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Evaluation of Different Nitrogen Fixing Strains on Faba bean (*Vicia Faba*) Yield at Munesa District, southeastern Ethiopia

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Field study was conducted for two consecutive years (2011 and 2012) at Menesa district in the southeastern highlands of Ethiopia in order to evaluate the effectiveness of three nitrogen fixing strains along with inorganic fertilizers on farmers' fields' conduction. The experiment comprised of four treatments included strain 1018, strain 1035, and strain EAL 110 and recommended nitrogen fertilizer for the study area (18 kg N ha^{-1}) from inorganic source (urea) as a control; using randomized compete block design with farmers. Treatments were arranged in a single replicate per farmer field. Recommended rate of phosphorous (P) fertilizer was applied uniformly to all plots. Yield and yield component data spike m^2, plant height, number of seeds per pod, harvest index, grain yield, biomass yield, hectoliter and thousand kernel weights were collected. Analysis of variance revealed that, there was no significant difference observed among treatments on yield and yield component of faba bean. The pooled mean result also showed that; the three nitrogen fixing strains were brought comparative yield to that of the recommended nitrogen rate applied from inorganic source. These result implied that, nitrogen fixing strains were very effective in fixing and providing the nitrogen requirement of faba bean crop. Hence, using either of the nitrogen fixing strains along with recommended rate of phosphorous from inorganic source has been recommended for increased and sustainable faba bean production in the study area.

Kew words: Faba bean, Nitrogen fixing strains, Rhizobia, Symbiotic effectiveness

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INTRODUCTION

Ethiopia is one of the largest faba bean producing countries in the world only second to China (Hawitin and Hebblewaite, 1993). The country is considered as the secondary center of diversity and also one of the nine major agro-geographical production regions of faba bean (Asfaw Telaye et al., 1994). Faba bean is grown as field crop throughout the highlands and is most common in Wayena Dega between the altitudes 1800m a.s.l and 2400m a.s.l in Ethiopia (Asfaw Telaye, 1985). It is one of the major food legumes grown, occupying about 26.86% of the area coverage of individual grain legumes (CSA, 2016), and it plays a major role in the diet of the

population; it serves as an important source of protein in the human diet (Desta, 1988). The seeds are mostly boiled and used as snack in the daily food of the rural people. They are also used in the preparation of local dishes such as '*shiro wot* 'and '*kik wot*' to be consumed with cereal *injera.* Moreover, they provide large cash for farmers and 10% foreign exchange for the country (CSA, 2016).

Although N2 as a macro nutrient is essential for legume crop production and it accounts for about 78% of the Earth's atmosphere, plants and animals do not have an easy time obtaining all the N they need for growth. This situation arises because the N2 molecule is very stable chemically and so is unusable by most biological organisms. It must be "fixed" in the forms of ammonium (NH4+) and nitrate (NO3-) before it can be assimilated (Fisher and Newton, 2002).

Faba bean is a legume crop capable of fixing nitrogen in an endo-symbiotic association with Rhizobium leguminosarum var.viciae and thereby an important role in the maintenance soil fertility. It has been found to be very efficient N fixers and can meet all of their N needs through biological nitrogen fixation (Lindemann and Glover, 2003; Hardarson, 1993). The amounts of N_2-fixed by faba bean have been 240-325 kg ha^{-1} (Somasegaran and Hoben, 1994). The residual nitrogen in excess of the growing season for faba-bean has been used in crop rotation and traditional mixed low input agricultural systems (Perret et al., 2000). Research reports indicated that substantial grain yield increments have been recorded in wheat grown after faba bean (Hailu et al., 1989; Amanuel and Tanner, 1991).

Inorganic nitrogen fertilization is widely and increasingly practiced to improve the yields of cereal crops; but rarely used in the production of faba bean and other pulse crops; instead, these crops are used as a restorer of soil fertility for the following cereal crops (Asfaw Telaye *et al*., 1994; Mulissa Jida and Fassil Assefa, 2012). Previous research finding indicated that average grain yield of faba bean have been significantly increased by the application of inorganic nitrogen fertilizer (Gete et al., 2010; KARC, 2011). However, most farmers have very low financial resources to make use of inorganic fertilizers and combat nutrient depletion. Among other constraints, depletion of soil fertility and use of suboptimal fertilizer resulted in the lowest national mean grain yield of faba bean, 1520 kg ha^{-1} (CSA, 2010). Hence, research should be directed to seek affordable and least risky technology to keep nutrient balance. So far isolation and characterization of the symbiotic effectiveness of rhizobia nodulating faba bean from southeastern Ethiopian soils was executed by National Soil Testing and Holeta Agricultural Research Centers. Accordingly; promising strains were also developed but not yet evaluated on their effectiveness under farmer's condition. Therefore; this study was geared towards evaluation of the effectiveness of three nitrogen fixing strains along with inorganic fertilizers on their yield and yield component of faba bean under farmers' field condition.

MATERIALS AND METHODS

During 2011 and 2012 main cropping seasons, field experiments were conducted under farmers condition in one of the major faba-bean growing areas of Arsi Zone called Munesa district in the southeastern highlands of Ethiopia. The trial was laid in randomized complete block design; farmers' fields were considered as replication. Hence, the experiment has a multi-location design. In every field, the treatments were fully randomized; different randomizations for each replicate were employed. The experiment comprised of four treatments, which contained combinations of biological and inorganic fertilizers at recommended levels as indicated Table 1.

The first two strains, strain 1018 and strain 1035 were obtained from Holeta Agricultural Research Center while the third one, strain EAL 110 was obtained from the National Soil Testing Center. All of the three nitrogen fixing strains were indigenous to Munesa and its surroundings.

The test crop used for the experiment was faba-bean (*Vicia faba*, *Degaga* variety). It was planted at a seed rate of 150 kg ha^{-1}. Planting was conducted at the third week of June each year. Seeds were drilled by hand at 0.40m spacing between rows in plot sizes of 10 m by 10 m. The spacing between plots and replications was 0.5 m and 1 m, respectively. Recommended rate of phosphorus fertilizer (46 kg P_2O_5 ha^{-1}) was applied to all plots as basal dose at planting from triple super phosphate (TSP) while nitrogen fertilizer was applied in splits, half at planting and the remaining half at tillering from urea. All recommended managements, hoeing, weeding, pests and disease control, etc were done as and when required.

Data collection and analysis

All yield and yield component data spike m^2, plant height, number of seeds per pod, harvest index, grain yield, biomass yield, hectoliter and thousand kernel weights were collected. The collected data were statistically analyzed using SAS computer soft ware version 9.0 English and the significance difference between any two treatments means were tested by least significant difference (LSD) at 5% probability level. It must be noted that data for each trait measured for the two years were pooled and analyzed to determine the year effect.

Table 1. Description of treatments for the experiment

Treatment No	Description of treatments
1	Recommended NP from UREA and TSP (control)
2	Strain 1018 + Recommended P from TSP
3	Strain 1035 + Recommended P from TSP
4	Strain EAL 110 + Recommended P from TSP

Table 2. Pooled mean effects of biological and inorganic fertilizers application, year and their interaction on yield and yield components of faba bean at Munesa district of southeastern Ethiopia in 2011 and 2012

Sources of variation	Yield and yield component parameters						
	Spike m^2 (No)	Plant height (cm)	No of seeds / plant (No)	Harvest index (%)	Grain Yield (kg ha^{-1})	Biomass yield (kg ha^{-1})	Thousand kernel weight (gm)
Replication	***	***	***	ns	**	**	**
Treatment (Trt)	ns	ns	*	ns	ns	ns	ns
Year (Y)	**	**	***	ns	ns	ns	ns
Y*Trt	ns	ns	*	ns	ns	ns	ns
Mean	38.57	150.77	41.66	50.75	3786.63	7531.09	467.78
CV	19.93	8.18	13.27	8.53	21.92	23.09	27.04
LSD	6.69	10.74	4.81	3.77	722.87	1514.20	110.61

Table 3. Table of means for the effects of biological and inorganic fertilizers application on yield and yield components of faba bean at Munesa district of southeastern Ethiopia in 2011 and 2012

Treatments	Yield and Yield Components Parameters			
	Grain yield (Kg ha^{-1})	Biomass yield (Kg ha^{-1})	Thousand kernel weight (gm)	Harvest index (%)
Recommended NP from UREA and TSP	3672.3	7266.9	464.75	50.75
Strain 1018 + Recommended P from TSP	3737.7	7591.6	476.82	50.05
Strain 1035 + Recommended P from TSP	3888.5	7666.8	475.35	50.92
Strain EAL 110 + Recommended P from TSP	3848.0	7599.1	462.21	51.29

RESULTS AND DISCUSSION

Yield and yield components

Pooled mean analysis of variance showed that, except number of seed per plant other parameters didn't show significant variation among treatments (table 2). However, years bring significant variation for some of the yield components including spike m^2, plant height and number seeds per plant. Concerning to the interaction effect, except number of seed per plant none of the parameters didn't bring significant variation.

According to the analysis of variance the three nitrogen fixing strains gave comparative yield with the recommended N from inorganic source and have been found very efficient. These implied that the three nitrogen fixing strains gave statistically similar yield and yield components of faba bean as that of application of recommended nitrogen and phosphorous from the conventional inorganic fertilizer sources, namely urea and TSP. Besides, significant yield differences were not observed among the three different nitrogen fixing strains; all of them performed very well under Menesa farmers' fields' conditions. The current result also similar with Fitsum *et al*. (2016) report that evaluations of *rhizobial* strains on soya bean revealed the highest grain yield was recorded by *rhizobial* strain MAR-1495 than others tested *rhizobial* strains, but statistically similar result was brought to that of recommended N fertilized treatments. They also suggested that inoculation of soya bean with *rhizobial* strain MAR-1495 replace the need for inorganic nitrogen fertilization to optimize soya bean

yields in soils of northwestern Ethiopia.

The result indicated that all of the three nitrogen fixing strains have been found very efficient. This is because the nitrogen requirement of faba bean, which is 18 kg Nha^{-1} for the experimental area that usually obtained from the conventional urea, could be fully provided by these nitrogen fixing strains. Had the nitrogen requirement of faba bean not been fulfilled by these nitrogen fixing strains, the yields of faba-bean would have been statistically lower than the conventional inorganic fertilizers.

As far as the phosphorous source for faba bean can be obtained from the locally available inorganic or organic sources of fertilizers, the nitrogen requirement of faba bean has been proved to be fulfilled by any of these three nitrogen fixing strains. From sustainability and economic points of views, these nitrogen fixing strains need to be considered as best sources of nitrogen fertilizers in the study and similar areas.

The result indicated that using the three *rhizobial* strains for faba bean production in the study area brought comparative grain yield with recommended N from inorganic source and can replace the need for inorganic N fertilization.

CONCLUSIONS AND RECOMMENDATIONS

The abovementioned result concluded that; there was no significant difference observed among treatments on yield and yield component of faba bean. The pooled mean result also showed that; the three nitrogen fixing strains were brought comparative yield to that of the recommended nitrogen rate applied from inorganic source. These result implied that, nitrogen fixing strains were very effective in fixing and providing the nitrogen requirement of faba bean crop. Hence, using any of the three nitrogen fixing strains along with recommended rate of phosphorous from inorganic source has been recommended for increased and sustainable faba bean production in the study area.

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REFERENCES

Amanuel G, Tanner DG (1991). The effect of crop rotation in wheat production zones of southeastern Ethiopia. In: Saunders DA (ed) Wheat for the non-traditional warm areas. CIMMYT, Mexico, pp 486–490

Asfaw Telaye., Geletu Bejiga., Alem Berhe. (1994). Role of Cool season food legumes and their production constraints in Ethiopian agriculture. In: Asfaw Tilaye, Geletu Bejiga, Saxena, M.C. and Solh, M.B.(Eds), Cool seasons food legumes of Ethiopia,ICARDA (International center for Aricultural Rsearch in the Dry Areas,), Addis Ababa, Ethiopia pp3-19.

Asfaw Tilaye (1985). Faba bean in Ethiopia. *FABIS News Letter* 12: 3-4.

Central Statistical Agency of Ethiopia (CSA). 2016. Agricultural sample survey 2015 / 2016. Volume III report on farm management practices. Addis Ababa, Ethiopia.

Central Statistical Agency of Ethiopia (CSA). 2010. Agricultural sample survey 2010 / 2011. Volume III report on farm management practices. Addis Ababa, Ethiopia.

Desta B (1988) Biological nitrogen fixation research on grain legumes in Ethiopia: an overview. In: Beck DP, Materon LA (eds) Nitrogen fixation by legumes in Mediterranean agriculture. Nijhoff, Dordrecht, pp 73–78

Fitsum Merkeb, Musefa Redi and Wubayehu Gebremedhin. Evaluation of Different Commercial *Rhizobial* Strains on Soybean (*Glycine max* L.) Yield at Pawe District, Northwestern Ethiopia. WSN 55 (2016) 15-26.

Gete, Z., Getachew, A., Dejene, A., and Shahidur, R. 2010. Fertilizer and soil fertility potential in Ethiopia: Constraints and opportunities for enhancing the system. IFPRI, Addis Ababa, Ethiopia, 63p.

Hailu G, Amsal T, Endale A (1989) Beneficial break crops for wheat production. Ethiop J AgricSci 11:15–24

Hardarson, G., 1993. Methods for enhancing symbiotic nitrogen fixation. J. Plant Soil, 152: 1-17.

Hawitin, G. C & Hebblewaite, P. D. 1993. Background and history of faba bean production. In: P. Hebblewate (Ed.), The faba bean (*Vicia faba*), Butter worth's, London, 1-21 pp.

KARC. 2011. Land and Water Resources Research Process: Kulumsa Agricultural Research Center. Progress report of 2010/2011. Kulumsa, Ethiopia.

K. Fisher and W.E. Newton. Nitrogen fixation- A General Overview. In: Nitrogen Fixation at the Millennium, pp.1-3, (G. Jeffery, eds). Elsevier Science B.V, Amsterdam, Netherlands (2002).

Lindemann, W.C. and C.R. Glover, 2003. Nitrogen fixation by legumes. Guide A-129, Cooperative Extension Service, College of Agriculture and Home Economics New Mexico State University, pp: 1-4. http://aces.nmsu.edu/pubs/_a/a-129.pdf.

Mulissa Jida, Fassil Assefa (2012). Phenotypic diversity and plant growth promoting characteristics of *Mesorhizobium* species isolated from chickpea (*Cicer arietinum* L.) growing areas of Ethiopia. *African Journal of Biotechnology* 11: 7483-7493.

Perret, X., C. Staehelin and W.J. Broughton, 2000. Molecular basis of symbiotic promiscuity.Microbiol. Mol. Biol. Rev., 64: 180-201.

Somasegaran, P., Hoben, H.J. (1994). Handbook for Rhizobia methods in Legume-Rhizobium Technology, springer Verlag, New York, USA.