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Response of Faba Bean (Vicia Faba L.) to Phosphorus Fertiliizer and Farm Yard Manure on Acidic Soils in Boloso Sore Woreda, Wolaita Zone, Southern Ethiopia

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Abstract
Faba bean (Vicia faba L.) variety was evaluated for its performance upon the application of P (TSP) fertilizers and Farm yard manure in Boloso sore Woreda of Wolaita Zone in 2014 cropping season. This study was carried out with the objectives of investigating the optimum rates of P fertilizers (0, 15, 30, 45 and 60 kg/ha) and FYM (0, 4 and 8 t/ha) for faba bean production on acidic soils. The experiment was laid out in factorial RCBD design with three replications. The data collected were plant height, tillers per plant (productive & Non-productive), Pods per plant, Seeds per pod, grain yield, biomass and thousand seed weight. In the analysis of variance some of the parameters such as tillers per plant, Seeds per pod and Moisture content showed significance difference ($p<0.05$). In the mean comparison analysis for significant parameters, the FYM with the rate of 8t/ha combined with no P fertilizer and the FYM with the rate of 4t/ha combined with 60kg/ha of P(TSP) fertilizer performed better than that other combinations.
Keywords: Farmyard manure, Triple superphosphate, treatments, replication

INTRODUCTION

Faba bean (Vicia faba L.) is among the major grain food legumes cultivated in different part of Ethiopia including woliata zone (CSA, 2013). Broad beans have a long tradition of cultivation in Old World agriculture, being among the most ancient plants in cultivation and also among the easiest to grow. Along with lentils, peas, and chickpeas, they are believed to have become part of the eastern Mediterranean diet around 6000 BC or earlier. They are still often grown as a cover crop to prevent erosion, because they can overwinter and because as a legume, they fix nitrogen in the soil. These commonly cultivated plants can be attacked by fungal diseases, such as rust (*Uromyces viciae-fabae*) and chocolate spot (*Botrytis fabae*). They are also attacked by the black bean aphid (*Aphis fabae*). The broad bean has high plant hardiness; it can withstand harsh and cold climates. Unlike most legumes, the broad bean can be grown in soils with high salinity, as well as in clay soil. However, it does prefer to grow in rich loams. In much of the English-speaking world, the name "broad bean" is used for the large-seeded cultivars grown for human food, while "horse bean" and "field bean" refer to cultivars with smaller, harder seeds (more like the wild species) used for animal feed, though their stronger flavour is preferred in some human food recipes, such as falafel. The term "fava bean" (from the Italian *fava*, meaning "broad bean") is usually used in English-speaking countries such as the US, but "broad bean" is the most common name in the UK and Australia.

Broad beans (Amharic: *baqella*) are one of the most popular legumes in Ethiopia. They are tightly coupled with every aspect of Ethiopian life. They are mainly used as an alternative to peas to prepare a flour called *shiro*, which is used to make *shiro wot* (a stew almost ubiquitous in Ethiopian dishes). *Baqella nifro* (boiled broad beans) are eaten as a snack during some holidays and during a time of mourning. Interestingly, this tradition goes well into religious holidays, too. *Boq'ullit* (boiled salted broad beans embryo) is one of the most favorite snacks in the evening, the common story-telling time in north and central Ethiopia. It is particularly a favorite for the story-teller (usually a society elder), as it is delicious, and easy to chew and swallow.

Thus the productivity of this crop is constrained by low soil P^H associated with low P availability. Acid soils occur widely in the highlands of Ethiopia where the rainfall intensity is high and the land has been under cultivation for many years. These soils have PH values of less than 5.5, which result in low faba bean yields compared to other faba bean growing areas of the country. The low yields in such soils could mainly be either due to the deficiency of nutrients, such as P, Ca and Mg (Taye , 1993; Cadish, 1990; Sommer,2000; Berry et al., 2003; Dodd and Mallarino, 2005), or toxicity of Al, Fe and Mn (Sharma, 2004). As a result, P deficiency is one of the most widespread soil constraints in these soils. Furthermore, Getachew et al. (2005) reported that acid soils could expose faba bean to greater chocolate spot infection thereby reducing yield.

Experimental results indicate that, in the humid tropics, there large area of acid soils whose clay minerals (largely oxides and hydroxides of Al and Fe, kaolinite and allophone) adsorb phosphate strongly (Sanchez, 1976). Amare et al. (1999) showed that adding P fertilizer to an acid soil resulted in a precipitation reaction between exchangeable Al^{3+} and added P resulting in the formation of a highly insoluble Al-phosphate compound. In such soils the proportion of P fertilizer that could immediately be available to a crop becomes inadequate and residues of the fertilizer may be released very slowly (Sanchez, 1976). phosphate can readily be rendered unavailable to plant roots as it is the most immobile of the major plant nutrients. Its efficiency can be affected by P fertilizer distribution and distance of application from the plant (Eghball Sander, 1989). The quantity of P in soil solution needed for optimum growth of crops lies in the range of 0.13 to 1.31 kg P ha^{-1} as growing crops absorb about 0.44 kg P ha^{-1} per day (Mengel and Kirby, 1996). The labile fraction in the topsoil layer is in the range of 65 to 218 kg P ha^{-1} , which could replenish soil solution P (Mengel and Kirby, 1996).

The application of P fertilizer on an oxisols resulted in significant effects on different tropical forage legumes (Cadish, 1990). I n soils where P deficiency on limited growth and N fixation to a greater extent, phosphorus supply increased dry matter by 193%, N concentration in shoot tissue by 10% and percentage of N derived from by 15% fourteen weeks after planting. The increase in P rate also resulted in 259% more N being fixed at 75 kg P ha-1 than at 5 kg P ha-1. Besides, severe P deficiency quickly led to a strong reduction in nodule weight (Cadish, 1990).

It is widely believed that productivity of acid soils could be improved through applying animal manure. According to Marschner (1995) and Mengel and Kirby(1996) animal manure releases a range of organic acids during its decomposition. This can form stable complexes with Al and Fe thereby blocking the P retention sites and ultimately resulting in higher P availability. The positive effects of manure on crop yields have been explained on the basis of cation exchange between root surfaces and soil colloids (Sharma et al., 1990). Application of FYM at any rate improved the soil properties reduced the bulk density, soil pH, EC and Soluble ions of Na^{+}, $HCO^{3-}$and Cl^{-}. However, markedly increased soil organic matter, total porosity, field capacity, available water and soluble ions of Ca^{+2}, Mg^{+2}, K^{+} and SO_4^{-2}. The highest rate of FYM surpassed the other treatments in enhancing the determined properties. Therefore, the objective of the study was to find out the effects of farm yard manure and P fertilizer on the yield and yield components and to determine the optimum rates of P fertilizer and FYM for faba bean production in acid soil of the study area.

MATERIALS AND METHODS

Description of the Study Area

The study site was located at Boloso sore woreda in wolaita zone, southern Ethiopia. The research site is found in the altitude ranging between 2100-2300 m.a.s.l, at 380 km from Addis Ababa and the average annual rainfall of 1750 mm**.**

Treatments and experimental design

A study was undertaken on the effects five levels of P fertilizer and three level of air dried decomposed farmyard manure on growth ,yield and yield components of faba bean. The P fertilizer was applied at the rate of 0, 15, 30, 45 and 60 kg ha-1 in the form of triple superphosphate (TSP). FYM was applied at the rate of 0, 4 and 8 tha^{-1}. The faba bean cultivar was used Gabalicho. The experiment was conducted in a RCBD factorial designed with three replications. FYM was kept under shade from two to three months until its decomposition.

P 0kg	P 15 kg	P 30kg	p 45kg	P 60kg	p 0kg	p 60 kg	p 30kg	p 45kg	P 15kg	p 0kg	p 15 kg	P 30kg	p 45kg	P 60kg
FYM=0kg					FYM=4kg					FYM=8kg				
P 60kg	45	30	15	0	60	45	30	15	0	60	45	30	15	0
FYM=4kg					FYM=8kg					FYM=0kg				
0	15	30	45	60	0	15	30	45	60	0	15	30	45	60
FYM=8kg					FYM=0kg					FYM=4kg				

Faba bean

1. B/n row=40cm, 2. B/n plant=10cm, 3. B/n plot=50cm, 4. B/n block=1.5m to 2m

The decomposed manure was applied 21-30 days before sowing and mixed thoroughly in the upper 15-20 cm soil depth. During application, the moisture content of the FYM was 24%. The phosphorus was applied along with seeds as triple superphosphate. Twenty two kg N ha-1 was applied as a starter dressing to all plots in the form of urea. In all replications, planting was done from 21 to 23 June at the seed rate of 200 kg ha-1 on a plot size of 2.6m x 2.6 m. All other cultural practices were followed as per the recommendation.

Soil sample analysis

Composite soil samples were collected before planting and after harvesting from 15-20 cm soil depth from each replication. They were then analyzed for pH, P, N, OC, and CEC. Soil pH was measured in 1:1 soil: water suspension. The standard kjeeldhal method was used for soil nitrogen determination. Available p was determined using Bray-II method. The cation exchange capacity of the soil was determined using ammonium acetate method. Similarly, farm yard manure samples were analyzed for P^H, P, N, OC, and CEC using the same analytical procedures used for soil analysis.

Agronomic data collection and analysis

Agronomic data such as stand count, plant height, number of pods per plant and seeds per pod total above ground biological and seed yields, harvest index (HI) and 1000-seed weight were recorded. To estimate total biological and seed yields, the whole plot size (2.6 x 2.6 m^2) was harvested and threshed manually. Seed yield was adjusted to 10% moisture content. Analyses of variance for all data were performed using the SAS statistical package program version 8.2 (SAS Institute Inc., 2001). In the case of significant differences between treatments, least significant differences (LSD) at 5% probability level were used to establish the difference among the means. Correlation analyses were made between seed yield and yield components. Since data were not homogenous, mean results of each cropping season were reported.

RESULT AND DISCUSSION

Composite soil sample before sowing and after harvesting the and also FYM chemical properties analysis

Composite soil samples were collected from experimental site before sowing and after harvesting from 15-20 cm soil depth from each replication. All of the soil samples were analyzed for pH, P, N, organic carbon (OC) and cation exchange capacity(CEC), which were presented in the Table 1. The initial soil analysis results sub-optimal for the production of faba bean. As revealed in Table 1, the soil reaction (PH), available P and exchangeable cations were far below the optimum requirement. According to Marschner (1995), soils with pH values of less than 5.5 are deficient in Ca and/or Mg as well as P. Soil pH values of below 5.5 of some horizons of the profiles could be an indication of presence of appreciable amounts of Al and removal of exchangeable cations, such as calcium and magnesium. These levels of soil pH could further indicate that phosphorus availability would be lowered through the binding effects of Al and Fe. Deforestation followed by cultivation of the same land with resulting export of basic cations in agricultural products, and leaching due to adequate rainfall, forms the major cause for the change in pH and acidification process as in the soils of the tropics (Smith *et al*., 1995). The results of this study indicated that FYM and phosphorus fertilizer positively influenced number of pods per plant and seeds per pod, total biological yield and seed yield of faba bean in all growing condition. In tropical soils, large quantities of soil P in mineral form are not readily available for absorption by the plant (Barber, 1984). This phosphorus occurs in numerous combinations with iron and aluminium in most of well weathered tropical soils, such as in the present study area. The phosphorus content in soil solution is low as compared to other nutrients such as nitrogen, potassium, calcium and magnesium (Tisdale *et al.,* 1993). Many soils fix large quantity of phosphorus by converting readily soluble phosphorus to forms less available to plants in the above combinations (Miller *et al.,* 1995). According to the ratings for some tropical soils (Olsen and Dean, 1965; Brook, 1983; Havlin *et al*., 1999), available P contents in the study site were low (soil indicates a crop response to P fertilizers) in the all plots of experiment. Topsoil phosphorus is usually greater than that in subsoil due to sorption of the added phosphorus and greater biological activity and accumulation of organic material in the former. However, soil phosphorus content varies with parent material, extent of pedogenesis, soil texture, and management factors such as rate and type of phosphorus applied and soil cultivation (Tekalign *et al*., 1988).

The considerably large losses of total nitrogen in the continuously cropped fields could be attributed to rapid mineralization of soil organic matter following cultivation, which disrupts soil aggregates, and thereby increases aeration and microbial accessibility to organic matter (Solomon *et al.,* 2002). These values can be rated as low following the ratings for some other soils of Ethiopia (Weigel, 1986). According to Havlin *et al.* (1999), TN content of study area soils were categorized under the low category. The results are in accordance with the findings of Wakene and Heluf (2003) and Tuma (2007) who reported that intensive and continuous cultivation forced oxidation of OC and thus resulted in reduction of TN.

According to Brook (1983), rating for soils of tropical and subtropical regions, organic matter content of the surface soils in the study area was in low class which is due to differing intensity of erosion, addition of organic material and level of the mineralization/decomposition of organic matter. According to Landon (1991), rating organic carbon content of the soils were low in all experimental replications.

Farm yard manure sample was analyzed for pH, P, OC, CEC and TN, 6.45, 65.82, 15.2, 29.40 and 0.39

respectively using the same analytical procedures used for soil analysis (Table 1).

Table 1 Soil chemical properties of experimental site before harvesting, after harvesting the crop and FYM before appilcation

Soil Sampling Time	pH	Av.P (ppm)	% OC	CEC	% TN
Composite Soil Sample before sowing mean	5.09	4.84	1.5	19.92	0.11
FYM Before sowing	6.45	65.82	15.2	29.40	0.39
Composite soil sample mean after harvesting	5.47	5.54	1.94	24.6	0.09

The composite soil sample mean after harvesting was analyzed for pH, Av.P, % OC, CEC and % TN parameters with values 5.47, 5.54, 1.94, 24.6 and 0.09 respectively (Table 1). The composite soil samples were collected after harvesting indicated that there were higher pH levels and nutrient concentrations on plots treated with both FYM and P fertilizer compared to sole application of either FYM or p fertilizer. The lowest pH and nutrient content were observed in soils, which were not treated with FYM. According to Sharma et al. (1990), the use of animal manure might have made the soil more porous and pulverized, allowing better root growth and development, thereby resulting in higher root cation exchange capacity. Sanchez (1976) has also indicated that the application of manure directly influences the availability of native or applied phosphorus. The soil chemical properties after harvesting higher than that of soil parameters before sowing the crop except TN.

4.3. Agronomic (growth and yield components) Data Analysis

Table 1. Mean square values from Analysis of variance Growth and yield parameters of Faba bean as affected by treatments

Analysis of Variance (ANOVA) Parameters studied

Source	DF	Ph(cm)	Tiiler/p	Pro. tiller	N-Pro/till	Pods/p	Seed/pod	Biom(gm)	Gyld(gm)	Stwt	Tswt	Mc
Replication	2	0.01ns	0.01ns	0.09ns	0.043ns	7.75	22.1	1902457.8ns	19710.5	1429225	1141340	0.63ns
Treatment(FYM x P)	14	0.01ns	0.26*	0.27*	0.011*	3.52*	24.2*	245100.7ns	77744.2*	103513*	1076753*	0.58*
error	28	0.02	0.17	0.15	0.009	3.77	27.2	398971.9	136591.3	192515	1086103.7	0.26

*, **, *** significant at $p<0.05$, $p<0.01$ and $p<0.001$ probability level, respectively; ns=Not significant

The above data revealed that growth and yield parameters of faba bean varied in their significance level. The results of this study indicated that FYM and P fertilizer combination positively influenced tillers per plant, productive tillers, non-productive tiller, pods per plant, seeds per pods, grain yield, straw weight, thousand seeds weight and moisture content. The application of FYM had significantly ($p<0.05$) affected all growth and yield parameters except plant height and biomass. All parameters are not significantly influenced among the replication (Table 1). Table 2 Mean Comparison analysis of significant parameters

Treatments		Tiiler/p	Pro. till	Non-Pro til	Pods/p	Seed/ po	Twt	MC
(t/ha)	(Kg/ha)	2.36*	2.26*	0.082*	8.84*	21.25*	949.3*	11.29**
0	0	2.4abc	2.3bc	0.06ab	9.4a	22.46ab	3113.5a	11.4abcd
	15	1.96c	1.86c	0.06ab	9.3a	19.9ab	763.4b	10.9cde
	30	2.2bc	2.06bc	0.13ab	7.8ab	18.23ab	798.0b	11.76ab
	45	2.11bc	2.00bc	0.11ab	5.9b	14.08b	774.6b	11.93a
	60	2.6abc	2.6ab	0.00b	9.6a	22.9a	829.8b	11.96a
4	0	2.3bc	2.2bc	0.06ab	7.6ab	17.8ab	824.4b	11.63abc
	15	2.06c	1.86c	0.20a	8.3ab	19.6ab	763.8b	10.96bcde
	30	**2.13bc**	**2.13bc**	**0.00b**	**9.43a**	**23.06a**	**798.5b**	**11.53abc**
	45	**2.26bc**	**2.2bc**	**0.03b**	**9.03ab**	**21.86ab**	**767.4b**	**10.53e**
	60	**2.2bc**	**2.16bc**	**0.03b**	**8.96ab**	**21.26ab**	**792.5b**	**11.33abcde**
8	0	**2.36bc**	**2.2bc**	**0.06ab**	**10.00a**	**24.9a**	**808.7b**	**11.13abcde**
	15	**2.53abc**	**2.43abc**	**0.06ab**	**9.2a**	**23.2a**	**793.1b**	**11.0bcde**
	30	**3.06a**	**3.00a**	**0.06ab**	**9.9a**	**24.0a**	**785.6b**	**11.46abcd**
	45	**2.43abc**	**2.3bc**	**0.13ab**	**8.26ab**	**22.93a**	**812.7b**	**11.23abcde**
	60	**2.8ab**	**2.63ab**	**0.2a**	**9.76a**	**22.46ab**	**812.7b**	**10.63de**
LSD5%		**0.69**	**0.65**	**0.16**	**3.25**	**8.72**	**1743**	**0.85**
CV(%)		**17.5**	**17.33**	**116.3**	**21.96**	**24.5**	**109.7**	**4.5**

As can be observed from table 3, the growth parameters such as plant height, tillers per plant, productive tillers per plant and non-productive tillers per plants affected by farm yard manure and Phosphorus fertilizer at $p<0.05$ significance level. The application of FYM at the rate of 4 and 8 t ha^{-1} increased plant height, tillers per plant, productive tillers per plant and non-productive tillers by 33 and 35 %, 31 and 37 %, 31 and 37 %, 26 and 44 % respectively. This finding is agreed with Getachew et al.(2005) that the application of FYM had significantly ($p<0.05$) affected the plant height. The application of FYM at the rate of 4 and 8 t ha^{-1} increased number of pods per plant and seeds per pod. Number of pods per plant and signicantly ($p<0.05$) influenced by application of both FYM and P fertilizer (Table 3). The application of FYM at the rate of 4 and 8 t ha^{-1} increased number of pods per plant and number of seeds per plant by 33 % and 36 %, 33 and 37 % respectively, compared to the control. As indicated by Getachew et al.(2005) the application of the 8 t ha^{-1} resulted in the highest number of pods per plant and seeds per pods of faba bean. Similarly, the application of FYM and P fertilizer on yield parameters of faba bean had positively($p<0.05$) influenced such as biomass, grain yield, straw weight and thousand seeds weight (Table 3). The application at the rate of 4 and 8 t ha^{-1} increased biomass, grain yield, straw weight and thousand seeds weight by 34 and 35, 35 and 34, 34 and 34, 28 and 28, respectively compare to the control.

Table 3. Main effects of FYM & P rates on Growth and Yield

		Ph (m)	Tiiler/p	Pro. til	Non-Pr	Pods/p	Seed/ po	Biom(kg/ha	Gyld(kg/ha	Stwt(kg/ha	Tswt	MC
FYM	0	1.06	2.25	2.16	0.07	8.40	19.51	5536.95	2155.118	3422.41	1255.8	11.59
mean	4	1.11	2.19	2.11	0.06	8.66	20.72	5935.36	2379.911	3555.41	789.32	11.20
	8	1.15	2.60	2.50	0.10	9.40	23.50	6047.04	2316.272	3571.30	802.60	11.10
P	0	1.11	2.35	2.23	0.06	9.00	21.72	5871.41	2322.885	3710.65	1582.20	11.39
Fertilizer	15	1.09	2.18	2.05	0.11	8.93	20.90	5672.68	2213.018	3462.68	773.43	10.95
rates	30	1.14	2.46	2.40	0.06	9.04	21.76	5741.27	2330.621	3410.61	794.03	11.58
Mean	45	1.09	2.27	2.17	0.09	7.73	19.62	5736.83	2274.66	3462.13	784.90	11.23
	60	1.11	2.53	2.46	0.08	9.44	22.21	6176.67	2277.707	3631.91	811.67	11.31
	LSD	0.21	0.69	0.65	0.16	3.25	8.72	1056.4	618.13	733.84	1743	0.85
	CV	11.29	17.5	17.33	116.3	21.96	24.5	16.0	23.93	18.5	109.7	4.5

CONCLUSION

The soil –plant interaction according to supplying nutrients for enhancement of plant productivity may be limited due to this reason adding nutrients to soil are necessary. The application of P fertilizer in conjuction with FYM, in addition to increasing crop yield, could improve the physical, biological and chemical condition of the soil.

- The study was conducted with the aim of evaluating the effects of P fertilizer with FYM on growth of Faba bean
- Increament was observed from 0 to 8t/ha of FYM with P fertilizer rate for some traits
- For the yield traits, the similar trend was observed
- Optimum combination seems 30kg/ha P with 4t/ha of FYM and okg/ha of P with 8t/ha of FYM

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