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Evaluation of Effective Rhizobium Strain on Nodulation, Yield and Yield Attributes of Faba Bean in Case of Chancha Woreda Southern Ethiopia

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Abstract
Nitrogen is an important element for plant growth and its availability in sufficient amount boosts production per unit area, increases the total supply of food and contributes to the quality of food. However, resource poor farmers in the tropics especially in Ethiopia are not able to use enough amount of inorganic N fertilizer for crop production due to high cost, and hence looking for alternative means of improving available nitrogen in the soil is crucial. Therefore, this study was conducted to indentify the best Rhizobium strain for faba bean production in chancha woreda and to determine the yield and yield attributes of the faba bean with the application of Rhizobium strains. The ANOVA revealed that the significance difference between the inculcation of different rhizobium spices for faba bean production in chancha woreda. The highest mean in all parameters of the faba bean was recorded from the inculcation of strain 1035 with the combination 50kg DAP/ha. The finding of this research will be repeated in same agro ecological areas before farmer's dissemination
Keywords: Biological nitrogen fixation, Faba bean, Rhizobium

Introduction

Faba bean is one of the commonest and cheapest sources of protein which generates a considerable household income for the farming community. It is the most important crop in high land areas of southern Ethiopia especially Gamo Gofa zone chancha high lands. Its prevalence and importance puts this crop second among the food legume crops in the country (CSA, 2000). However, yield is usually unsatisfactory due to poor production schemes and poor soil physical and chemical properties as major factors contributing to the low yield (Asfaw *et al*., 1994).

It is obviously understood that commercial fertilizers have helped to improve yields of some pulse crops. However, farmers are reluctant to use sources of inorganic N fertilizers because of the associated management problems and the higher costs compared with organic N fertilizers.

Symbiotic nitrogen fixation may be exploited to reduce use of industrially fixed nitrogen. Although intensive agricultural systems are usually sustained through liberal use of industrially fixed nitrogen; economic and environmental pressures dictate reduction of fertilizer use and maximization of *in situ* biological nitrogen fixation.

Symbiotic nitrogen fixation is the process whereby legume crops and specific *Rhizobium* bacteria work together to capture N from the soil air surrounding the roots of the plant.

Air held in small pores in the soil contains approximately 78% N in a gaseous form (N_2). In this form, the N is unavailable for plant use. However, *Rhizobium* in the root nodules can fix gaseous form of N to the form that is available for use by plants. In rural areas of Ethiopia the small holder farmers are not able to use the inorganic fertilizers for crops production because of these the study were conducted with the following objectives

- To indentify the best *Rhizobium* strain for faba bean production in chancha woreda
- To determine the yield and yield attributes of the faba bean with the application of *Rhizobium* strains

Materials and methods

Description of the Experimental Site

The experiment was conducted on farmers' fields during the main rainy season (June-November) of 2007 in Chancha District of south National Regional State (SNNP). Chancha is located at coordinate of 37oc 60' E and 6o c13' N and altitude 3005 m. From the experimental site the phyisco chemical characteristic was determined and shown in the table 1 below

Laboratory Analyses

All laboratory analyses were done following the procedures in laboratory manual prepared by Sahlemedhin and Taye (2000). The soil samples were air-dried and ground to pass a 2-mm sieve and 0.5 mm sieve (for total N) before analysis. Soil texture was determined by Bouyoucos hydrometer method. The pH and electrical conductivity of the soils were measured in water (1: 2.5 soils: water ratio). Organic carbon content of the soil

was determined following the wet combustion method of Walkley and Black while Total nitrogen by (wet digestion) procedure of

Kjeldahl method. The available phosphorus content of the soil was determined by Bray II method. The available potassium was determined by Morgan's extraction solution and potassium in the extract was measured by flame photometer.

Table 1 physico chemical properties of the tested soil before planting

Parameters	Texture	pH	OC (%)	N (%)	Available P(pmm)	Exchangeable K(ppm)
	Clay loam	5.2	2.4	0.4	3.7	13

Experimental Details

During the course of study the three different kinds of rhizoum strain were collected from the private company Managash. The faba bean local variety **Moti** collected from the chancha woreda cooperative union and before sawing the seed of the faba bean they were sterilized with alcohol and gently washed with pure water after rinsing with alcohol. The strains were prepared by pit carrier method and inoculated systematically on seeds firstly the seeds were moistened by water and sugar was added on the seed as attaching agents of the strains

Experimental Treatments, Design and Procedures

The treatments used for this experiment were three *Rhizobium* strains and the combination of the three different kinds of strains and 50 kg/ha DAP in addition to the negative control. The treatments are Strain 1035, Strain 1018, Strain EAL110, strain 1035+50kgDAP/ha, Strain 1018+50kgDAP/ha, Strain EAL110+50kgDAP/ha and the negative control. The treatments were laid down on an area of 4cm by 3cm by using complete randomized block design with three replication on the field and space between the plants and raw were 10cm and 40 cm respectively. All agronomic, growth and yield data were collected from each plot

Data collection procedures

Nodules /plant

Sampling for nodulation was performed by excavating the roots of five random plants from two boarder rows of each plot leaving the central rows at mid flowering stage of faba bean. A spade was used to collect an undisturbed soil core (measuring approximately 20 cm deep, with a radius of approximately 12 cm extending out from the central stem) containing entire root system. The undisturbed soil samples were wrapped in plastic and transported to the laboratory where the soil was washed from the roots using gently running tap water. After that the number of nodules was counted.

Plant dry matter

Plant dry matter was determined at mid flowering stage of the crop from plants sampled for nodulation. After the nodules had been collected from roots, the plant samples were placed in a labeled perforated paper bags and oven-dried to a constant weight to determine the plant dry matter. The average dry weight of five plants was measured to determine dry weight per plant.

Statistical Analysis

The data obtained through various methods were subjected to variance analysis following procedures that are appropriate to experimental design (Gomez and Gomez, 1984) with the help of SAS 9.2 software package. Whenever treatment effects were significant, mean separations were made using the LSD test.

Result and discussion

Nodule no/plants

The significance difference between the treatments was happened with the inculcating of different ***Rhizobium*** strains at probability level of ($p \leq 0.5$) level. The highest mean of the nodule number reordered from the combination of strain 1035+50kgDAP/ha treatments while the lowest nodules/plant was recorded from the negative control treatment. Strain 1035, Strain 1018, Strain 1018+ 50kg DAP/ha and Strain EAL110+50kg DAP/ha treatments are at par to each other by nodulation. The highest nodule no/plant was recorded from the inculcation of strain 1035+50kg DAP/ha these might be due to the inherent fixation capacity of the strain. Agreed with the present result Peoples *et al.* (1995) reported that there are tremendous potential among legumes for nodulation also Beck *et al*., (1993).reported that the significance difference was recorded on nodulation of Faba bean with the inculcation of ***Rhizobium***

Nodule dry

With respect to response of varieties in terms of nodule dry weight, there is no significance difference between

the treatments was recorded with in the treatments except the negative control. The highest mean (44 mg/plant) nodule dry weight was recorded from treatment Strain 1035+50kg DAP /ha while the lowest mean (0mg/plant) was recorded from the negative. The highest mean of nodule dry weight was recorded from the treatment Strain 1035+50kg DAP/ha in fact that the dry weight of the nodule was proportional to the nodule number /plant when the nodule no increase the dry weight of the nodule also increase

Dry matter

The ANOVA confirmed that the significance difference between the treatments with the inculcation of different *Rhizobium* stains on the dry weight of the faba bean. The4 highest mean (2.8g/plant) of the dry matter/ plant of was recorded from the inculcation of Strain 1035+50kg DAP/ha while the lowest mean of the dry weight (2g/plant). Was obtained from the negative control. In agreement with the present finding Yifru (2003), in his studies on field pea in Sinana area, also reported the increased in dry matter due to inoculation of *Rhizobium leguminosarum* alone by 22.4% over the control. Similarly, Mitiku (1993) also reported the increased grain yield, dry matter and nitrogen content due to inoculation of bean genotypes.

Table2 the growth and yield parameters

Treatments	Nodule no./plant	Nodule dry wt./plant (mg)	Dry matter/plant (g)
Un inoculated	**0^{d}**	**0^{c}**	**2d**
Strain 1035	**24^{b}**	**42^{ab}**	**2.7ab**
Strain 1018	**22^{bc}**	**38^{ab}**	**2.4bc**
Strain EAL110	**20^{c}**	**37^{b}**	**2.2cd**
Strain 1035+50kg DAP/ha	**27^{a}**	**44^{a}**	**2.8a**
Strain 1018+ 50kg DAP/ha	**24^{b}**	**40^{ab}**	**2.75a**
Strain EAL110+50kg DAP/ha	**22^{bc}**	**39^{ab}**	**2.67ab**
LSD (5%)	**2.5**	**6.2**	**0.34**
CV (%)	**10.5**	**17**	**13**

Table 3 the yield and growth parameters

Treatments	Plant height(cm)	Pods /plant	Grains/pods
Un inoculated	**88b**	**22**	**4**
Strain 1035	**102a**	**23**	**5**
Strain 1018	**98a**	**23**	**5**
Strain EAL110	**96a**	**23**	**5**
Strain 1035+50kg DAP/ha	**104a**	**24**	**7**
Strain 1018+ 50kg DAP/ha	**101a**	**23**	**5**
Strain EAL110+50kg DAP/ha	**99ab**	**23**	**5**
LSD (5%)	**12**	**NS**	**NS**
CV (%)	**17**	**5**	**13**

Plant height

ANOVA test indicated significant statistical difference existed between the treatments at probability level of ($p \leq 0.01$).the highest mean (104cm) was recorded from with the inculcation of Strain 1035+50kg DAP/ha while the lowest mean (88cm) was recorded from the negative control but there is no significance difference between the rest treatments they are statically at par to each others. The highest mean recorded from the application of 1035+50kg DAP/ha might be due to due to the increasing of nitrogenous compounds in the soil with the inculcation of *Rhizobium* mostly nitrates and ammonium, which has readily taken up by vascular plants (Rogers and Burns, 1994). Absorbed nitrogen in turn increases leaf length through steam elongation brought about by cell division and expansion trap sun light more (Havlin *et al*., 2010).

Pods/plant

The statistical analysis's showed that no significance difference between the treatments but the mean difference between the treatments. The highest mean recorded from (24 pods/plant) from the application of Strain 1035+50kg DAP/ha while the lowest mean (22pods/plants) were obtained from the negative control. The highest mean recorded from the application of application of Strain 1035+50kg DAP/ha might be due to application of

rahizobum strain fix more nitrogen from the environment which enhances the cell division and the accumulation of the stored materials in faba bean.

SUMMARY AND CONCLUSIONS

Most tropical soils including that in Ethiopia have limited potential of giving high crop yields due to nutrient limitations particularly that of nitrogen. Because of this fact yield is usually unsatisfactory. Farmers are unable to mitigate this because they are applying chemical fertilizers less than the recommended doses because of economic considerations and faulty distribution system. Thus, it is a high time to look for alternatives to supplement nutrient requirement of crops and improve reduction. For these reasons the use biological nitrogen fixation through microbial process is important for improving the yield of crops in small holder farmers

The study was conducted clay loam soil with soil PH of 5.2 by using completed randomized block design by using three replication and seven treatments totally 21 experimental plots . During the course of study all necessary material was collected by following the standard procedures.

The ANOVA confirmed that the significant different between the treatments on plant height, nodule number/plant and nodule dry weight, but no significant difference between the grain/ pod and pods/plants. The highest mean of the plant height, nodule number, and nodule dry weight was recorded from the application of strain 1035+50kg DAP/ha while the lowest was obtained from the negative control. From oboes finding strain 1035+50kg/ha DAP recommended for faba bean production

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