n_1	2160 k	6986 f	23.6 g	236.3 d	6 g	4.12 g
t_2n_2	2885 h	7464 e	27.86 e	247 bc	14.63 de	4.74 ef
t_2n_3	3110 g	8120 bc	27.69 e	248.5 bc	15.49 cd	4.94 de
t_2n_4	2474 j	7760 d	24.18 g	244.6 c	13.95 e	4.61 f
t_2n_5	4624 b	7850 d	37.06 a	249.3 bc	17.51 b	5.29 c
t_2n_6	4127 d	8387 a	32.97 c	252.3 b	16.27 c	5.13 cd

Within each column, treatments that carry the same superscript letter are not significantly different at $P<0.05$

Interaction Effect: Interaction effect of tillage systems and nitrogen fertilizer levels on seed yield, harvest index, 100 seeds weight and number of seed per pod had significant differences in 1% and on straw yield and number of pods per plant in 5% probability level. Also on biological yield and plant height was non significant (Table 2). Comparison of mean between interaction levels show that (Table 4), the highest seed yield, harvest index, number of pods per plant and seeds per pod obtained from t_1n_5 (conventional tillage along with 25 kg/ha nitrogen + nitroxin) treatment respectively with 4869 kg/ha, 36.92 %, 19.97 pods per plant and 6.64 seeds per pod. Also, the lowest amounts of this traits was recorded from t_2n_1 treatment with 2160 kg/ha seed yield, 23.6 % harvest index, 6 pods per plant and 4.12 seeds per pod. The maximum straw yield with 8542 kg/ha and 100 seeds weight with 268.9 g was found from t_1n_6 (conventional tillage along with 50 kg/ha nitrogen + nitroxin) treatment. Minimum amounts of straw yield and 100 seeds weight respectively with 6986 kg/ha and 236.3 g was recorded from t_2n_1 (Minimum tillage without nitrogen and nitroxin application) treatment. Similar results were reported by Wange [25], Salah *et al.* [26], Zeidan *et al.* [27] and El-Ahmed *et al.* [28].

CONCLUSION

With attention to obtained results use of seed inoculation with nitroxin biofertilizer along with nitrogen chemical fertilizer had a significant and positive effect on yield and yield components of faba bean. Also, Conventional tillage cause to increase of performance attributes. Due to good response of faba bean to conventional tillage system and combined chemical nitrogen with nitroxin biofertilizer (compound Fertilizer), this method was suggested for faba bean farming in this region.

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