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Asian Journal of Plant Science and Research, 2017, 8(4):8-12

ISSN : 2249-7412
CODEN (USA): AJPSKY

Integrated Effect of Vermicompost, Rhizobia Inoculation and NP Fertilizer on Yield of Fababean at Kulumsa in Arsi Zone Ethiopia

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ABSTRACT

Faba bean (Vicia faba L.) is a major grain legume widely cultivated in many countries for food and feed purposes. Faba bean contributes to sustainable agriculture by fixing atmospheric nitrogen in symbiosis with soil rhizobia. Biological and organic fertilizers are the alternative solutions and the promising technologies which play an important role in reducing the consumption of chemical N-fertilizers, increasing yield, improve soil fertility, decreasing the production cost, and eliminating the undesirable pollution impact of chemical fertilizers in the environment. Therefore, the aim of this study was to evaluate the impact of integrated effect of vermicompost, rhizobia inoculation and NP fertilizer on yield of fababean. A field experiment was conducted at Kulumsa Agricultural Research Center for two years from 2014 to 2015 cropping seasons. The experiment consisted of seven treatments, namely no input, 18-46 kg N-P_2O_5 ha^{-1} from DAP, 18-46 kg N-P_2O_5 ha^{-1} from vermicompost, Rhizobium (EAL-110)+18-46 kg N-P_2O_5 ha^{-1} from DAP, Rhizobium+18-46 kg N-P_2O_5 ha^{-1} from vermicompost, Rhizobium+9-23 kg N-P_2O_5 ha^{-1} from DAP and Rhizobium+9-23 kg N-P_2O_5 ha^{-1} from vermicompost, were laid out in randomized complete block design with three replications. The results showed that application of 18-46 kg N-P ha^{-1} either from organic or inorganic nutrient sources need to be continued for sustainable production of fababean under Kulumsa Agricultural Research Center on station condition.

Keywords: Vermicompost, Rhizobia inoculation, NP fertilizer, Fababean yield

INTRODUCTION

Fababean (*Viciafaba*) is one of the major pulses grown in the highlands of Ethiopia (Jarso and Keneni, 2006). Currently, fababean in Ethiopia occupies 28.45% of the total 1.6 million ha of land cultivated to pulses, and 3.53% of the total 12.6 million ha of land allocated for grain crops production in the country [1]. Faba beans are high- yield crop whose both–economic and ecologic role is very significant; they contain up to 35% of crude protein, approximately 50% of carbohydrate and no more than 15% of crude lipid [2]. Despite its multifaceted benefits the productivity of faba bean in Ethiopia has been found low compared to its attainable yield [3,4] due to abiotic and biotic factors. Among them, depletion of soil fertility is the most important one [5].

In order to improve the productivity of fababean, alleviation of soil fertility depletion through proper fertilizer management is very important along with other agronomic practices. Integrating organic and inorganic fertilizers for tackling soil fertility depletion and sustainably increasing crop yields [5,6] is the best alternative to avert soil fertility depletion and increasing crop productivity. The readily available macro and micro-nutrients are provided by inorganic sources while soil organic matter maintenance and soil structure improvement is provided by organic fertilizers [7,8]. Fababean responds to and changes its environment by altering on-site soil fertility, microclimate, and co-habitats of wild flora and fauna [9,10] and is an excellent crops for sustainable Agriculture because of its unique ability to fix atmospheric nitrogen symbiotically which is heavy depends on sufficient populations of effective rhizobia [11,12].

One of the best organic materials for increasing crops yield is Biological nitrogen fixation, especially rhizobia-legumes symbiosis, is one of the alternative solutions and the promising technologies which play an important role in reducing the consumption of chemical N-fertilizers, increasing soil fertility, decreasing the production cost, and eliminating the undesirable pollution impact of chemical fertilizers in the environment [13,14]. The inoculation of the legume seed material with active nitrogen fixing bacteria strains before sowing has a significant role for the increase of the legume yield [14,15]. Inoculation can improve crop yields in cases where appropriate rhizobia are not present in the soil or the soil contains a significant proportion of non nodulating or ineffective nitrogen-fixing strains. Inoculation of legume seeds with Rhizobium affects soil microbial community and processes, especially in the rhizosphere [14]. Faba bean contributes to sustainable agriculture by fixing atmospheric nitrogen in symbiosis with soil rhizobia.

Another organic materials is vermicompost that involves the bio-oxidation and stabilization of organic material by the joint action of earthworms and microorganisms [16]. Although, they are the microorganisms that biochemically degrade the organic matter, earthworms are the crucial drivers of the process, as they aerate, condition and fragment the substrate, thereby drastically altering the microbial activity. Earthworms act as mechanical blenders and by comminuting the organic matter they modify its physical and chemical status by gradually reducing the ratio of C:N and increasing the surface area exposed to microorganisms; thus making it much more favorable for microbial activity and further decomposition [17]. The organic carbon in vermicompost releases the nutrients slowly and steadily into the system and enables the plant to absorb these nutrients. The soil enriched with vermicomposting provides additional substances that are not found in chemical fertilizers [18]. Therefore, the objective of this study was to determine the effects of vermicompost, Rhizobium inoculation and NP fertilizer on yield of faba bean at Kulumsa on station in Arsi Zone Ethiopia.

MATERIALS AND METHODS

Description of the study area

The experiment was conducted at the main station of Kulumsa Agricultural Research Center for two cropping season from 2014 to 2015. The dominant soil type of the study area is Vertic-luvisol [19]. It receives an annual mean rainfall of 811 mm. The mean minimum and maximum temperatures are 10.5 and 24.5°C, respectively (Figure 1).

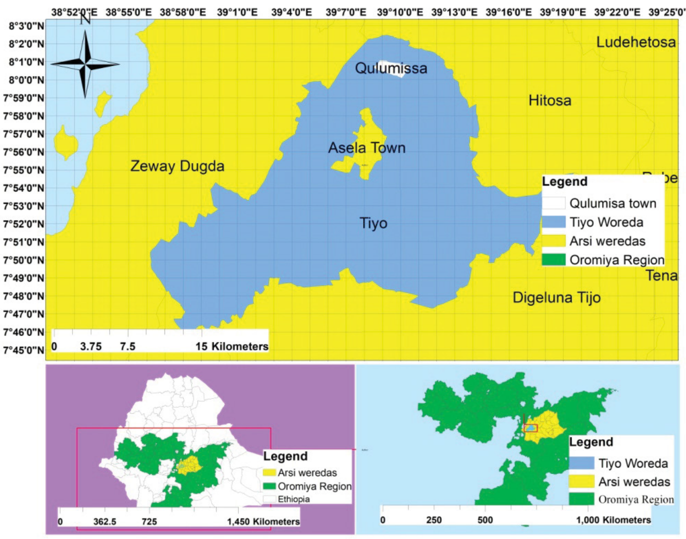

Figure 1: Map of study site

Experimental set-up and procedure

Vermicompost and biological fertilizers were obtained from Ambo Plant Protection and Holetta Agricultural Research Centers, and Menagesha Biotech Industry, respectively. The total nitrogen was determined by the Kjeldahl digestion and distillation and moisture contents of the vermicompost were determined by oven dry method just before application in to the soil. The raw materials used for vermicomposting during the two experimental periods were the same; however, due to variations in the nutritional contents of the raw materials, the total nitrogen contents of the vermicompost were different for each year. In 2014, the total nitrogen and moisture content of the vermicompost were 1.8% and 29%, respectively. The corresponding results for 2015 cropping season were 1.1% and 66%, respectively. Hence, recommended amount of nutrients for fababean was calculated based on the total nitrogen content of the vermicompost. Accordingly, the total amount of vermicompost used in 2014 and 2015 were 1.4 and 3.0 t ha^{-1}, respectively.

The experiment consisted of seven treatments, namely no input, recommended NP (18-46 kg N-P_2O_5 ha^{-1}) from DAP, recommended NP from vermicompost, Rhizobium (EAL-110) along with recommended NP from DAP, Rhizobium along with recommended vermicompost, Rhizobium along with 50% recommended NP (9-23 kg N-P_2O_5 ha^{-1}) and Rhizobium along with 50% recommended vermicompost. The experiment was laid out in randomized complete block design with three replications.

Fababean (*Tumsa* variety) crop was planted on plot sizes of 10.4 m^2 (2.6m x 4m) in the 4^{th} week of June in each year.

The spacing between blocks and plots were 1 m and 0.5 m, respectively. Weeding was carried out by hand based on research recommendations. Macozeb and karate were applied against chocolate spot and aphid, respectively twice per season.

Data collection and analysis

Plant population, plant height, number of seed per pod, harvest index, grain and biomass yields and seed weights were the plant parameters collected. Analysis of variance was carried out for each of the measured parameters. All yield and yield component data were subjected to analysis of variance using PROC ANOVA of SAS version 9.0 statistical software [20]. The significance of differences among treatment means was compared using least significant difference (LSD test).

Effectiveness on the plant development

The integrated use of vermicompost, rhizobia inoculation and NP fertilizer application did not show significant difference mean among treatments on the plant population, plant height and number of seed per pod during 2014 and 2015 at Kulumsa research farm site. Comparably, study by Bezabih; Livija Zarina, et al. disclosed that inoculation of rhizobium strain significantly affected on plant population, Plant height and number of pod per plant. The mean of growth parameters of faba bean are indicated in Table 1. The effect of year was significant on the number of pods per m^2 and plant height of faba bean (Table 1), indicating there is environmental variation across years.

Table 1: Mean growth parameters of faba bean due to integrated use of vermicompost, Rhizobium inoculation and NP fertilizer rate in 2014 and 2015 cropping season at Kulumsa.

Sources of variation	Yield and yield component parameters		
	Plant population m^{-2}(No)	Plant height (cm)	No of seeds pod^{-1}
Treatment	Ns	Ns	ns
Year	***	***	ns
Year*Treatment	ns	ns	ns
Mean	76.09	143.36	21.50
CV	9.83	2.70	12.18
LSD	8.87	4.60	3.11

Mean values followed by the same letters in each column and treatment showed no significant difference by LSD (p=0.05). *, **, ***, denotes significance at p=0.05, 0.01, 0.001, respectively, and NS denotes no significant difference.

Effectiveness on the yield

The Integrated use of vermicompost, rhizobia inoculation and NP fertilizer application did show significant difference mean among treatments on the grain yield and biomass yield. during 2014 and 2015 at Kulumsa research farm site.

Similarly, study by Bezabih; Livija Zarina, et al. that inoculation of rhizobium strain significantly affected on yield while harvest index and thousand seed weight did not show significant results. The mean yield of faba bean due to integrated application of vermicompost, Rhizobium inoculation and inorganic fertilizers are indicated in Table 2. Regardless of the previous results [21]. Application of neither inorganic nor organic fertilizers did not result in significant yield increment on faba bean. The non-significant results might have been attributed to the sufficient residual nutrients of the soils of Kulumsa. This can be explained by the logging of plots particularly those treated with organic or inorganic nutrients.

Table 2: Table of means for the effects of microorganisms enriched vermicompost on yield of fababean at Kulumsa in the southeastern highlands of Ethiopia in 2014 and 2015.

Factor	Yield and Yield Components Parameters			
	Harvest index (%)	Grain yield (Kg ha^{-1})	Biomass yield (Kg ha^{-1})	Thousand seed weight (gm)
Year				
2014	27.66^a	2939.7^a	10784.4^a	695.964^a
2015	30.02^a	2283.5^b	7800.5^b	586.857^b
Integrated nutrient				
No input	27.59	1479.30^b	6695.00^c	621.59
18-46 kg N-P ha^{-1} from inorganic fertilizer	28.38	2703.60^a	9506.00^{ab}	657.91
18-46 kg N-P ha^{-1} from vermicompost	30.61	2565.40^a	8858.00^{ab}	639.87

Rhizobium +18-46 kg N-P ha^{-1} from inorganic	26.08	2338.30^{a}	9692.00^{ab}	630.74
Rhizobium +18-46 kg N-P ha^{-1} from vermicompost	30.06	2753.00^{a}	9312.00^{ab}	643.99
Rhizobium + 9- 23kg N-P ha^{-1} from inorganic	26.01	2743.50^{a}	10811.00^{a}	650.43
Rhizobium + 9-23 kg N-P ha^{-1} from vermicompost	30.17	2698.00^{a}	8973.00a^{b}	645.35
Treatment	Ns	***	**	Ns
Year	Ns	Ns	***	***
Year*Treatment	Ns	Ns	Ns	Ns
CV	15.20	17.74	20.20	5.00
LSD	5.20	549.93	2227.10	38.13

Mean values followed by the same letters in each column and treatment showed no significant difference by LSD (p=0.05). *, **, ***, denotes significance at p=0.05, 0.01, 0.001, respectively, and NS denotes no significant difference.

CONCLUSION

Integrated use of vermicompost, rhizobia inoculation and NP fertilizer rate did not bring any significant increase on the yield and yield components of fababean at Kulumsa. Application of 18-46 kg N-P_2O_5ha^{-1}from either inorganic or equivalent amounts from vermicompost or other organic sources of nutrient sources need to be continued for sustainable production of fababean under Kulumsa condition.

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