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Evaluation of Effective Rhizobium Strain with Chemical Fertilizer on Enhancement of Fababean Production in Woliaita Zone Southern Ethiopia

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Abstract

Fabab bean is the most important grain legume in Ethiopia in terms of area, production source of protein and as rotation of crop ameliorating soil fertility, oil production as well as for soil fertility improvement by fixation of nitrogen. The benefits by the use of Rhizobium inoculants show that a quite good deal of money can be saved by marginal farmers by using quality tested inoculants on the farm. Rhizobia inoculation to seeds is well studied and exploitation of this beneficial nitrogen fixing root nodule symbiosis represents a hallmark of successfully applied agricultural microbiology. So this study was aimed to study types of strain for better production faba bean at the study area. This experiment was conducted in two consecutive cropping season of the area with the objective of evaluating commercial strains with and without inorganic fertilizer and consisted of eight treatments. The experiment was laid out in complete randomized block design (CRBD) with replications three times. The experiments analysis of variance indicated that there was significant difference ($P < 0.05$) among treatments in nodules weight and biomass but, there was no significant difference in plant height and grain yield of faba bean. This may be due to soil acidity; accordingly, the experiment result indicated that the highest number of nodules and nodule weight plant-1 recorded by treatment 8 and 6 than un inoculated treatment plots. However, the highest biomass and grain yields were recorded by treatment 5(EAL110). Therefore, EAL110 rhizobium strains was found to be the most suitable commercial rhizobial inoculants for fababean production and yield improvement with supportive of chemical fertilizer in the study area, therefore further study and check-up is needed by using lime for amelioration of soil acidity.

Keywords: N-fixation; Inoculation; Rhizobia; Soil-fertility; Leguminous

Introduction

Fabab bean is the most important grain legume in Ethiopia in terms of area, production source of protein and as rotation of crop ameliorating soil fertility. Faba bean is a legume capable of fixing nitrogen in an endo symbiotic association with root nodule bacteria: Rhizobium leguminosarum var. viceae. It is the most efficient nitrogen fixer of the pulse crops grown (McVicar et al., 2005). According to Somasegaran and Hoben (1994), the amounts of N2-fixed (kg/ha) by faba bean have been 240-325.The dual contribution of faba bean as a source of protein for the majority of population, and its capability to fix nitrogen and improve soil fertility has been used in crop rotation and traditional mixed low-in put agricultural systems. Faba bean is the major pulse crop grown in the country. Ethiopia is considered to be one of the centers of secondary diversity for fab bean (Toreres A.M. et al., 2006). Currently the crop is grown in several regions of the country receiving annual rain fall of 800-3000 where the temperature is cold (Yohannes 2000) [1].

Soil acidity and associated low nutrient availability is one of the major constraints to fababean production Ethiopian high lands. Under such soils severe chemical imbalance caused by toxic levels of exchange aluminum (AL), manganese and hydrogen (H) ions coupled with a paralle critical deficiency in available nitrogen (N), phosphorus (P), potassium (K), calcium (Ca), magnesium (Mg), zinc(Zn) and molybdenum (Mo) limits the growth and production of legume (Fageria Nk 2002) [2].

Low diversity of rhizobium leguminuosarium has been reported in acid soils compared to limited soils (Andrade DS et al., 2002). Thus limited persistence of rhizobium in soil can depress nodulation and growth of fabaeban in acid soils. Several factors account for the low productivity of faba bean, of which soil acidity and fertility decline land degradation, moisture shortage ground and surface area water depletion, increasing soil infertility, frequent disease occurrence , parasitic weeds and lack of high yielding varieties could be mentioned (Getachew A and Rezene F, 2006) [3].

Faba bean has an important place in the Ethiopian national diet and is consumed in various forms for its high protein content. In some parts of the world, the green, immature beans are eaten as a vegetable after boiling. The bean is also eaten roasted in India, where it is used as a coffee extender. The mature seeds may be used for feeding livestock such as swine, horses, and poultry, and stalks or haulms may be used as feed for horses and cattle. The stalks are also used as firewood for cooking, and may be composted. The faba bean has an important role in improving soil fertility by fixing nitrogen from the atmosphere in association with bacteria, and it is used in crop rotation with cereal crops. The crop can be grown for green manure, silage, cover crop, and animal forage. Production in Ethiopia is entirely rainfed on nitosols and cambisol soil types [G. Keneni 2002] [4].

It is established that the symbiosis between Rhizobium and legumes are a cheaper and usually more effective agronomic practice for ensuring an adequate supply of N for legume based crop and pasture production than the application of fertilizer N (Zahran, 1999). With increasing costs of chemical fertilizers and farmers inability to purchase them, the need to exploit inexpensive means of soil fertility maintains such as

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biological nitrogen fixation is becoming important (Tekalign Mamo and Asegelil Dibabe, 1994). Faba bean (Vicia faba L.) is the fourth most important pulse crop in the world. It occupies the greatest area planted to legume crops in the Arab countries (Amin, 1988). Faba bean is a valuable food legume rich in proteins and carbohydrate (Karamanose t a l., 1994). Faba bean (Vicia fabae) is ranked first among cool season food legumes based on area of production and foreign exchange earnings (CSA, 2010). It has also a great contribution for sustainable soil fertility management due to its ability to fix atmospheric N2 (Beck et al., 1991) [5].

Several researchers (Getachew A.et al., 1999, Asgelil D. 2000, Getachew A. et al., 2005) have conducted studies on soil fertility management of faba bean in different areas of Ethiopia most of reports revealed that significant improvement on the yield of faba bean due to chemical fertilizers . However the integrated effect of chemical fertilizers and rhizobium or bio fertilizers on the growth and yield of faba bean remain less investigated. Farmers in kokate district usese chemical fertilizers for production of faba bean even thou chemical fertilizers cost is high beyond thire purchasing capacity and have negative impact on soil microbes and nutrients. There for the contribution of rhizobium microbes integrated with chemical fertilizers on fababean yield need investigation. Consequently this study aimed evaluate the best performing rhizobium strain for faba bean production in kokate district of south Ethiopia, Woliata.

Methods and Materials

Description of experimental sites

The study area is located in the southwest part of South Ethiopia Regional State; wolaita zone at kokate kebele. The experimental site is located at about 5 km west of sodo town. The altitude of the experimental site ranges from 2145 to 2300 m above mean sea level. Rainfall is seasonal.

Experimental design

The experimental design was randomized complete block design (RCBD) with three replications. Each plot consisted of ten rows spaced 40 cm × 4 m long. The plot area used was 16 m2 (4m × 4m). A 1m distance was maintained between replications. Date of planting was the same for all treatment. Planting was made at same seed rate. Weeding and other agronomic practices were carried out as per recommendations of respective locations. insecticides were applied.

Plant materials and growing condition

Faba bean seeds obtained from Areka Agricultural Research Centre (AARC) Ethiopia, were surface sterilized by Mercuric chloride (0.1%) for 2 min., and thoroughly rinsed with distilled water. Thereafter, seeds were soaked in distilled water for 6 hours. For inoculation with inoculums (Rhizobium strain EAL 110, FB1035 and FB1017), seeds were moistened in sugar solution (48%) before application of inoculums to get a thin uniform coating of inoculums on seeds immediate before sowing. The experiment using laid out in Randomized Complete Block Design (RCBD) with three replications. The treatments were as follows:

Control, Recommended NP 100kg /ha, FB1035, FB 1017, EAL110, FB1035+50kg DAP, FB1017+50kg DAP and EAL 110+50kgDAP [6].

Result and Discussion

Soil physicochemical properties of the site

Analysed soils sample result showed that the soil particle size distribution of the experimental site was in proportions of 38, 50, and 45 % of sand, silt and clay respectively. Soil textural classification the textural class of the experimental soil is silty clay loam, which is suitable for soybean production (Butcher et al., 2018). The soil pH of experimental site before planting showed that the pH value was 6.8. According to jones et al., (2003), the rating of soil pH was under slightly acid soil reaction. pH of experimental site is ranged within satisfactory range for soybean production as well as for most crops (Johnsson, L., 1991). The OC and TN content of the experimental site was 1.68 % and 0.01% respectively. Which is rated as under the medium and low range respectively (Tadesse T. et al, 1991).

The low TN contents indicated that the soil of experimental site was not sufficient in available N to support proper growth and development of agricultural crop production. Experimental sit's availability of phosphorus was 13.2 ppm and rated as medium; and it is indicative that the soil has probable yield response to external P application according to (Olsen, 1965) rating. Based on the analysis of experimental site cation exchangeable capacity of soil was 38 meq/100g. According to (Johnsson, L., 1991) rating, the CEC of soil study was under high class and adequate for crop production. Furthermore such as high CEC value provides the soil with maximum buffering capacity so that one applies the required amount of fertilizer dosage without any immediate negative effects on the soil (Table 1) [7].

Integrated effect of fertilizers (bio fertilizer and chemical) on plant height of fababean

Plant height of fababean was varied slightly in number, but did not significantly influenced by interaction effect of both bio-fertilizer and chemical fertilizer types as well as rates. Maximum (85.9cm) plant height was observed with application of MAR 1495 + 50 kg DAP while the shortest (83.06 cm) plant height was obtained from application of recommended DAP (100kg). This finding was in agreement with that of okubay et al. (2014) who report that maximum soya bean height was recorded from the treatment which maximum fertilizer is applied (Table 2).

Effect of rhizobia strains on nodule number and grain yield

The experiments analysis of variance indicated that there was significant difference among treatments in number of nodules and biomass. Accordingly, the highest number of nodules were recorded by treatment 8,7and 3 (10.8, 9.8 and 7.2) respectively and biomass recorded by treatment 2,4and 6 (2750, 2479.2 and 2343.8) respectively. However the grain yield is not significant this may due to soil acidity and strain sensitivity to acidic pH.

Whereas, the lowest number of nodules 4.7and 4.6 were recorded by treatment 1and 4 respectively and the lowest grain yield (1395.8 and

Table 1: physicochemical properties of soil before planting.

Soil Properties	Unit	Values	Rating
% sand	%	38	
% silt	%	50	
% clay	%	45	
Textural class			Clay
Soil pH		4.8	strongly acidic
Organic carbon (%)		1.68	medium
Phosphorus (ppm)		13.2	medium
Total nitrogen (%)		0.01	medium
Available potassium (ppm)		61	Low
CEC (meq/100g)		38	High

Table 2: Integrated effect of fertilizers (bio fertilizer and chemical) on plant height of faba bean.

Treatment	PLH	NNO	PNo	BNo
1. Control	76.03a	4.7c	15.4a	12dc
2. Recommended NP 100kg /ha,	85.9a	5.1c	8.15ba	11d
3. FB1035	78.6a	7.2bc	7.76ba	14.6a
4. FB 1017	80.8a	4.6c	8.1ba	14.3ba
5. EAL110,	79.8a	5.6c	7.73ba	12.3bdc
6. FB1035+50kg DAP	85.5a	5.8c	9.03ba	13.3bac
7. FB1017+50kg DAP	78.3a	9.8ba	7.26b	12.6bdac
8. EAL 110+50kgDAP	75.4a	10.8a	8.53ba	14bac
CV	13	34	74	14
LSD	12.4	2.69	7.8	2.2

Table 3: Integrated effect of fertilizers (bio fertilizer and chemical) on plant height of faba bean.

Treatment	NWt (g)	SWt (g)	Biom(kg/ha)	Gy(kg/ha)
1. Control	0.36c	640.07b	2020.8b	1750a
2. Recommended NP 100kg /ha,	0.53bac	693.2ba	2750a	1500a
3. FB1035	0.53bac	637.6b	2166.7b	1604a
4. FB 1017	0.60ba	699.07a	2479.2ba	1791.7a
5. EAL110,	0.40bc	693ba	2229.2ba	1916.7a
6. FB1035+50kg DAP	0.73a	698.6a	2343.8ba	1479.2a
7. FB1017+50kg DAP	0.66a	707.07a	2229.2ba	1872.5a
8. EAL 110+50kgDAP	0.56bac	683.3ba	2291.7ba	1395.8a
CV	34	7.3	20.5	35
LSD	0.21	58.3	555.02	725.03

1479.2) were recorded by treatment 8 and 6 respectively even if it isn't significant (Table 3).

As result shown the application of rhizobial strain EAL110 gave highest grain yield even if it is not significantly statistically different and followed by application of FB1017+50kg DAP gave the maximum grain yield of 916.7a kg ha-1 and 872 kg ha-1 respectively. Experiments result shown that combined application of local strain s with DAP and TSP could increase total grain yield of fababean, this may be due to availability of optimum plant nutrients from both combination application of bio fertilizer and chemical fertilizer of N and P sources. This study is in line with finding of Abeje A. et al., 2021 who report that grain yield, effective nodule number and leaf area index were highly affected by the interaction application of bio fertilizer and in organic fertilizers. However combined application of EAL 110 and FB35 with chemical fertilizers TSP and DAP did not show significant result as such on fababean production at the area. this may be due to some strain kinds needs adaptability to the environment and some bio fertilizer need to be adaptable for different agro ecology of environment as reported by Win T.T eta la., (2018).

On the other hand the treatment EAL 110+50kgDAP gave the minimum grain yield of (1395.8) of fababean when compared with other un-inoculated and other combination application of bio-fertilizers and inorganic fertilizers (DAP and TSP).This may be due to the some microbial strains could be affected negatively by chemical fertilizers.

his study agreed with findings of Kyei-Boahen et al., (2017) who report that inoculation and P application increased cowpea grain yield and above ground plant dry matter where as inoculation without P application cause yield reduction of cowpea [8].

Biomass and branch number

From the experiment high biomass (2750 kg ha-1) were recorded in treatment application of Recommended NP 100kg /ha than control treatment. Whereas minimum value was recorded control group (2020.8). Beside this branch number result shows that maximum (14.6) result is observed from the treatment of strain (FB1035) than control group and other form of fertilizer. This may be due to inoculation with adaptable strains of bio-fertilizer could increase branch number. Because as report of Kyei-Boahen et al., (2017) findings, inoculation with bio-fertilizer increase all parameters of cow pea [9].

Conclusion

The experiments analysis of variance indicated that there was significant difference ($P < 0.05$) among treatments in nodules weight and biomass but, there was no significant difference in plant height and grain yield of faba bean. This may be due to soil acidity; accordingly, the experiment result indicated that the highest number of nodules and nodule weight plant-1 recorded by treatment 8 and 6 than un inoculated treatment plots. However, the highest biomass and grain yields were recorded by treatment 5(EAL110). Therefore, EAL110 rhizobium strains was found to be the most suitable commercial rhizobial inoculants for fababean production and yield improvement with supportive of chemical fertilizer in the study area, therefore further study and check-up is needed by using lime for amelioration of soil acidity. The analysis of soil samples collected before planting indicated that the experimental site had insufficient amount of soil fertility status for faba bean crop production. The inoculation of faba bean with Rhizobium strains alone and with TSP fertilizer revealed a significant improvement of the plant height, number of pod per plant, above-ground biomass, and grain yield as compared to the control Application of FB1018 Resulted in the highest grain yield. These results indicated that inoculation of faba bean with effective Rhizobium strains can reduce use of inorganic fertilization and improve productivity of crop yield. The use of FB1018 strain with 9 kg/ha starter N can be recommended for soils of the study area and similar agro-ecology.

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References

1. Ghizaw A, Mamo T, Yilma Z, Molla A, Ashagre Y, et al. (1999) Nitrogen and phosphorus efects on faba bean yield and some yield components. J Agron Crop Sci 182:167-74.
2. Asgelil D (2000) Efect of fertilizer on the yield and nodulation pattern of faba bean on a Nitisols of Adet, Northwestern Ethiopia. Ethiop J Nat Resour 2:237-44.
3. Getachew A, Taye B, Agajie T (2005) Phosphorus fertilizer and farmyard manure efects on the growth and yield of faba bean and some soil chemical properties in acid Nitisols of the central highlands of Ethiopia. Ethiop J Nat Resour 7:23-39.
4. Getachew A, Rezene F (2006) Response of faba bean to phosphate fertilizer and weed control on Nitisols of Ethiopian highlands. Int J Agron 2:281-90.
5. Fageria NK (2002) Nutrient management for sustainable dry bean production in the tropics. Common Soil Sci Plant Anal 33:1537-75.
6. Andrade DS, Murphy PJ, Giller KE (2002) The diversity of Phaseolus-nodulating rhizobiuml populations is altered by liming of acid soils planted with Phaseolus vulgaris L. in Brazil. Appl Environ Microbiol 68:4025-34.
7. Keneni G, Jarso M (2002) Comparison of three secondary traits as determinants of grain yield in faba bean on waterlogged Vertisols. J Genet Breed 56: 317-326.
8. Zahran HH (1999) Rhizobium-Legume symbiosis and nitrogen fixation under severe conditions and in an arid climate. Appl Environ Microbiol 63: 968-989.
9. Beck DP, Wery J, Saxena MC, Ayadi A (1991) Dinitrogen fixation and Balance in cool-season food legumes. Agron J 83: 334-341.