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Full Length Research Paper

Response of Faba Bean (*Vicia Faba* L.) to Rhizobium Inoculation Rate at Dodola District, South East Ethiopia

Desalegn Dejene[1] and Jemal Abdulkerim[2]*

[1]Dodola district agricultural office, email= belendesedejene@gmail.com
[2]Madda Walabu University, School of Agriculture, Department of plant Science

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Abstract

The investigation was done to evaluate the effect of Rhizobium leguminosaru vicae (EAL110) inoculation rate on the yield components and yield of Faba bean (Vicia faba L.). The test was performed in randomized complete block design with 3 replications under field condition during 2015 cropping season at Dodola district ketaberenda farmers training center, South Eastern Ethiopia. Treatments were 0,330,580 and 830 g/ha rhizobium inoculation. The collected parameters were plant height, root length, nodule density, number of tillers per plant, number of effective tillers per m^2, number of pods per plant, number of seeds per pod, nodule density, grain yield and hundred grains weight. Significant effect at ($p<0.01$) due to rhizobium inoculation rate was observed on plant height, number of tillers per plant, number of effective tillers per m^2, of pod per plant and grain yield. But rhizobium inoculation rate did not show significant effect on root length and number of seeds per pod. Maximum yield (2591.70 kg/ha) was recorded at rhizobium rate of 580g/ha. Thus, it can be recommended for Faba bean growing areas with enhancement of Faba bean production and productivity.

Key words: Faba *bean, Rhizobium inoculation rate, Yield components, Yield*

* Corresponding Author email: belendesedejene@gmail.com

Introduction

Faba bean (*vicia faba* L.) is protein rich legume crop which is used in human nutrition and animal feeding. It is traditionally grown in the Mediterranean basin, Ethiopia, Central and East Asia, Latin America and northern Europe. There is a strongly increased interest in Northern America and Australia on the production of faba bean (Torres and Ávila, 2011). Food legumes such as beans, chick peas and lentils have significant nutritive value for humans and animals, as well as for agricultural sustainability.

Because of their outcome in ensuring food and feed security, and the benefit to soil eco-system, the need of legume crops production is increasing from time to time (Daoui *et al*., 2015).

In Ethiopia pulse crops rank second next to cereals in terms of production volume and cultivated land out of the total grain production and cultivated land, and Faba bean is first among pulse crops (Biruk Bereda*,* 2009). Pulse crops are important to Ethiopian farmers because they provide an alternative source of protein, income, and food security. Faba bean has various valuable advantages for the country in general and for farmers in particular. These advantages includes: being one of the major food items in the national feeding culture and it is also a major source of income for a number of farmers, foreign currency earner among the top agricultural export item, and for crop rotation due to its ability to fix atmospheric Nitrogen through symbiotic association and thus, improve soil structure and health (Sheleme *et al.*, 2010).

Different scholars suggested the importance of bio-fertilizer for safe and healthy soil environment. Rugheim and Abdelgani (2012) announced the need for biological fertilizers with compatible effective strains to compensate the chemical fertilizers, to decrease the expenses of chemical fertilizers and to protect the environment from pollution hazards. Mehdi (2011) reported that Rhizobia showed 44% yield increment as compared to control treatment on common bean crop. Muhammad *et al*. (2006) also stated that yield and yield components of mung bean crop have been significantly increased due to inoculation and chemical nitrogen fertilizer applications. The same authors proved that, Seed inoculation was more effective and gave better results than soil inoculation.

Despite increasing trend in volume of production of Faba bean due to increasing demand for crop both in domestic and international market, the production activity of Faba bean fails to fulfill the required emand due to various factors such as drought, high temperature, inadequate supply of nutrients, salinity and excessive moisture (Biruk Bereda*,* 2009). Similarly, Sheleme *et al.* (2010) reported that even though pulse crops used in crop rotation to increase soil fertility and improve soil health, those used in Ethiopia typically provide low yield and inadequate protein, and have limited capacity to improve the soil.

The same situation was observed in Dodola District among Faba bean producing farmers' land; the productivity of Faba bean has remained low 19.12 qt/ha and inconsistent CSA (2016). Surprisingly, poor nodulation has been detected when the seedlings uprooted during preliminary field assessment. On the other hand, inappropriate use of bio fertilizer rates and total absence in some areas are among the principal problems that challenging farmers and result in yield reduction. With this the importance of rhizobium inoculation in legume production has to be considered and taken into action for proper yield. Therefore, the objective of this study was to identify the effect of different application rate of rhizobium inoculation on the yield and yield components of Faba bean.

Materials and method

Description of the study area

The study was conducted in Dodola District, South eastern Ethiopia during 2015 cropping season. Geographically the study area is located at $6^{0}58$ N latitude and $39^{0}11$ E longitudes and at the altitude of 2371 m.a.s.l according to data obtained from GPS record. Minimum and maximum temperature is $10.33^{0}C$ and $26.3^{0}C$, respectively. The district characterized by mono modal rainy season which started from June and end at late September. The main farming practice in the study area is mixed farming system and the major crops produced in study area are wheat, barley, Teff, Faba bean, field pea, maize and linseed. The dominant soil type is black clay loam soil 85% and sandy loam 15% (DAO, 2002, unpublished).

Treatments and Experimental Design

The treatments were four levels of (0, 330, 580 and 830g/ha) rhizobium inoculation rates which had been tested under field condition. The experiment was laid out in a randomized complete block design with three replications.The treatments were randomly assigned to each plot. Each plot has a length of 2 m and width of 3.2m (6.4m^2). Spacing between plots and blocks were 50cm and 1m respectively. Raw planting were used at a depth of 4.5cm with 40cmx20cm spacing. Finally, harvesting was done from 6 central rows and two rows were left from both side to control border effect.

Procedures of Rhizobium inoculation

Rhizobium leguminosaru vicae (EAL110), Sugar, boiled water, container, sensitive balance and Gora variety of Faba bean seed had been used during field work. The rhizobium inoculation procedure that was followed from beginning to end were; 1 Clean Faba bean seed (200 kg/ha) has been measured and transferred to the container; 2: a boiled water was filled into 1L Plastic bottle and mixed with 1kg/ha of sugar to create sticker; 3: a sticker was added to the weighed amount of seed as droplet form to control down ward fall of innoculant and mixed with different rate of *Rhizobium leguminosaru vicae (EAL110*) until all the seeds are evenly coated changed to black color, 4: Shaded area was used to keep inoculated seeds away from direct sunlight. After clean seed get inoculated it was planted in raw immediately and the seed was covered in the soil after planting to avoid the death of rhizobium bacteria due to the exposure of direct sunlight. The procedure were taken from EIAR (2014), Rhizobia-based biofertilizer guidelines with some improvement on sticker solution by increasing sugar concentration (1:1) for further attechment of innoculants.

Data Collected

- Plant height: was measured from ground to tip of the plant from 10 randomly selected plants at the time of 95% maturity or 157 days after planting.
- Root length: roots of ten sample plants from each plot was measured by uprooting the plant safely and this was done at the time of maturity and before harvesting performed.
- Number of tiller per plant: number of tiller per plant was counted by taking ten sample plants from each plot at maximum vegetative growth stage or at the begning of flowering stage.
- Number of effective tillers: number of effective tillers per meter square from net plot area in each plot was counted at the time of 90% physiological maturity.
- Number of pod per plant: was counted from randomly selected ten representative sample at harvest.
- Number of grain per pod: five sample pods were selected from base,midle and top most and avareged.
- Grain yield: each plot harvested and thrashed separetly and weighted and finally converted per ha basis.
- Grain Weight: 100 seeds were randomly counted and weighted using sensetive balance.
- Nodule denisty: The root was carefully washed in a container containing water and the number of nodules per root system was counted thoroughly.

Method of data analysis

SAS software was used for analysis of variance and mean separation was done by least significant differences (LSD) at 0.05 probability level.

RESULT AND DISCUSSION

The result of the analysis of variance indicated that main effect of rhizobium inoculation rate did not show significant effect on root length and number of seed per pod (Table-1).

Plant Height (cm): Statistical result indicate that plant height was highly significantly ($p<0.01$) affected by rate of rhizobium inoculation. Accordingly, rhizobium rate of 580g/ha produced the tallest plants (127cm) but it is statistically at par with that of 830g/ha. On the other hand, the shortest plant height (109cm) was detected from control treatment (Table 1). The difference in plant height of Faba bean under different rhizobium rate could be attributed to difference in adequate supply of available nitrogen in the soil system due to fixation. This finding was in line with (Gabr *et al*., 2007; Farfour and Al-Saman,2014) reported that application of rhizobium gave the best plant growth in Faba bean crop. This implies that the increasing rate of rhizobium inoculation contribute more for vigorous growth the host plant. In contrast, non significant effect of rhizobium inoculation on plant height of faba bean was reported by Abebe and Tolera (2014).

Number of tiller per plant was highly significantly ($p<0.01$) affected by rate of rhizobium inoculation. In plots received 580gr/ha of rhizobium inoculation showed the maximum number of tiller per plant (3.23) and the minimum number of tiller was recorded from control treatment (2.20) (Table 1). This could be attributed due to direct involvement of Nitrogen in the metabolic activities which finally determine the growth and development of plants by enhancing cell division. Similar result was reported by Farfour and Al-Saman (2014) who stated that application of rhizobium *leguminosaru* play important roles in enhancing the plant growth and controlling several diseases like root rot and stem canker. This situation could directly or indirectly increase the number of tillers per plant by enhancing vigorous growth of above ground biomass.

Number of effective tillers per m^2 was highly significantly ($p<0.01$) affected by rate of rhizobium inoculation. Since the final yield of Faba bean is depend on pod bearing tillers, the number of effective tillers per unit area is very important. With this, maximum number of effective tillers per m^2 (100.33) was recorded from the plot treated with 580g of rhizobium inoculation while, the minimum (64.00) was recorded from the control treatment. It is obvious that the final plant population is in line with number of tillers produced per plant. According to Ghasem *et al*.(2015) the inoculation cause increase of vegetative development, plant height, number of branches, number of leaves, leaf area and especially the biological performance of soybean. El_Khatib *et al.* (2014) also found inoculated plants with rhizobia produced shoot biomass higher than those received no rhizobial inoculums in faba bean.

Number of Pod per plant was significantly affected ($p<0.05$) by the rate of rhizobium inoculation. Under rhizobium inoculation statistical difference was not observed in other treatments except at control. This implies effective symbiotic associations were created among all treated seeds increase the photosynthetic and fertilization potential of Faba bean that boosting pod bearing capacity. Accordingly, the highest (12.16) number of pod per plant was recorded at rate of 580g/ha rhizobium inoculation while, less number (10.63) of pod per plant were observed at control. This could be due to effective nodulation performed by symbiotic association which increases agronomic efficiency of the plant by increasing available nitrogen in the host plant which enhances photosynthesis process that can induce the pod filling and pod bearing capacity of the plant which can give witness for good yield. Inline to this finding Somayeh and Hashem (2015) reported that after application of P (25 kg ha^{-1}), plants inoculated with *Pseudomonas fluorescens* strain 168 (32.8±0.6) and strain 136 (30.5 ±0.7) recorded the greatest number of pods per plant while the un-inoculated plants were recorded the fewest pods per plant (26.3 ±1.1).

Hundred grains weight (g): The effect of rhizobium rate on the hundred grain weight was highly significant at the 1% probability level. The highest hundred grain weight (77.67 g) was recorded in plants inoculated with 580g of rhizobium rate while the minimum hundred grain weight (64.00 g) was recorded in un-inoculated plants (Table 1). In consistent to this finding, Somayeh and Hashem, (2015) reported that 100-grain weight was significantly lower for un-inoculated plants than for plants inoculated with strains.

Grain yield (Kg ha^{-1}): According to the result of ANOVA the main effects of rhizobium rates showed highly significant ($p<0.01$) effect on grain yield of faba bean. Maximum grain yield (2591.70 Kg/ha^{-1}) was recorded from rhizobium inoculation rate (580g/ha). Even though, there was a difference numerically, statistical result showed similarity between 580g and 830 g of rhizobium inoculation while the minimum grain yield (1300 Kg/ha) was obtained from control treatment. This could be due to the introduced rhizobium strain to the host was effectively performed and increased the level nitrogen in photosynthesis activity thus enhanced the yield potential of the plant which resulted in good yield. Generally seeds priming by various inoculation could increase about 43 percent of yield than the control (Mehdi, 2011). Similar finding was reported by Rugheim and Abdelgani (2012) who stated that *Rhizobium* and phosphate solubilizing bacteria significantly increased yield and seed quality of faba bean plants. Rudersh *et al.* (2005) also reported an increase in nodulation, nitrogen uptake, growth and yield response of crop plants due to inoculation of *Rhizobium* spp.

Nodule Density

According to the result of ANOVA test there was highly significant ($p<0.01$) difference among the treatments. Accordingly, 580 g/ha rhizobium rate showed absolutely good nodule density (77.00) per plant while it was found statistically at par with 830g/ha of rhizobium inoculation rate. The control treatment was poor towards nodule density (Table-1). This implies that inoculation was effective to create positive interaction and symbiotic association with the host plant which finally increases nodule density and level available nitrogen. Ananda and Fazlul (2005) tested the number of nodules among inoculated seed with rhizobium and uninoculated seed in sterile soil where they found no nodule was formed in uninoculated bean plants cultivated in sterile soil in plastic pots, but remarkable number of nodules was formed in inoculated bean plant cultivated in sterile soil.

Table 1.The main effect of rhizobium inoculation on plant height (cm), root length (cm), number of tiller per plant, Number of effective tillers per m2, number of pod per plant, number of grains per pod, grain yield and hundred grain weight

Rate of rhizobium inoculation (g/ha)	Plant Height (cm)	Root Length (cm)	Number of tillers per plant	Number of effective tillers/m^2	Number of Pod Per Plant	Number of grains per pod	Grain Yield (Kg/ha)	Hundred Grain Weight (g)	Nodule Density
Control	109.00^{c}	17.33	2.20^{c}	64.00^{c}	10.63^{b}	3.03	1300.00^{b}	64.00c	24.00^{c}
330	114.33^{bc}	22.33	2.80^{b}	71.16^{c}	11.46^{ab}	3.16	1585.00^{b}	70.33b	56.33^{b}
580	127.00^{a}	25.66	3.23^{a}	100.33^{a}	12.16^{a}	3.40	2591.70^{a}	77.67^{a}	77.00^{a}
830	122.00^{ab}	24.00	3.13^{ab}	88.00^{b}	11.30^{ab}	3.30	2200.00^{a}	75.00^{ab}	75.33^{a}
LSD	7.99	Ns	0.36	11.03	1.14	Ns	455	5.81	9.01
Cv (%)	3.38	24.04	6.45	6.82	5.04	7.79	11.87	4.09	7.75

Note: Means followed by the same letter case in the column has no significant difference at 5% probability level. Ns, not significant

Conclusion

In this investigation rhizobium inoculation affected many of the growth parameters including plant height, number of tillers per plant, number of effective tillers/m^2, number of pod per plant, nodule density, hundred grain weight and grain yield; which indicate that introducing rhizobium inoculants shows overall improvements in yield and yield attributes of Faba bean. Generally, based on the result obtained from the study, 580g/ha of *Rhizobium leguminosaru vicae (EAL110*) can be recommended for maximum grain yield and further study should be done on different varieties.

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Conflict of interest

We are responsible for any conflict of interest that may arise concerning research article.

REFERENCE

Abebe Zerihun and Tolera Abera (2014).Yield Response of Faba bean to Fertilizer Rate, Rhizobium Inoculation and Lime Rate at Gedo Highland, Western Ethiopia. *Glob. J. Cropens, Soil Scien. Plant Breeding*, 2 (1): 134-139.

Ananda Kumar Saha and Md. Fazlul Haque (2005). Effect of Inoculation with *Rhizobium* on Nodulation and Growth of Bean, *Dolichos Lablab. J. Life Earth Scie.*, 1(1): 71-74.

Biruk Bereda (2009). Production & Marketing Activity of Broad Bean in Ethiopia. Ethiopia Commodity Exchange Authority, Addis Ababa, Ethiopia.

CSA (2016). Agricultural Sample survey 2015/2016 (5):10-12.

Daoui KM, Karrou R, Mrabet Z, Fatemi and K Oufdou (2015). Faba Bean Fertilization in Morocco. Better Crops /Vol. 99 (No. 4): 12-13.

El-Khatib SI, El- Bialee, NM, El- Khatib, Ilham, I and El- Bialee, A.M (2014). Effect of laser leveling, water quantities and rhizobium inoculation on fixing N2 efficiency with Faba Bean. *Agri. Bio. J. North America, 5(2): 87-96.*

EIAR (2014). Rhizobia-based biofertilizer guidelines for smallholder farmers. EIAR, Addis Ababa, Ethiopia.

Farfour SA, Al-Saman MA (2014). Root-rot and Stem-canker Control in Faba Bean Plants by Using Some Biofertilizers Agents. *J Plant Patho. Microb.* 5:218.

Gabr,S.M, H.A.Elkhatib and A. M.El-Keriawy (2007). Effect of Different Biofertilizer Type and Nitrogen Fertilizer Levels on Growth, Yield and Chemical Contents of Pea Plants (*Pisumsativum* L.). *J. Agri. Env. Sci. Alex. Univ., Egypt*, 6 (2):192-218.

Ghasem Sancholi, Hamid Reza Mobasser and Hamid Reza Fanaei (2015). Effect Inoculation of Soybean Cultivars with bacteria *Rhizobium japonicum* in Sistan *Biological Forum – An Inter. J.,* 7(1): 552-558.

Mehdi Mehrpouyan, 2011. Nitrogen fixation efficiency in native strains compared with non-native strains of Rhizobium leguminosarum. *International Conference on Environment Science and Engineering, Singapore.*

Muhammad Shehzad Anjum, Zammurad Iqbal Ahmed and Ch. Abdul Rauf (2006). Effect of *Rhizobium* Inoculation and Nitrogen Fertilizer on Yield and Yield Components of Mungbean. Inter. J. Agri. Bio., *8(2):* 238–240.

Rudersh DL., Shivaprakash MK., Prasad RD. (2005): Effect of combined application of *Rhizobium*, phosphate solubilizing bacterium and *Trichoderma* spp. on growth, nutrient uptake and yield of chickpea (*Cicer aritenium* L.). *Appl. Soil Ecol.,* 28: 139–146.

Rugheim, A. M. E. and Abdelgani, M. E (2012). Effects of microbial and chemical fertilization on yield and seed quality of faba bean (*Vicia faba*). *Inter. Food Res. J. 19(2): 417-422.*

Sheleme Beyene, Bunyamin Tar'an and Fran Walley (2010). Improving pulse crop production in Southern Ethiopia. International Food Security Research Fund (CIFSRF), www.idrc.ca/cifsrf.

Somayeh Ghasempour Nikfarjam and Hashem Aminpanah (2015). Effects of phosphorus fertilization and *Pseudomonas fluorescens* strain on the growth and yield of faba bean (*Vicia faba* L.). IDESIA (Chile), 33 (4): 15-21.

Torres A.M and Ávila CM (2011). Molecular breeding approaches in faba bean. The magazine of European association for grain legume research. Issue no: 56. Page 21.