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Soil Characterization and Response of Haricot Bean (Phaseolus Vulgaris L.) to Application of Blended and Bio Fertilizer in Meskan District, Southern Ethiopia

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ABSTRACT

Information onsoil characterization and effects of blended and bio fertilizer application on haricot bean production is crucial for best land management practices. Therefore, afield experiment was conducted to assesssoil, response of haricot bean to application of blended, and bio fertilizer in Meskan district, Southern Ethiopia. A pedon 2 x 2x 2 m deep was opened by hand digging at experimental site. Soil samples from each horizon and three surface samples around the profile were collected for laboratory analysis of the most important soil physical and chemical properties. Based on the field survey and soil analytical results, soils of the study area were classified as Vertisols. The field experiment was laid out in RCBD with treatments including control, NPS, NPK, NPSB, NPSZNB and NPKSZNB with inoculants and three replications. The results of field experiment showed that blended fertilizer with sterilized soil with inoculation was significant on number of pods per plant, 1000 seed weight, grain yield and biomass yields. The number of pods per plant (18), 1000 seed weight (482.71 g hr-1), grain yield (3481.5 kg hr-1) and biomass yield (8939.2 kg hr-1) were recorded from NPKSZNB application. Additionally, the results of the field experiment revealed significantly higher yield, MRR percentage and economic benefit was obtained by the application of NPKSZNB. Therefore, the present study suggests that, there should be a site-specific soil characterization for a better understanding of soil properties and application of NPKSZNB containing fertilizer with inoculant for better haricot bean production at Meskan and areas with similar soil and agro ecological conditions. The experiment was conducted for one season and location but it is better to repeat in different locations and season to draw sound conclusion.

Keywords: *Blended fertilizers, Yield and Yield components, Bio fertilizer, Soil characterization*

INTRODUCTION

Degradation of resources such as soil is one of the reasons for declining of agricultural output. Research result pointed out that, resource degradation particularly soil degradation in the form of nutrient depletion is an important cause for the decline of agricultural production in the country (Bekele and Holden, 1998). However the success in soil management to keep soil quality depends on the understanding of how soils react to agricultural use and practices over time (Wakene, 2001).This implies that understanding the characteristics of soils is precondition for designing proper management strategies thereby solving many challenges that the Ethiopians are facing in the crop and livestock production sectors and in their efforts towards natural resource conservation and management for sustainable growth(Wakene, 2001).

Ethiopia has a wide diversity of legumes that grow from the lowlands to the highlands. This ranks legumes second after cereals as agricultural staples and occupy13.4percentage of the total cultivated area in the country (CSA, 2016). In recent years, production of haricot bean (Phaseolus vulgaris L.) and soybean (Glycine max L.) has increased as they are exportable and cash earning commodities (Girma et al., 2013). It is one of the fast expanding legume crops that supply an essential part of the daily diet and foreign earnings for most Ethiopians (Girma, 2009). The major haricot bean producing areas of Ethiopia are central, eastern and southern parts of the country (CSA, 2016). Among legumes, haricot bean constitutes a significant part of human diet in Ethiopia, and haricot bean has been cultivated as a field crop for a very long time (Ali et al., 2003). Haricot bean is a principal food crop particularly in southern and eastern part of Ethiopia, where it is widely intercropped with maize and sorghum, respectively, to supplement farmer's income (EPPA, 2004).

Bean productivity is greatly influenced by soil fertility especially phosphorous and nitrogen. It has high nitrogen requirement for expressing its genetic potential. However, as bean can fix and use atmospheric nitrogen concerning soil fertility and mineral nutrition requirement, phosphorus is considered as the first and nitrogen as the second limiting plant nutrients for bean yield in the tropical zone of cultivation (CIAT, 1998).

Moreover, phosphorus plays an important role in biological nitrogen fixation. For the symbiotic fixation of nitrogen to occur, the roots have to interact with compatible rhizobia in the soil and factors that affect root growth or the activity of the host plant would affect nodulation (Freire, 1984). Bacterial growth, nodule formation, and the biological nitrogen fixation activity itself are processes that are dependent on the energy supplied from the sugars that need to be transacted downwards from the host plant shoots.

Therefore, phosphorus is the basis for the formation of useful energy, which is essential for sugar formation and translocation. (Graham, 1984) reported that haricot bean crop dependent on nitrogen fixation needs more inorganic phosphorus than the same crop provided with mineral nitrogen. Beans are therefore especially susceptible to low soil phosphorus when accompanied by low soil fertility condition.

Phosphorus availability in soil is a major constraint to haricot bean production in the tropics (Allen et al., 1997). From the essential plant nutrients, nitrogen and phosphorus are often deficient in many soils of tropical Africa as well as in many Ethiopian soils (Ngugi, 1982). In the tropics, the amount of available phosphorus in soils is largely in sufficient to meet the demand of legumes and thus phosphorus deficiency is widespread in pulse crops (Rao et al., 1998). Available P content of most soils in SNNPR of Ethiopia is less than 5 mg kg^{-1}, which is in the range of low P content (Gifole *et al*., 2011).

Clearly, N and P were not the only yield constraining factors, but others such as S, Zn, B, Fe, Cu and K-deficiency are common soil fertility problems due to inherent soil fertility status and/or poor management (Tegbaru. 2015). Although information on the impact of different types of fertilizers, except nitrogen and phosphorous, is low, mapping of soil fertility over 150 districts showed that most of the Ethiopian soil lack about seven nutrients (N, P, K, S, Cu, Zn and B) (EthioSIS, 2013). Continuous cultivation and biomass harvest without replenishment, and low or no application of fertilizer have been the major factors for the low yield and failure to express potential productivity of the crop (Wakene et al., 2012). Therefore, this study was conducted to determine the following specific objectives:

- To study the influence of blended fertilizer and Bio fertilizers on nodulation, yield and yield components of haricot bean,
- To characterize the soil type of the study area and
- To evaluate the economic feasibility of the use of blended and Bio fertilizers.

Materials and Methods

Description of the Study Area

The study was conducted at Meskan district in the Gurgae Zone of Ethiopia. The site is located at geographic coordinates of 080 06' 0944"N and 380 22' 341" E, with an elevation of 1842 meters above sea level (m.a.s.l). Cereal crops including maize, teff, wheat and barley; legume like haricot bean, faba bean and chickpea are grown predominantly during the wet season. Maize cropping covers large areas at the experimental site.

The soil of the study area was reported to be Cambisols (Ministry of Agriculture unpublished). The mean annual rainfall of the study area is 1064 mm with a uni-modal pattern, which extends from June to September (MWFEDD, 2016:4), with mean minimum and maximum temperatures of 10.3 and 240C, respectively (MWFEDD, 2016:4).

Characterization of Experimental Soils

A pedon 2 x 2x 2 m deep was opened by hand digging at experimental site. The soil profile was described in situ following Guidelines for Field Description (FAO, 2014). Soil samples were collected from every identified horizon. Six random surface soil samples (0-20 cm) were also collected from all directions around the pedon and three composites were made.

The composite surface soil samples and samples collected from every horizon were air-dried, ground to pass through 2 mm sieve for physicochemical analyses at the Soil Laboratory of the Hawassa College of Agriculture. For determinations of organic carbon and total nitrogen however, a 0.5 mm sieve was used.

Experimental Design and Treatments

The field experiment was laid out in a randomized complete blocked design (RCBD) with six treatments and three replications. The haricot bean variety used was Ibado while rhizobia strain (MBZ-HB-EAL-429) was used.

Table1. *Treatments for field experiment*

Treatments	Composition						
	N	P_2O_5	K	S	Zn	B	Remark
Control	0	0	0	0	0	0	
NPS	19	38	0	7	0	0	
NPK	16	32	16	0	0	0	
NPSB	18.1	36.1	0	6.7	0	0.71	
NPSZNB	16.9	33.8	0	7.3	0	0.67	
NPKSZNB	13	26.1	13.7	5.6	1.72	0.51	

The size of the experimental plots was 3 x 4 m (12 m2) with 1.5 m spacing between blocks and 1.0 m between plots. Each plot had 10 rows while each row had thirteen plants. The inter-row and intra-row spacing were 40 and 10 cm respectively. The central eight rows were used for data collection.

Experimental Procedures, Soil Sampling And Analyses

Representative soil samples were collected at a depth of 0-20 cm from 10 to 15 randomly selected spots before planting and then bulked to have one composite to analyze for selected physico-chemical properties using standard laboratory methods.

Data Collection

Data on yield components including number of pods per plant, number of seeds per pod, 1000 seed weight, biomass and grain yield were recorded at their respective sampling time. From field experiment, the central eight rows of each plot were used for data collections and out of these eight rows, the two border rows were used for destructive sampling.

Statistical Analysis

Analysis of variance was performed using SAS V.9.0 and means were compared using LSD at 5% probability level. Correlation coefficients were computed to assess the relationships between yield and yield components of haricot bean.

Economic Analysis

Simple partial budget analysis was done for economic analysis of fertilizer effects. The price of blended fertilizer and the crop potential response towards the added fertilizer were determined through estimation the economic feasibility of fertilizer (CIMMYT,1988). To estimate the total variable costs, blended fertilizer cost and mean market price of haricot bean were taken though market at the time of planting and harvesting. The labor cost was also incorporated according to the price at the time of planting. The economic analysis was done by the formula developed by CIMMYT (1988).

Results and Discussion

Morphological and Physico- Chemical Properties of the Soil

Morphological Properties

The moist soil color ranged from black (10YR 2/1) in surface horizon to olive brown (2.5YR) in the bottom layer. Generally, surface layers had darker color as compared to their subsurface counterparts, which can be due to the accumulation of organic matter in the surface layers (Table 2). The surface horizon had moderate, very fine to coarse sub-angular blocky structure, whereas the structure was changed to angular blocky and massive in B and C-horizons respectively (Table 2). The better developed structure in the subsurface layers (B horizons) as compared to the surface horizon could be due to the relatively higher clay content of the subsurface horizons than that of the surface horizons (Ahn, 1993). The result is in agreement with the findings reported Ashenafi et al., 2010; Alemayehu and Sheleme, 2013 and Sheleme, 2017. The consistencies of soil in the surface layer was friable (moist) and slightly sticky and slightly plastic (wet) while the subsurface horizons (B1 and B2) had very sticky and very plastic wet consistencies. The bottom horizons (BC and C), had slightly sticky and slightly plastic wet consistencies (Table 3). Moreover, few calcium carbonate concretions were observed throughout the middle layers (48-200+ cm).

The friable and slightly sticky/slightly plastic consistency observed in the surface horizons of the pedon could be attributed to the relative higher organic matter content of the surface than subsurface layers. These results were in agreement with that of Wakene (2001) who argued that although consistency is an inherent soil characteristic and mainly a reflection of the particle size composition of the soil, high organic matter content changed stickiness and plasticity of surface soil layer.

Table2. *Selected morphological characteristics of the soil*

Horizon	Depth (cm)	Color moist	Structure	Consistency		Boundary	Texture feel method
				Moist	Wet		
Ap	0-19	10YR 2/1	MO,VFC,SAB	FR	SS,SP	C,S	Clay loam
B_1	19-48	2.5YR2.5/1	MO,FM,AB	FI	VS,VP	C,S	Clay loam
B_2	48-80	2.5YR2.5/1	WE,FM,AB	FR	VS,VP	G,S	Clay
BC	80-121	2.5YR3/3	WE,VFF,SAB	FR	SS,SP	G,S	Sandy loam
C	121^+	2.5YR4/3	MA	FR	SS,SP		Sandy clay

The description and Abbreviations in the table are in accordance with guidelines for field soil description (FAO, 1990).

Physical Characteristics

Texture

Based on the soil analysis made, the textural class of the soil was clay and the clay fraction content increased consistently from the surface to the sub surface layer except the bottom two horizons (Table 3), the sand content was highest in the C horizon, whereas the silt percentage varied from 16 to 26 throughout the profile depth. The textural classes of the surface soil (0-20cm) taken from pits surroundings were similar to that of the surface horizon of the pedon (Table 3).

Bulk Density

The highest bulk density (1.21 g cm^{-3}) was noticed at the B2- horizon whilst the lowest (1.03g cm^{-3}) was found at surface horizon and it increased with depth from A to B horizons and decline in bottom layers (Table 3).

Lower bulk density in surface horizon could be due to higher organic matter content as compared to the subsurface horizons, although this cannot explain the decreased bulk density in BC and C horizons.

Moreover, higher compaction due to the weight of the overlying layers might have also increased the bulk densities of the B-horizon (Shiferaw, 2004).

Table3. *Selected physical characteristics of the soils in the pedon*

Horizon	Depth (cm)	Particle size (%)			Texture	Bulk density g/cm^3
		Sand	Clay	Silt		
Surface sample	-	42	31.5	26.5	Clay loam(CL)	1.1
Ap	0-19	42	32	26	clay loam (CL)	1.03
B1	19-48	41	34	25	clay loam (CL)	1.19
B2	48-80	42	42	16	clay (C)	1.21
BC	80-120	40	40	20	clay loam(CL)/clay (C)	1.07
C	121+	48	36	16	sandy clay (SC)	1.1

Chemical Characteristics

Soil pH

The pH (H_2O) values increased down the profile, ranging from 6.19 in the surface layer (Ap) to7.89 in bottom layer (Table 4). This might be due to the slightly increase of total exchangeable bases. This result in line with (Özsoy and Aksoy, 2007) reported that pH increased as depth increased due to an increase in the concentrations of base forming cations and a decrease in the soil OM. Soil pH greatly affects a number of important processes in the soil, including the rate of chemical weathering of soil minerals, decomposition, mummification, formation of new minerals, activity of soil microorganisms, and availability of nutrient to plants and growth of many agricultural crops (Miller and Donahue, 1995).

The magnitude and characteristic nature of soil reaction is influenced by different anthropogenic and natural processes such as leaching (removal of exchangeable bases), decomposition of organic materials, continuous cultivation, acid rains, and steepness of the topography and application of acid forming inorganic fertilizers (Bouman et al., 1995).

Organic Carbon, Total Nitrogen and C/N Ratio

The organic carbon content of the surface horizon could be rated as low according to Landon (2014) who rated OC contents less than 2% as very low, 2 to 4 as low, 4 to 10 as medium, 10 to 20 as high and greater than 20 as very high.

Total nitrogen measures the total amount of nitrogen present in the soil, much of which is held in organic matter and is not immediately available to plants. It may be mineralized to available forms. However, total nitrogen cannot be used as a measure of the mineralized forms of nitrogen (NH_4^+, NO_3^- , and NO_2^-) as much of it is held in the organic matter in the soil.

Total nitrogen content in the surface horizon was 0.30 and was rated as medium according to Landon (2014), whereas the contents of the bottom two layers fall under deficient range. The trend in total nitrogen distribution within the pedons was similar to that of OC implying that the organic matter was the major source of total nitrogen in the soils.

The total N contents of the bottom two layers fall under deficient. Higher total nitrogen content in the surface layers as compared to the subsurface could be due to OM content, as there exists strong correlation between total nitrogen and OC. Caravaca *et. al.* (2002), also found significant difference between total nitrogen and organic carbon content in different types of soils of Italy.

The C: N ratios of the soil layers were below 10 showing the soils were in good state of mineralization. There was only a slight increase with soil depth owing to the decrease in microbial biomass and low mineralization rate of the available soil OM. These results are in agreement with the observation of Sahlemedhin (1999) who reported that N and P are tied to humus content of the soil and their value decrease along with a decline in soil OM content.

Available Phosphorus

The available phosphorus content of the horizons of the pedons ranged from 1.19 mg kg^{-1} in the B1 horizon to 12 mg kg^{-1}soil in the AP horizon (Table 4) and showed decreasing trend with depth. This could be due to additions of phosphorus fertilizers in the surface soils. The relatively higher available P in surface horizon as compared to subsurface ones could be also attributed to the difference in organic matter contents of the layers. High organic matter content and a good rate of organic matter mineralization ensure release of phosphate ions, though most of the phosphate released in this way will be in topsoil. According to FAO, (2014), the available P contents of the soils in the subsurface soils were rated as very low, whereas that of the surface horizon was medium.

Cation Exchange Capacity, Exchangeable Bases, and Percent Base Saturations

Cation exchange capacity is the capacity of the soil to hold and exchange cations. It provides a buffering effect to changes in pH, available nutrients, calcium levels and soil structural changes. CEC is one of the most important chemical properties of soils and strongly affects nutrient availability for plant growth. Cation exchange capacity (CEC) of the soil in the horizons varied from 37.6 to 52 cmol (+) kg^{-1} (Table 6) which could be categorized as high to very high (FAO, 2006). These high CEC values could be attributed to the high basic cations content of the soils.

Exchangeable calcium and magnesium are the dominant cations in the exchange sites, whereas the mono-valent cations (K and Na) occupied a very small proportion of the exchange complex sites in the soil profiles of the study area (Table 4). The magnitude of cations in the surface horizon was in the order of Ca>Mg>K> Na.In fact, soils of inherently high productivity usually have an exchange complex dominated by calcium and magnesium and contain only minor amounts of potassium and sodium (FAO, 1979). Exchangeable calcium and magnesium together consisted of 95% of the exchange complex in the surface horizon. Exchangeable calcium alone constituted 68% of the exchange complex in the surface horizon and the subsurface horizons it constituted about 64 to 69% of the total exchange site. Generally, the contents of exchangeable calcium in all surface and subsurface horizons were very high; this could be due to appreciable amount of calcium carbonate concretion present in the pedon. The $CaCO_3$ will dissolve in the extractant (ammonium acetate, pH 7) and contribute to the exchangeable Ca content in the determination. The exchangeable sites of the soils in the pedon consisted of 27 – 31% exchangeable magnesium indicating the presence of sufficient magnesium in the soils of the study area.

Exchangeable potassium and sodium together occupied 0.97 to 9.92% of the total exchange sites of the soils in the pedon. According to the ratings of FAO (2006), the level of exchangeable potassium was high in surface and subsurface layers.

The contents of potassium were relatively higher in the subsurface horizons than top horizons showing a non-consistent pattern with depth (Table 6). The level of exchangeable sodium at surface soils was low and the values increased to 1.08 cmol(+) kg^{-1} in the subsurface horizon showing the presence of medium to high levels of exchangeable sodium (FAO, 2006). Also, the result of exchangeable bases: Ca, Mg, K and Na in the surface sample showed that 34.9, 14.8 2.68 and 0.48 cmol (+) kg^{-1} soil respectively and was in the order of Ca> Mg> K>Na. The exchangeable bases were in very high according to FAO (2006) except for sodium which was medium (Table 4).

Percent base saturation (PBS) values are used as indicator of soil fertility status. Generally the soils of the study area had high base status values, which was ranged from 115 to 135% (Table 6) and thus indicating the presence of hypereutric base status (IUSS WORKING GROUP, 2015).These very high base saturation values (over 100%) indicate the contribution of dissolved calcium carbonate concretions to the sum of exchangeable cations and making it over the CEC value.

Table4. *Exchangeable bases, CEC, and PBS of the soil under each experimental site*

Depth	Horizon	(cmol(+)/kg of soils						%
		K	Na	Ca	Mg	Sum	CEC	PBS
Surface sample		2.6	0.48	34.9	14.8	52.78	32.20	
Ap	0-19	2.1	0.50	36.0	14.29	52.91	40.0	132
B1	19-48	1.2	0.31	34.7	14.60	50.81	37.6	135
B2	48-80	2.3	0.70	34.7	14.87	52.64	44.2	119
BC	80-120	3.7	0.78	34.4	14.66	53.52	40.0	134
C	121+	4.8	1.08	38.7	15.02	59.68	52.0	115

Soil Classification

The subsurface horizons had a thickness greater than 25 cm, a clay content greater than 30 percent throughout, wedge-shaped soil aggregates and shrink-swell cracks qualify for a Vertic horizon.

The soils were therefore classified as Vertisol according to IUSS WORKING GROUP (2015). Soils of the study area have in the upper 30 cm of the soil a Munsell colour value of ≤ 3 and a chroma of ≤ 2, both moist. These properties of the soils satisfy for Pellic principal qualifier listed under Vertisol.

The soils had a plough depth greater than 20 cm from the soil surface, having ≥ 1% soil organic carbon in the fine earth fraction as a weighted average to a depth of 50 cm from the mineral soil surface, to qualify Aric and Humic supplementary qualifier respectively.

Therefore, soils of the study area were classified as Pellic Vertisols (Aric Humic).

Effects of Blended and Bio Fertilizer on Yield and Yield Components of Common Bean

Number of Pods Per Plant

The main effects of blended fertilizer and rhizobia inoculation and their interaction had significantly affected number of pods per plant (Table 5). The highest number of pods per plant (18) was recorded with NPKSZnB was applied to sterilized soil whereas the lowest number of pods (13.53) was obtained from control. In NPKSZnB Significantly increase number of pods per plant as compared to the control, NPS, NPK and NPSB (Table 5). In this study there might be antagonistic effects of native rhizobium and inoculants so by sterilizing the soil, it might be possible to improve this negative effects. This result was in line with the findings of Taye Belachew (2006), who reported that strain EAL300 gave low in so many parameters in unsterilized soil compared to the native rhizobium but it gave higher result in sterilized soil. The increase in number of pods with blended fertilizer might possibly be due to the application of K and Zn because these two nutrients were known to increase the availability of P and N, which might have facilitated the productivity haricot bean. In conformity with this result, Moniruzzaman et al. (2008) reported significant effect of N fertilizers on pod production per plant of French bean with the maximum number of pods per plant (25.49) obtained at 120-120-60-20-4-1 kg of N- P2O5-K2O-S-Zn-B. The result is also in conformity with the finding of Deshbhratar et al. (2010) who reported that phosphorus application at 75 kg P2O5 ha-1 and its interaction with sulfur significantly increased the number of pods per plant of pigeon pea. Similarly, the increase in number of pods per plant could also be due to the increased leaf area with additional P being associated with more reproductive nodes (Saxena, 1984). A greater leaf area also results in a corresponding increase in assimilate supply which has been reported to determine pod number in field bean (Husain et al., 1988). In conformity with this result, Singh and Singh (2000) also reported significant increase in number of pods per plant of French bean (Phaseolus vulgaris L.) due to increased P fertilization. The analysis of also more pronounced by the interaction effects of fertilizer and strain.

Number of Seeds Per Pod

Neither the main effects of blended fertilizer and Rhizobia inoculation nor their interaction effect was significant on the number of seeds per pod (Table 5).

Thus, variations on the number of seeds per pod possibly affected by genetic factors than the management. In conformity with this result, Fageria and Santos (2008) reported that the number of seeds per pod of different common bean genotypes varied in the range of 3.1 to 6 and attributed the difference due to the genetic variation of cultivars.

The current result was consistent with the finding of Fisseha and Yayis (2015) who reported that the main effects of N and P as well as their interactions had no significant effect on number of seeds per pod of haricot bean. Ali and Raouf (2011) also reported that nitrogen fertilizer had no significant influence on the number of seeds per pod of chickpea. Likewise, Nebret (2012) observed that application of sulfur up to 60 kg ha-1had no significant effect on the number of grains per pod of common bean.

Thousand Seed Weight

The results of field experiment showed that there were significant differences in thousand seed weight in response to blended fertilizer application. The highest seed weight was obtained by the application of NPKSZNB while the lowest was with the control (Table 5). This result was similar with the finding of Shamim and Naimat (1987) who related the increment in 100-seed weight to the influence of cell division, phosphorus content in the seeds as well as the formation of fat and albumin. The increase in hundred seed weight as a result of increased P application might be attributed to important roles the nutrient plays in regenerative growth of the crop (Zafar et al., 2013), leading to increased seed size (Fageria, 2009), which in turn may improve hundred seed weight. Similarly, Amare et al. (2014) observed significant increase in thousand seed weights of common bean because of phosphorus application up to 40 kg ha-1. In conformity with this result, Gobeze and Legese (2015) found that varieties and their interactions with P fertilizer had significant effect on bean thousand seed weight.

Above Ground Dry Biomass Yield

The above-ground dry biomass yield was significantly ($P<0.01$) affected by the blended fertilizer application and Rhizobia inoculation, while the interaction effect was not significant (Table 5). The highest biomass yield (8935.2 kg ha-1) was obtained by the application of NPKSZNB while the lowest (5740.7 kg ha-1) was at the control (Table 7).

This increment of biomass yield might be due to the increment of growth parameters due to sufficient nutrient availability for plant growth. This result was in line with Dhanjal et al. (2001) found significantly higher branches per plant at 120 kg N ha-1 Application of 60 kg K2O, 10 kg S, 4 kg Zn and 1 kg B ha-1 significantly influenced number of branches per plant. Potassium and S enhanced the formation of chlorophyll and encouraged vegetative growth while Zn promotes biosynthesis of auxin and B helps in N absorption.

Therefore, their collective actions increased number of branches per plant. In addition, the increase in above ground dry biomass yield at the application of this blended fertilizer might be attributed to the enhanced availability of P for vegetative growth of the plants. This result was in agreement with Shubhashree (2007) who reported that dry matter accumulation increase with application of phosphorus rates. The increment in dry matter yield with application of P fertilizer might be due to the adequate supply of P could be attributed to an increase in number of branches per plant, and leaf area. This in turn increased photosynthetic area and number of pods per plant, which demonstrates a strong correlation with dry matter accumulation and yield.

Grain Yield

The effects of blended fertilizer showed significant difference among treatments. Application of NPKSZNB produced the highest grain yield (3481.5 kg ha^{-1}) as par with NPSB and NPSZNB whereas these results were significantly different from control (1768.5 kg ha^{-1}), which was 96.9% higher over the control (Table 5).

This result was similar with the finding of Moniruzzama et al (2006) reported that application of NPKSZnB increase green pod yield of French bean over control. Similar results were also reported by Gebre- Egziabher et al. (2014) that P application at the rate of 46 kg P2O5 ha-1 gave higher number of pods per plant and yield as compared to unfertilized plots in common bean. This result is also in agreement with that of Fisseha and Yayis (2015) who reported that the application of 27 kg N and 69 kg P2O5 ha^{-1} had significantly improved grain yield of common bean. Birhan (2006) also reported a significant yield response of haricot bean to application of P because of P deficiency in the area. In line with this result, application of S with or without P recorded significantly higher seed yield up to 40 kg S ha^{-1} on chickpea (Shivakumar, 2001); and on blackgram (Jawahar et al., 2017).

It might also be due to increased levels of S, its availability along with major nutrients and higher uptake of crop and influencing growth and yield components of the crop, which ultimately lead to effective, assimilate partitioning of photosynthesis from source to sink in post-flowering stage and resulted in highest seed yield. Differences in seed yield might also be related to their response to applied N. In conformity to this result, Dwivedi et al. (1994) found increased yield of common bean due to increasing levels of nitrogen up to 100 kg ha-1with the difference between 80 and 100 kg N ha-1 being not significant. Boroomanndan et al. (2009) also reported that seed yield of soybean increased significantly at 40 kg N ha-1 compared to the control *treatment.*

Table5. *Effects of blended and Bio fertilizers on yield and yield components of common bean*

Treatments	NPPP	NSPP	1000SW	ABY	GY
Control + inn	13.53a	4.07a	401.9c	5740.7b	1768.5a
NPS + inn	16.53a	4.2a	451.29b	8240.7a	2972b
NPK + inn	16.4a	4.27a	475.88ab	8055.6a	3018.5b
NPSB + inn	17.6a	4.47a	465.16ab	8611.1a	3250ab
NPSZnB + inn	16a	4.4a	482.71a	8148.1a	3250ab
NPKSZnB + inn	18a	4.4a	480.32a	8935.2a	3481.5a
Significance	*	Ns	*	*	*
LSD	Ns	Ns	26.9	1230.7	451.22
CV (%)	21.2	7.74	3.2	8.5	7.17

*Means within a column followed by the same letter are not significantly different at 5% level of significance. *= significant; ** = highly significant; ns = non- significant; NPPP= number of pods per plant; NSPP= number of seeds per pod and 1000 seed weight of common bean ST sterilized soil, BY = biomass yield, GY = grain yield*

Economic Analyses

Economic analysis was undertaken with different blended fertilizer treatments to determine the highest net benefit with acceptable marginal rate of return. The result revealed that the maximum net benefit was obtained with NPKSZnB (Table 6). The result show that a general decrease in benefit cost ratio with increasing type of fertilizer this showed that balanced fertilization increase yield sufficiently relative their cost.

Thus, on the basis marketable yield, net benefit, and marginal rate of return it can be decided that NPKSZnB was the most recommended and economically viable for haricot bean Production which provided marketable yield, net benefit, and marginal rate of return of 3133 kg ha^{-1}, 42076.9 ETB, and 1844% respectively.

Table6. *Partial budget analysis of effects blended fertilizer on yield of haricot bean*

Treatments	AGY (Kg ha^{-1})	GB (birr ha^{-1})	TVC (birr ha^{-1})	NB (birr ha^{-1})	Dominance	B:C Ratio	MRR (%)
Control +INN	1591.65	22283.1	0	22283.1			0
NPK+ INN	2716.65	38033.1	1236	36797.1		29.7	1174
NPS+INN	2674.8	37447.2	1410	36037.2	Dominated		
NPSB+ INN	2925	40950	1600	39350		24.6	1743.5
NPSZNB+ INN	2925	40950	1640	39310	Dominated		
NPKSZNB+ INN	3133.35	43866.9	1790	42076.9		23.5	1844.6

The dominant (un-dominated) treatments were ranked from the lowest to the highest costs that vary. The dominant analysis showed that the net benefit of NPS, and NPSZNB treatments were dominated. These indicate that the net benefit was decrease as the total cost that varies increased beyond un-dominated treatments.

Summary and Conclusions

In Ethiopia, smallholder farmers usually grow common bean and the average yield of the crop is low. This low yield of common bean in Ethiopia is attributed to several production constraints, which include poor agronomic practices such as low soil fertility management, untimely and inappropriate field operations and rainfall variability. Therefore, an experiment was conducted during the main 2018 cropping season with the objective of evaluating the influence of blended and bio fertilizer on nodulation and yield of haricot bean, to evaluate the economic feasibility of blended and Bio fertilizers and to characterize and verify the soil type of the study area.

Soil profile was opened and collects soil samples both horizon-wise and from side of a horizon and processed for laboratory analysis to determine physico chemical properties of the area using standard methods. The studied morphological, physical and chemical characteristics were used to classify the studied pedons. Diagnostic horizons, properties and materials of the individual pedons were considered to distinguish the major soil type of the study area. The subsurface horizons had a thickness greater than 25 cm, a clay content greater than 30 percent throughout, wedge-shaped soil aggregates and shrink-swell cracks qualify for a Vertic horizon.

The soils were therefore classified as Vertisols. The soils had a plough depth greater than 20 cm from the soil surface, having ≥ 1% soil organic carbon in the fine earth fraction as a weighted average to a depth of 50 cm from the mineral soil surface, to qualify Aric and Humic supplementary qualifier respectively. Therefore, soils of the study area were classified as Pellic Vertisols (Aric Humic). Although soils of the study area were reported to be Cambisols, results of the study showed that the soils were Vertisols, implying the need for a site-specific soil characterization and classification.

The main effects of blended fertilizer were significant in all growth, nodulation and yield parameters except number of seed per pod. Application of NPKSZnB with sterilized soil gives highest score on, grain yield, biomass yield, number of pods per plant, 1000 seed weight, which was 3481kg ha^{-1}, 8935.2kg ha^{-1}, 18pod per plant, and 482.71 g ha^{-1} respectively.

Based on economic analysis of the experiment the highest net benefit (42076.9 birr ha^{-1}) was obtained by the application NPKSZNB while the lowest was from control (22283.1 birr ha^{-1}). Thus, on the basis marketable yield, net benefit, and marginal rate of return it can be decided that NPKSZnB was the most recommended and economically viable for haricot bean Production which provided marketable yield, net benefit, and marginal rate of return of 3133 kg ha^{-1}, 42076.9 ETB,1844% and 23.5 respectively. Thus, it can be concluded that application of NPKSZNB was found to be superior and can be used for common bean production in the study area. However, since the experiment was conducted for one season at one location, the experiment has to be repeated over seasons and locations to make a conclusive recommendation.

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