Journal of Natural Sciences Research www.iiste.org
ISSN 2224-3186 (Paper) ISSN 2225-0921 (Online)
Vol.8, No.11, 2018

Evaluation of N and P Contribution to Improve Soil Fertility Potentials of the (Vicia faba L. and Glycine max L.) to Subsequent Cereal Crops

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Abstract
Decline in soil fertility has become a serious problem in the Sub Saharan Africa region. Among the countries in SSA, Ethiopia has the highest rates of nutrient (N and P) depletions mainly due to the low nutrient input. However, the net contribution of legumes to soil nutrient balance is determined by the extent to which crop residue is removed from the field. Therefore, we assessed two possible selected grain legumes (Vicia faba L. and Glycine max L.). Soil samples were collected on a transect walk from Dedo and Tiro-Afeta districts. Six composite soil samples from each transect based on elevation were collected at the depth of (0-30cm). The soil samples were collected from fields that are known to grow continuous cereal-cereal at least for the last three years. A pot experiment was therefore conducted under screen house a condition in a RCBD with three replications on soils obtained from transects. Soil physic-chemical properties were studied before and after sowing. All plants related data from crops were recorded at 75% flowering stage. The effect of different elevation levels showed that soil properties before planting were significantly ($P<0.05$) for all studied parameters. The effect was observed by measuring soil and plant biomass (N and P) for each Vicia faba L. and Glycine max L. The study showed a significant ($P<0.05$) difference and positive correlation between treatments with soil available P before planting for both crops. Vicia faba L. recorded higher value for the N and P under Dedo soils than Glycine max L. for the same parameter. Similarly, Glycine max L. recorded higher value under Tiro-Afeta soils than Vicia faba L for the N and P. Thus, this study concludes that firstly growing Vicia faba L. crop on the Dedo soils and the Glycine max L. crop on the Tiro-Afeta soils would improve N and P quickly and inexpensively thereby crop productivity can be enhanced.
Keywords: Vicia faba L., Glycine max L., N and P.

1. Introduction

Soil nutrient balance studies in Africa show evidence of widespread nutrient mining (Speirs and Olsen, 1992; Bohlool *et al*., 1992; Smaling, 1993; Boddey *et al*., 1996 and Okalebo *et al*., 2007). Amount of nutrients annually lost through leaching, erosion and volatilization is higher than the amount of nutrient inputs through fertilizers, deposition and Biological N_2 fixation (Smaling and Braun, 1996, Bado *et al*., 2004; Ndema *et al.,* 2010).

Nitrogen (N) is thought to be the nutrient that mostly limited in tropical agricultural production (Rufino *et al*., 2006). As an alternative to N inputs from fertilizer or manure, intensification of nitrogen-fixing legumes is often promoted to increase productivity of cereal-based cropping systems in developing countries. They have the potential to increase the N content of the soil and thereby subsequent cereal yields. At the same time sustainability of soil will be improved by diversifying the cereal dominated cropping with legume rotations (Vanlauwe and Giller, 2006). Furthermore, crop diversification, in the form of rotation or intercropping, with edible grain legumes could be an option.

The use of legumes in rotations may enhance P availability and yields of the subsequent cereal crop (Vanlauwe *et al*., 2000a; Horst *et al*., 2001). P efficient legumes are characterized by rhizosphere processes (acidification of the rhizosphere and/or excretion of organic acids) that allow these species to mobilize P from sparingly soluble P pools (Braum and Helmke, 1995; Hocking *et al*., 1997; Bloem and Barnard, 2001). The P is taken up by the legume and partly returns to the soil through the residues as a high quality organic P source for the subsequent cereal crop.

Dedo and Tiro afeta, located south west part of Ethiopia are known for cereal crop production and the highlands are dominated by acid P-fixing soils like Nitisols and occur widely in highlands where rainfall intensity is high and P fixation due to high Fe and Al content of these soils makes is the major problem. Therefore, low productivity, poor response of crops to chemical fertilizers, because very high cost of chemical fertilizers are major problems. Therefore, takes the above problems under consideration, scientific studies on the effects of Fababean and soya bean on Integrated Soil Fertility Management was essential and may be plays a significant important for police maker, academic purpose, research institution and rural communities. Therefore, this study is designed to evaluate N and P contribution potentials of grain legumes

2. Materials and methods

2.1. Description of the study area

The experiment was conducted in Dedo between 07°22'- 07° 58' N latitude and 36°21'- 36°52' E longitude and the altitude extend between 1600 to 2400m asl. Tiro-Afeta district ranges from 1200 to 1800 m a s l and lied between 07° 20'- 07° 45' N latitude and 034° 25'- 34° 53' E longitude of the Oromia Regional State, South West Ethiopia. Average day temperatures are about 18.6°C and annual total rainfall ranges between 1592-1275mm, with bimodal distribution. The dominating soils of the region are Nitisols. The main crops cultivated in this region are maize, sorghum, wheat, barley, teff, enset, faba bean and coffee).

2.2. Soil Sampling and laboratory analysis

Soil samples were collected from the two study sites (Dedo and Tiro-Afeta) based on Elevation and cropping history. The sampled sites were known grow continuous cereal-cereal at least for the last three years. A total six composite soil samples were collected by transect walking from both location to another, such as (Location I, Location II and Location III) from each district. From different farm plot soils sample collected separately were different Elevation and the sampled sites were recorded by GPS. The selected representative fields were replicated three times, and from each field, fifteen soil sub-samples were collected at depths of 0-30cm by using an Auger. Just before grown to make composite according to (Wilding, 1985) procedure, that represent the experimental area for detailed physicochemical analysis each individual.

The pH of the samples was measured with 1:2.5 soil-water ratio methods (Reeuwijk, 2002). The solution was stirred for one minuet and left for 1hr to rest. Then, the soil suspension was stirred and measured by using a glass electrode pH meter.

Soil particle size distribution was determined by the Boycouos hydrometric method (Bouyoucos, 1962; Van Reeuwijk, 1992) after destroying OM using hydrogen peroxide (H_2O_2), sodium carbonate (Na_2CO_3) was used a soil dispersing agent and two drops of amyl alcohol were used for foam reduction. The soil textural classes were determined using the International Soil Science Society (ISSS) system (Yong and Warkentin, 1966), triangular guideline.

Bulk density of the undisturbed soil sample was determined by the core method (FAO, 2007) using a core sampler and determining the mass of solids and the water content of the core, by weighing the wet core, drying it to constant weight in an oven at 105°C for 24 hours.

The Soil organic carbon was determined by the Walkley-Black oxidation method with potassium dichromate (K2Cr2O7) in a sulfuric acid solution and titrated with 0.5 N ferrous sulfate solutions (Walkley and Black, 1934) and percent soil OM was obtained by multiplying percent soil OC by a factor of 1.724 (Sahlemedhin and Taye, 2000) following the assumptions that OM is composed of 58% carbon.

Percent of Organic matter (OM) = 1.724 x % C.

Total N of the soil was determined through digestion, distillation and titration procedures of the wet digestion by Semi-micro Kjeldhal method (Bremmer and Mulvancy, 1982) whereby the ammonia evolved was collected in a boric acid solution in the presence of indicators (methyl red and bromocresol green) and titrated with 0.1N H_2SO_4 to pink end color (Sahlemedhin and Taye, 2000).

The plant available P fraction in the soil samples was determined using the Bray II method extraction method as described by (Bray and Kurtz, 1945). Thus, 0.2 g of soil was mixed with 14 mL extracting solution Bray, containing 0.03M NH_4F and 0.025 M HCl. The solution was shaken for 1 minute and filtered through Whatman filter paper. The 2 ml of the sample was piped into a test tube and 8 ml boric acid as well as 2 ml mixed reagent was added. Solutions were left for about 1 hour to develop the blue color. Absorbance was measured at 882nm with a UV/VIS spectrophotometer and plant available P concentrations (mg P kg^{-1} soil) in the soil samples were derived from the calibration curve.

2.3. Total nitrogen content of plant tissues

Bulk of plant samples were taken at 75% flowering and oven dried at 70°C for 72 hours and then ground. Plant samples of 0.3 g were ashed in porcelain crucibles for 5 hours at 550°C. Total N was determined through digestion, distillation and titration procedures of the wet digestion by Semi-micro Kjeldhal method (Bremmer and Mulvancy, 1982) whereby the ammonia evolved was collected in a boric acid solution in the presence of indicators (methyl red and bromocresol green) and titrated with 0.1N H_2SO_4 to pink end color (Sahlemedhin and Taye, 2000).

2.4. Total phosphorus content of plant tissues

Determination of phosphorus was carried out on the digest aliquot obtained through wet digestion by (Chapman and Pratt, 1961; Ryan *et al*., 2001). Plant samples of 0.5 g were ashed in porcelain crucibles for 5 hours at 550°C. The phosphorus in the solution is determined calorimetrically by using molybdate and metavanadate for color development. Plant phosphorus is converted to orthophosphates during digestion. These orthophosphates react with 10ml molybdate and vanadate and give yellow colored unreduced vendor-molybdo-phosphoric heteropoly complex in acid medium.

The yellow color is attributed to a substitution of oxyvanadium and oxymolybdenum radicals for the oxygen of phosphate. The reading is made at 460nm wavelength. The P concentration (PC) was expressed in kg P ha^{-1} dry weight (Khair *et al.,* 2002).

2.5. Estimation of N_2 fixed by legumes

The nitrogen difference method was used for calculation of the amount of N_2 fixed by a legume. In this method, the amount of N-fixed obtained through comparison of a legume and a non N_2-fixing reference plant. The N yield of the legume, here the (*Vicia faba L.* and *Glycine max L.*) are composed of N derived from the soil and N derived from the atmosphere, whereas the N yield of a reference plant is derived from the soil only (Peoples *et al*., 2009). Assuming that the legume assimilates the same amount of soil mineral N as the reference plant, the amount of N_2 fixed can be calculated by subtracting the N yield of the reference plant (Wheat and Teff) from the N yield of the legume from *Vicia faba L.* and *Glycine max L.*):

N_2 fixed = (N yield N_2-fixing plant - N yield reference plant) + (Soil mineral N under N_2-fixing plant - soil mineral N under the reference plant) -- **(Eq 1.1)**

Above "equation 1.1" procedure has been suggested to improve the accuracy of the methodology for legumes when the legume and reference plant are may not well matched in terms of soil N uptake (Evans and Taylor, 1987). In this method the difference in postharvest soil mineral N is also determined in the N_2-fixing and reference pots, and added to the difference in total N yield of the two crops.The difference in total N accumulation between the N_2-fixing and non N_2-fixing plants grown in the same soil is attributed to N_2 fixation. The assumption here is that the non N_2-fixing and N_2-fixing plants extract the same amount of N from the soil (Unkovich *et al*., 2008).

$$\%\ \text{Ndfa} = \frac{[\text{Total N in legume} - \text{Total N in reference crop}]}{\text{Total N in legume}} \text{X}100$$ --------------------------------------- **(Eq 1.2)**

Where % Ndfa is the percentage of N_2 derived from the atmosphere

2.6. Experimental layout

A pot experiment was conducted on soils obtained from fields that are known to grow continuous cereal-cereal at least for the last three years. Grain legumes such as such as *Vicia faba L. and Glycine max L* were grown on these soils under screen house condition without any inorganic and organic fertilizers. A check plot (pot) that contains only cereal crops (wheat for Dedo and teff for Tiro-Afeta) was also included. The experiments were laid out in randomized complete block design (RCBD) with three replications.

2.7. Pot experiments in the screen house

A total of 274.56 Kg of bulk soil was collected from both districts (Dedo and Tiro afeta) at different elevations. Of these soils, 3.52 kg was filled in the each pot. From the total of 78 pots, in the 72 pots, the selected grain legumes namely *Vicia faba L. and Glycine max L.)* were sown. But in the rest 6 pots wheat and teff crops were planted. The seeding rates for legumes were four seeds per pot while for cereals 16 seeds for wheat. On June 07/2015, Planting was conducted after 1 week, right from filling of soil in the pots. After 10 days of planting, 1 seedling out of four was removed from each pot. The soil analysis was conducted both before planting and after harvesting.

2.7. Statistical Analysis

Both soil physicochemical properties and plant data were subjected to analysis of variance using the general linear model procedure of the statistical analysis system version 9.2 (SAS, 2002). The least significance difference test (LSD) test was used to separate the significances between treatments at 5% probability level. Moreover, simple correlation analysis was executed with the help of (Gomez and Gomez, 1984) to reveal the relationships between selected soil and plant parameters among location.

3. Results and discussion

3.1. Physico-chemical properties of soil before experiment

According to the soil textural triangle of USDA system the soils of the two sites are classified as clay. This is due to the fact that on the analysis result the highest percentages (61%, 45.6%) and (55%, 41%) of clay values were recorded from both at location 3 of Dedo and Tiro-Afeta locations respectively. On the other hand, the highest value of silt and sand under Dedo location 2 and 1 were (36.6, 18.3) and the lowest value location 3 and 2 (26, 10.3) respectively. Under Tiro-Afeta the highest value of silt and sand was (30, 30) at location 3 and 1, while the lowest values were recorded at location one and three respectively.

All of the soil samples have clay content more than 30%, which is the marginal ranges of total clay requirement for Nitisol (WRB, 2006). The highest percentages of clay were observed at Dedo, while the lowest values were recorded at Tiro-Afeta (Table 1). The clay and sand property were significantly ($P \leq 0.05$) affected by different locations at both Dedo and Tiro-Afeta sites as shown (Table 1). Because of high rain falls the fine particles from the upper elevation can easily detach and transported to the lower elevation positions in the study area. These results agreed with (Roukos *et al*., 2011; Mtambanengwe *et al*., 2004; Jobbagy & Jackson, 2000) significant attitudinal/elevation variations of soil physical properties.

The mean value of bulk density of the soil in the two sites was significantly different ($P < 0.05$) affected by different elevation level. The highest mean (1.31 g/cm^3) value of bulk density was recorded in the Dedo location three and the highest mean (1.5 g/cm^3) under Tiro-Afetalocated three might be associated with relatively low content of organic matter and very high clay. The lowest mean (1.14 g/cm^3) value under the Dedo locate one and the lowest mean (1.17 g/cm^3) value under the Tiro-Afeta location one as shown (Table 2). The reason for higher soil bulk density on the DL3 as well as in the TaL3 could be due to the very high clay content (Sevgi, 2003; Kidanemariam *et al*., 2012; Shazia *et al*., 2014) and low SOM are low in percent pore space and result in higher Bulk density.

Table 1: SD± and Mean comparison of soil particles and bulk density before planting on Dedo and Tiro afeta.

Locations	% clay	% silt	% sand	STC	BD (g/cm^3)
DL1	45.6 ± 0.5^c	36 ± 1.0^a	18.3 ± 0.5^a	Clay	1.14 ± 0.02^b
DL2	53 ± 1.0^b	36.6 ± 0.5^a	10.3 ± 0.5^b	Clay	1.25 ± 0.03^a
DL3	61 ± 1.7^a	26 ± 2.0^b	13 ± 1.0^c	Clay	1.31 ± 0.01^a
P Value	**	**	**		**
LSD (0.05)	3.16	3.66	1.51		0.05
CV (%)	2.62	4.9	4.8		2.08
TaL1	41 ± 2.6^c	29 ± 1.7^a	30 ± 1.0^a	Clay	1.17 ± 0.03^b
TaL2	46.3 ± 3.7^b	29 ± 4.1^a	24.3 ± 1.5^b	Clay	1.22 ± 0.02^b
TaL3	55 ± 2.6^a	30 ± 1.1^a	14.3 ± 1.5^c	Clay	1.5 ± 0.01^a
P value	**	ns	**		**
LSD (0.05)	3.02	4.89	2.38		0.06
CV (%)	2.77	7.36	4.67		2.05

**=highly significant (0.01); *= significant (0.05), ns =non-significant. Means in a column show different letters are highly significantly different (p<0.05) and similar letters show non-significant by LSD Test.STC = soil texture class; BD= Bulk density; DL= Dedo location; TaL= Tiro afeta location; LSD= Lattice square design and CV= Coefficient variability.

The organic carbon, organic matter, total nitrogen (TN), plant available phosphorus and pH of soils from Dedo and Tiro-Afeta farm fields were given in (Table 2). The results showed that soil pH_{H2O} varied significantly ($P<0.01$) across locations (Table 2). The pH of the highest mean of Tiro-Afeta soil was lower than the pH of the highest value of Dedo soil. For instance, the highest value (6.22±0.15) and (5.91±0.04) soil pH_{H2O} values were recorded at lower elevation (location 3) for both districts (Table 3). Whilst the lowest value of pH (5.46) and (5.46) were recorded at higher elevation (location 1) with both Dedo and Tiro-Afeta districts, respectively.

Soil pH-H_2O ranged from 5.46 to 6.22 at both transect location one and at Dedo location three respectively. All of the soil samples had pH-H_2O less the critical level (6.5-8.5) given by (Landon, 1991). This low soil pH at the study sites could be attributed to the leaching into soil profiles even beyond sampling depth through leaching and drain to streams through runoff generated from accelerated erosion. This enhances the activity of Al^{3+} and H^+ in the soil solution, which reduces soil pH and thereby increases soil acidity. The depletion of basic cations in crop harvest, as indicated in their significant reduction, due to continues crop production is another cause for the fall in soil pH (Schumann and Glover, 1999; Nanthi and Mike, 2003). Furthermore, continuous use of ammonium based fertilizers such as diammonium phosphate, $(NH_4)_2HPO_4$, and urea in such cereal based cultivated fields, which upon oxidation by soil microbes produces strong inorganic acids. These strong acids in turn provide H^+ ions to the soil solution that in turn lower soil pH. Acidic nature of Nitisol was also reported by (Yihenew, 2002). Thus, it is pertinent to raise the soil pH through liming to increase crop productivity of the study areas. Generally, the pH values observed that soil pH was significantly affected by upper elevation as compared to lower elevation (Pradhan *et al*., 1996) difference and in the study area were within the ranges of strongly acidic to slightly acid soil reactions as indicated by (Landon, 1991; Tekalign, 1991; Tisdale *et al*., 1993).

Reported by (Mahler *et al*., 1988) the optimal values for pH_{H2O} in soils for legume crop, especially *Vicia faba L* production ranges from 5.7 to 7.2. Soils with a pH_{H2O} lower than 5.6 results in lower grain yields, while soya bean can service lower pH than 5.7. Therefore, Tiro-Afeta soil has thus a pH that is too low for optimal *Vicia faba L.* production. Dedo soil does reach optimal pH values either. It has a pH above the 5.6 border value of good production.

The soil OM content is highly affected by different elevation levels. These elevation variations resulted in highly significant differences (P <0.01) of OM content among the different elevation at both sites (Table 2). The highest value (4.49±0.03) and the lowest value (3.12±0.11) of OM contents were recorded in farm field Dedo location 3 and location 1, respectively, while the highest value (2.61±0.11) and the lowest value (1.12±0.55) of OM contents were recorded in farm field of Tiro-Afeta location 3 and location 1, respectively. The highest OM content was recorded on the lower elevation of Dedo location three and the highest OM contents was recorded on the lower elevation of Tiro afeta location three as shown (table 3) were signed (P <0.05) different at different elevations. In the higher elevation, relatively low soil OM, as compare to both middle and lower elevation of farm land in both sites. In line with the present findings, earlier results suggested that the low accumulation of OM in farmland soils could be due to, the reduction in total organic inputs (litter and crop residues); increased mineralization rates of organic matter caused by tillage and increased wetting-and-drying cycles and the loss by soil erosion (Gregorich *et al*., 1998; Chroth *et al*., 2003). Generally, the OM values observed in the study area are within the ranges of low to medium and/moderate as indicated by (Berhanu, 1980andTekalign, 1991).

Soil OC is highly affected by different management practices continues cereal-cereal cropping system and variation in elevation at different locations, (Table 2). Organic carbon varied significantly (P<0.01) across locations. Organic carbon was recorded of higher value (2.61±0.02) and lowest value (1.81±0.06) for Dedo soils location 3 & 1 respectively. Similarly, the highest value (1.51±0.06) and the OC lowest value (0.65±0.32) were recorded on location 3 and location 1 respectively, of Tiro-Afeta districts.

Organic carbon ranged from 0.65% at Tiro-Afeta location o1 to 2.61% at Dedo location 3 (Table 2). According to (Sanchez *et al*., 1982; Landon, 1991), all of the sampled soils had organic carbon greater than the critical level (0.5-1%) except Tiro afeta location one. High organic carbon than the critical, in Nitisol was also reported by (Mesfin, 1998; Eylachew, 1999; Wakene and Heluf, 2001; Shimeles *et al.,* 2006).

With increasing elevation the organic carbon content were decreased and the organic carbon status of the soils in lower elevations were higher because of transportation bases and top part of soil particles from upper elevation to lower elevation.OC values for Dedo location 1 and Tiro-Afeta location 3 soil are in the range of values found by (Agegnehu and Fessehaie, 2006), for Nitisols in Ethiopia (1.5-1.8% C). OC values for Dedo location two and three were higher than (Agegnehu and Fessehaie, 2006), but location 3, OC content was lower than values found by (Amanuel *et al*., 2000) for Nitisols in the southeastern Ethiopian highlands (3.0% C). The value of OC at Tiro-Afeta location 1 and 2 were lower than the value found by (Agegnehu and Fessehaie, 2006). The TC values observed in the study area are within the ranges of low to medium and/moderate as indicated by (Tekalign, 1991).

Table 2:SD± and Mean comparison of soil pH, TC, OM, TN and Av.P of Dedo and Tiro afeta districts before planting of grain legumes.

Location	pH (H_2O)	OC (%)	OM (%)	TN (%)	Av.P (mg P kg^{-1})
DL1	5.46±0.06^c	1.81±0.06^c	3.12±0.11^c	0.15±0.01^c	6.7±0.84^b
DL2	5.69±0.13^b	2.07±0.03^b	3.56±0.06^b	0.18±0.00^b	8.8±0.85^b
DL3	6.22±0.15^a	2.61±0.02^a	4.49±0.03^a	0.22±0.01^a	12.2±0.85^a
P Value	**	**	**	**	*
LSD (0.05)	0.14	0.11	0.19	0.01	2.21
CV (%)	1.07	2.32	2.29	3.09	10.5
TaL1	5.46±0.11^c	0.65±0.32^b	1.12±0.55^b	0.05±0.03^b	4.3±0.36^c
TaL2	5.67±0.05^b	1.22±0.06^a	2.11±0.10^a	0.11±0.01^a	5.9±0.9^b
TaL3	5.91±0.04^a	1.51±0.06^a	2.61±0.11^a	0.13±0.01^a	8.9±0.64^a
P Value	**	**	**	**	**
LSD (0.05)	0.15	0.35	0.59	0.03	1.46
CV (%)	1.182	13.6	13.56	15.43	10.07

**=highly significant (0.01); *= significant (0.05), ns =non-significant. Means in a column show different letters are highly significantly different (p<0.05) and similar letters show non-significant by LSD Test. OC= Organic carbon; OM= Organic matter; TN= Total nitrogen; Av.P= Available phosphorus; DL= Dedo location; TaL= Tiro afeta location; LSD= Lattice square design and CV= Coefficient variability.

The total N content of soils was signed (P ≤ 0.01) different at both Dedo and Tiro afeta location affected by different elevation level as shown (Table 3). The average values of total N were highest at location 3, while the lowest value was recorded on location 1 in the Dedo location 3 & location 1 respectively. The highest value (0.13±0.01) and the lowest value (0.05±0.03) recorded under the Tiro-Afeta location 3 & location 1 respectively (Table 3). Total nitrogen ranged from 0.05% at Tiro-Afeta location one to 0.22% at Dedo location three. Based on the classification of (Landon, 1991; Sanchez *et al*, 1982), total nitrogen was found as one of the limited plant nutrient in the study sites. The values of total nitrogen in all soil samples were below the critical level (<1%). The observed nitrogen deficiency in all soil samples could be because of low input of plant residues, nitrogen rich organic materials like manure and compost in cereal based farming systems. As the area receives high rainfall, the nitrogen leaching problem can be another reason for the decline of total nitrogen in crop fields. Moreover, farmers of the study area do not integrate leguminous plants on their farmlands. Shimeles *et al.* (2006), similar nitrogen contents in the cultivated Nitisol was reported.

Total nitrogen was almost doubled for Dedo compared to Tiro-Afeta. TN values for Dedo soil were in the range of values found by (Agegnehu and Fessehaie, 2006), for Nitisols in Ethiopia (0.17-0.22% N) and the value of TN to Tiro-Afeta were low. TN values for Dedo and Tiro-Afetaare lower compared to values found by (Emmanuel *et al.,* 2000) for Nitisols in the southeastern Ethiopian highlands (0.25% N). The TN values observed in the study area are within the ranges of Low to Medium and/high (0.10-0.25) as indicated by (Tekalign 1991).

Plant available phosphorus, as determined by the Bray method (Bray and Kurtz, 1945) in the Tiro-Afeta soil is relatively low compared to Dedo soil. The available phosphorus was significantly ($P \leq 0.01$) different at different elevations (Tables 3). The content of available P in the Dedo and Tiroafeta at the lower elevation level of farm land appeared to be significantly higher than the rest upper two elevation level. Accordingly, the highest (12.2±0.85 mg P kg^{-1}) and the lowest (6.7±0.84 mg P kg-1) available P contents were observed under the Dedo location 3 and location 1, respectively, and the highest value (8.9±0.64 mg P kg^{-1}) and the lowest (4.3±0.36 mg P kg^{-1}) available P contents were recorded under the Tiro-Afeta location 3 and location 1, respectively as shown (Table 3).

Available phosphorous ranged from 4.3 mg P kg^{-1} at Tiro-Afeta location 1 to 12.2 mg P kg^{-1} at Dedo location 3 (Table 3). From the soil samples, except Dedo location 3 all available phosphorous below the critical level (10-15 mg P kg^{-1}) given by (Landon, 1991; Sanchez *et al*., 1982). The low level of available phosphorous in the study area might be due to its fixation by Al and Fe, as their presence is expected at the pH values of the soils of the study areas (Tisdale *et al*., 1993). High phosphorous sorption capacity of Nitisols was also reported by (WRB, 2006). The reason for higher P contents at lower elevation might be due to attributed to higher soil organic matter, content, the nutrient availability, improved through recycling of the biomass back into the soil and high OM decomposition that enhance the amount of available P in the soil at the lower elevation level.

According to (Cook, 1967; Cottenie, 1980; Landon, 1991) available soil P level of < 5 mg P kg^{-1} is rated as very low, 5-9 mg P kg^{-1} as low and 10-17 mg P kg^{-1} as medium, 18-25 mg P kg^{-1} as high and >25 mg P kg^{-1} is rated as very high. Thus, the available P of the soils of the study area, with the exception of the higher elevation of Tiro-Afeta and lower elevation Dedo sits of farmland, was between 5-9 mg P kg^{-1} qualifying for the low ranges and Dedo location 3 was qualifying for moderate level, were Tiro-Afeta location 1 qualify for the very low ranges (Table 3). Also results from the soil analysis for plant available P in Dedo and Tiro afeta upper and middle elevation are in the range of the values (5.0 to 10.1 mg P kg^{-1} soil) found for Nitisols in the Ethiopian highlands (Agegnehu and Fessehaie, 2006) but lower elevation were higher in the ranges of (10.0 to 17.0 mg p kg^{-1}) under Dedo sites.

In general, soils with a pH less than 5.5 (as is the case for both Dedolocations 1 and Tiro-Afeta location 1) in the higher elevation, are deficient in available P content because of complexation and the fixation of cations by adsorbing surfaces in the soil. Due to P complexation and slow release of P fertilizers, the proportion of the P available for plants becomes inadequate (Leon and Le Mare, 1990; Marschner, 1995; Agegnehu and Sommer, 2000).

Effects of Vicia faba L. and Glycine max L. on chemical characteristics of soil

The pH_{H2O} of Dedo and Tiro-Afeta soil after plant growth in the pot experiment showed significant ($p<0.01$) differences. There was a decline in pH for all treatments relative to the initial soil pH (Table 3) under faba bean grown. The highest value of pH was recorded under Dedo lower elevation (6.18±0.14) and the lowest value of pH was under Dedo location 1 (5.4±0.05) pH value of faba bean grown. The faba bean grown under Tiro-Afeta soils at each treatment were significantly affected ($P<0.01$). The highest value of pH was recorded under location 3 (5.8±0.06), while the lowest value (5.4±0.12) was recorded under location 1 Tiro-Afeta as shown (Table 3).

Generally, as shown *Vicia faba L.* (Table 3) grown soil pH was decreased under all locations, props, legumes remove more calcium and magnesium (replaced with hydrogen) than some cereal crops. Removing the basic cations decreases OH^- ions and increases H^+ thus lowering the pH. Thus, net efflux of H^+ into the rhizosphere occurs, resulting in decreases in pH and eventually in bulk soil pH. This has been demonstrated in a number of studies (e.g. Red clover, Mengel and Steffens 1982; white clover, Lucerne, faba bean and soybean, in Haynes, 1983; pasture legumes, Tang *et al*., 1997). Legume species differ greatly in their ability to acidify the rhizosphere and external media. A net excretion of protons from roots per unit biomass has been reported to range up to an order of magnitude across different species (Jarvis and Hatch, 1985; Liu *et al*., 1989; McLay *et al.*, 1997; Tang *et al*., 1997a; 1997b). As reported (Raven, 1993), the acid generated by N_2-fixing legumes varies from 0.2 to 1 Mol H^+ per Mol N fixed.

But in this investigation all legume crop residues were removed from the soil and transported to analysis of N and P in the laboratory, these might be another reason for the decrease of pH value in the soil after harvests *Vicia faba L.* crops. The magnitude of the pH changes varied with type and rate of plant materials added and was positively correlated with the amount of excess cations added via plant materials to the soils. This is supported by other studies in which the degree of pH increase of an acidic soil with organic matter addition was well correlated with the amount of basic cations (Pocknee and Sumner, 1997). In contrast the application of legume shoots, roots and leaves into soils significantly increased soil pH (Tang *et al*., 1997c).

The form and amount of nitrogen in soil have a prominent influence of acid production of the plants. The uptake and assimilation of one mole of $NH4^+$ are associated with the excretion of 1.1-1.2 moles of H^+ (Raven, 1993). However, if all the legume residues were returned *in situ* to the soil and no N losses occurred, net acidification of the soil would be zero (Helyar, 1976) because of the de-acidifying process in the decomposition of plant materials (Mengel, 1994). It can be concluded that the application of legume residues, which usually have high ash alkalinity, is not in itself likely to cause soil acidification. By contrast, the return of legume residues to the soil may increase soil pH. The decarboxylation of organic anions appears to be a major cause of soil pH increases.

The concentration of N in the soils was significantly ($P<0.05$) different and increased after *Vicia faba L.* grew under Dedo soil, as compared to soil nutrient conditions before faba bean planting (Table 3). The highest value of N after harvest of *Vicia faba L.* was (0.23±0.01) recorded Dedo location 3 at lower elevation level increased by 4.5% as compared to initial soil N before planting (Table 4). The lowest value of N was recorded under Dedo location 1 (0.17±0.01) which increased by 13.3% as compared before planting N availability (Table 3). Similar results have been reported that legume crops have positive effects on nutrient status, especially on N and P status (Wang Z *et al*., 2008). For example, it has been reported that legume crops with the ability of symbiotic N_2 fixation in nodules could lead to significantly increase in the available soil N, and thus increased N availability for the cereal crops in the legume/cereal rotation system (Jeffries *et al*., 2003).

The concentration of N in the soil after *Vicia faba L.* grew under Tiro-Afeta was significantly different ($P<0.05$) among locations. The highest value N in the soil of Tiro-Afeta was recorded under location 3 (0.14±0.01) increased by 7.6% as compared to soil N before planting and the lowest value of N recorded under location 1 was (0.07±0.02) increased by 40% as compared to soil N before planting (Table 3). Thus, in these *Vicia faba L.* plants play an important role in increasing the N status in soils, which may be further increased the fertility of soils.

Generally, under both locations the amount of N added in to the soil after plants harvested were different. The high value of N was added at low N concentration in the soil before planting *Vicia faba L.* This might be related to the amount of N existed before planting in the soil, as soil relatively high amount of initial N affect N-fixation in the soil (high amount of mineral nitrogen in soil has slows of the effect on nodulation) (Dogan *et al*., 2010; Keerio *et al*., 2001) which used a sufficient amount of N for their growth.

The concentration of P in the soils was significantly ($P<0.05$) different after *Vicia faba L.* growth under both Dedo and Tiro-Afeta locations (Table 3). The highest value of available P was recorded under Dedo location 3 (12.6±0.4 mg p kg^{-1}), which resulted in increased of N by 9.01% after *Vicia faba L.* growth, while the lowest value of available P concentration was recorded under Dedo location 1 (6.9±0.8 mg p kg^{-1}) increased by 2.9% (Table 3). The highest value under Tiro-Afeta location 3 was recorded (9.28±0.3 mg p kg^{-1}) increased by 4.2%, similar effects have been reported as, (Kamh *et al*.,1999, Nuruzzaman *et al*.,2005) legumes can mobilize more P from poorly soluble P compared to non-legumes. The lowest value under location 1 recorded (4.3±0.3 mg p kg^{-1}) not increased compared to before planting were affected by low pH value soil was recorded at the initial pH value. The main limiting factors for crop growth, such as low pH, low cation exchange capacity and organic matter, which easily lead to nutrient deficiency and element toxicity, such as phosphorus (P) deficiency and aluminum (Al) toxicity, results in decreasing the amount P around the root area by P complexation (Zhang *et al*., 2009).

After *Vicia faba L.* grew under both transects at different location OC, where decreased as compared to its results before planting. This was might be due to crop residue removal (leaf and litter from the plant) and limited mineralization by microorganisms within a short period of time, therefore crops can only uptake existed carbon for their growth were decreased initial nutrient availability.

Table 3: Effects of *Vicia faba L.* in selected chemical characteristics of soils after harvest

Location	Parameters			
	pH $_{H2O}$	% N	Av. P	%OC
DL1	5.4±0.05[c]	0.17±0.01[c]	6.9±0.8[b]	1.6±0.01[c]
DL2	5.6±0.13[b]	0.19±0.01[b]	9.26±0.52[b]	1.8±0.06[b]
DL3	6.18±0.14[a]	0.23±0.01[a]	13.3±0.2[a]	2.2±0.01[a]
P value	**	**	**	**
LSD (0.05)	0.151	0.022	1.61	0.09
CV (%)	1.15	4.83	7.22	2.08
TaL1	5.4±0.12[c]	0.07±0.02[b]	4.3±0.36[c]	0.6±0.28[b]
TaL2	5.6±0.04[b]	0.12±0.01[a]	5.9±0.8[b]	1.09±0.02[a]
TaL3	5.8±0.06[a]	0.14±0.01[a]	9.28±0.3[a]	1.36±0.04[a]
P value	**	*	**	*
LSD (0.05)	0.16	0.03	1.49	0.37
CV (%)	1.32	13.58	10.11	16.25

**=highly significant (0.01); *= significant (0.05), ns =non-significant. Mean ± standard deviation of fababean grown soil chemical characteristics after pot experiments in Dedo and Tiroafeta where a %N= percentage of Nitrogen, Av. P= available Phosphorus (mg kg^{-1}) and OC= organic matter.

The pH$_{H2O}$ of Dedo and Tiro afeta soil after *Glycine max L.* growth in the pot experiment showed a significant ($p<0.05$) difference and their way decrease of pH for all locations relative to the initial soil pH (Table 5 and Appendix table 1), for Dedo district the highest value of soybean grown of pH was recorded under lower elevation (6.18±0.14) at location 3, while the lowest value of pH was under location 1 (5.44±0.04). The highest and lowest value of pH (5.86±0.05 and 5.44±0.11) of *Glycine max L.* grown soil under Tiro-Afeta located three and one respectively (Table 4).

The concentration of N in the soils *Glycine max L.* grown pots were signed (P<0.05) different and increased after harvested under both Dedo and Tiro-Afeta soil (Table 4). The highest value of the N after *Glycine max L.* harvested by was (0.23±0.01) under Dedo location 3. It was increased by 4.5% as compared to initial soil N before planting (Table 5). The lowest value of N was recorded under Dedo location 1 (0.16±0.01), which increased by 6.6% as compared before planting N availability as shown (Table 4). The highest value N in the soil was recorded under Tiro-Afeta location three (0.14±0.01) increased by 7.6% as compared to soil N before planting and the lowest value of N recorded under location one was (0.07±0.02) increased by 40% as compared to soil N before planting (Table 5). As reported (Wang *et al*., 2008) *Glycine max L.* crops have positive effects on soil nitrogen. It has higher nodulation and symbiotic N_2 fixation potential, and in turn could significantly increase in the available soil N, and thus increased N availability for the cereal crops in the legume/cereal rotation system (Jeffries *et al*., 2003).

Table 4: Effects of *Glycine max L.* in selected chemical characteristics of soils after harvest

Location	Parameters			
	pH $_{H2O}$	% N	Av. P	OC
DL1	5.44±0.04[c]	0.16±0.01[c]	6.84±0.8[b]	1.6±0.02[c]
DL2	5.64±0.12[b]	0.19±0.00[b]	8.89±0.8[b]	1.8±0.06[b]
DL3	6.18±0.14[a]	0.23±0.01[a]	12.66±0.4[a]	2.2±0.01[a]
P value	**	**	**	**
LSD (0.05)	0.13	0.013	2.2	0.09
CV (%)	1.02	2.9	9.3	2.2
TaL1	5.44±0.11[c]	0.07±0.02[b]	4.7±0.9[b]	0.5±0.3[b]
TaL2	5.63±0.03[b]	0.12±0.01[a]	6.01±0.9[b]	1.09±0.01[a]
TaL3	5.86±0.05[a]	0.14±0.01[a]	10.06±0.3[a]	1.3±0.05[a]
P value	**	**	**	*
LSD (0.05)	0.163	0.03	2.05	0.35
CV (%)	1.27	11.31	13.06	16.06

**=highly significant (0.01); *= significant (0.05), ns =non-significant. Mean ± standard deviation of soybean grown soil chemical characteristics after pot experiments in Dedo and Tiroafeta where a %N= percentage of Nitrogen, Av. P= available Phosphorus (mg kg^{-1}) and OC= organic matter.

The concentration of P in the soils was significantly ($P<0.05$) different under both Dedo and Tiro-Afeta locations, P increased after soybean growth, however Dedo location 1 and 2 were not significantly different as Tiro-Afeta located 1 and 2 (Table 4. The highest value of available P under Dedo location 3 (12.25±0.8 mg p kg^{-}

^{1}) increased by 3.77% after *Glycine max L.* growth and the lowest value of available P concentration under Dedo location 1 (6.84±0.8 mg p kg^{-1}) increased by 2.1% (Table 5). The highest value under Tiro-Afeta location 3 was recorded (9.66±0.29 mg p kg^{-1}) increased by 13.03%, similar effects have been reported as, (Kamh *et al.* 1999; Nuruzzaman *et al.,* 2005; Hassan *et al*., 2012) legumes can mobilize more P from poorly soluble P compared to non-legumes and the lowest value under Tiro-Afeta location 1 recorded (4.7±0.9 mg p kg^{-1}) increased by 9.3% compared to before planting as shown (Table 5). Generally *Glycine max L.* grown under Tiro-Afeta soil was better to increase P from 9.3% to 13.03%than Dedo soil were 2.1% to 3.77% added during pot experiment under greenhouse conditions.

After *Glycine max L.*growth under both Dedo and Tiro afeta sites at different location OC where decreased as compared to its results before planting. As reported (Tarwali *et al.*, 1987; Abayomi *et al.*, 2001) and weed suppression (Versteeg *et al.*, 1998). Organic inputs from legumes could improve nutrient supply/availability and/or improved soil-water holding capacity. Moreover, legumes offer other benefits such as providing cover to reduce soil erosion, maintenance & improvement of soil physical properties, increasing soil organic matter, cation exchange capacity and microbial activity unlikely, these pot experiments was might have no added organic matter and limitation of mineralization by microorganisms within a short period of time and crops can only uptake existed carbon for their growth were decreased initial nutrient availability.

Contribution of N and P by Vicia faba L. and Glycine max L. biomass

The biological nitrogen fixation of the *Vicia faba L.* and *Glycine max L.* grown in Dedo and Tiro afeta was calculated with the nitrogen difference method. For nitrogen difference, the percentage of the total N in the aboveground biomass that was derived from atmospheric N fixation and the amount of N_2 fixed (kg N ha^{-1}) was calculated (Table 5).

Total Nitrogen concentration in the above ground biomass of *Vicia faba L.* for both Dedo and Tiro-Afeta locations were given in (Table 5). Total Nitrogen was significantly affected ($P \leq 0.05$) by elevation under Dedo and highly significantly ($P \leq 0.01$) different under Tiro-Afeta locations (Table 5). The highest value obtained (174.1±7.12 kg N ha^{-1}) from Dedo location 3 and the lowest value under Dedo recorded from location 1 (127.4±7.12 kg N ha^{-1}). An average of *Vicia faba L.* concentration under Tiro-Afeta (113.4±5.4 kg N ha^{-1}) at location 3 was highest value and (71.4±2.7 kg N ha^{-1}) was the lowest value at location one (Table 5).

When thus, entire (total) above ground biomass of *Vicia faba L.* is incorporated into the soil, an extra (127.4 to 174.1 kg N ha^{-1}) for Dedo and (71.4 to 113.4 kg N ha^{-1}) for Tiro-Afeta will be added to the soil and contribute to the building up of soil fertility in the districts. With the usual practice, only nodules and roots remain in the soil after harvest. When farmer's practice would be changed and above ground biomass are incorporated, the total N available for mineralization is then the sum of the N that was present in the nodules, roots and shoots. The results for N return to the soil (kg N ha^{-1}) are similar to the values found by (Nemecek, 2010) (125 to 168 kg N ha^{-1}), except for Tiro-Afeta.

The highest plant N was when *Glycine max L.* was supplied with Dedo location 3 (12.2 mg P kg^{-1}) as shown (Table 5). This increase may be due to supply of phosphorus that seems important for Rhizobium to fix relatively more nitrogen from the soil, which resulted in increased plant growth and N uptake by root and then to shoot. Phosphorus plays a vital role in physiological and developmental process in plant life and favorable effect of this important nutrient might have accelerated the growth process that increases N uptake in plants (Fatima *et al*., 2007).

Table 5: SD± and Mean comparison of TP, TN and ANF of *Vicia faba L.* and *Glycine max L.* plant for Dedo and Tiro afeta soil after pot experiment.

Location	*Vicia faba L.*			*Glycine max L*		
	TNP	ANF	P	TNP	ANF	P
DL1	127.4±7.12^{b}	129.6±7.3^{b}	19.2±2.1^{b}	75.6±7.1^{b}	77.3±7.6^{b}	17.6±2.6^{b}
DL2	141.4±7.12^{b}	142.6±8.3^{b}	22.03±1.1^{b}	91.3±12.5^{b}	92.6±12.6^{b}	20.5±1.5^{b}
DL3	174.1±7.12^{a}	175.3±7.1^{a}	28.7±1.6^{a}	148.8±7.1^{a}	150.3±7.7^{a}	28±1.8^{a}
P Value	**	**	**	**	**	*
LSD (0.05)	19.29	20.85	3.39	23.03	23.98	5.112
CV (%)	5.76	6.16	6.404	9.65	9.91	10.22
TaL1	71.4±2.7^{c}	73.3±0.5^{c}	12.3±0.8^{c}	97.5±7.3^{c}	99.6±5^{c}	12.5±0.8^{c}
TaL2	96.3±7.1^{b}	96.6±6.8^{b}	15.2±2.4^{b}	127±7.1^{b}	128.3±7.3^{b}	15.4±2.3^{b}
TaL3	113.4±5.4^{a}	114±5.1^{a}	22.3±0.7^{a}	139.4±7.1^{a}	140.6±6^{a}	22.5±0.9^{a}
P Value	**	**	**	**	**	**
LSD (0.05)	14.154	13.08	2.64	3.64	4.41	2.712
CV (%)	6.65	6.1	6.97	1.32	1.58	7.101

**=highly significant (0.01); *= significant (0.05), ns =non-significant. Given the above table as men± standard deviation, where, ANF= Amount of N fixed (kg N ha^{-1}), TNP= Total N in plant (kg N ha^{-1}) and P= Phosphorus in plant biomass (kg ha^{-1}) determined by the nitrogen difference method.

Total Nitrogen concentration in the aboveground biomass of *Glycine max L.* for both Dedo and Tiro-Afeta locations were given in (Table 5). Total nitrogen was significantly affected (P≤ 0.05) by elevation under both Dedo and Tiro-Afeta locations (Table 5). The highest value was obtained (148.8±7.1 kg N ha^{-1}) from Dedo location 3 and the lowest value under Dedo recorded from location 1 (75.6±7.1 kg N ha^{-1}) at Dedo district. An average of *Glycine max L* concentration under Tiro-Afeta (139.4±7.1 kg N ha^{-1}) at a location three was highest value and (97.5±7.3 kg N ha^{-1}) was the lowest value at location one (Table 5).

When entire (total) above ground biomass of *Glycine max L* is incorporated into the soil, an extra (75.6 to 148.8 kg N ha^{-1}) for Dedo and (97.5 to 139.4 kg N ha^{-1}) for Tiro-Afeta will be added to the soil and contribute to the building up of soil fertility in the region. Similarly, the highest N concentration was recorded location 3 (139.4±7.1), while the lowest was at location 1 at Tiro-Afeta district (Table 5). When farmer's practice would be changed and above ground biomass are incorporated, the total N available for mineralization is then the sum of the N that was present in the nodules, roots and shoots.

Values for amounts of N_2 fixed (kg N ha^{-1}) of *Vicia faba L.* were significantly different (P≤ 0.05) under both Dedo and Tiro-Afeta locations (Table 5). The highest value of N_2 fixed in the *Vicia faba L.* under Dedo location 3 (175.3±7.1 kg N ha^{-1}), while the lowest value obtained from location 1 (129.6±7.3) kg N ha^{-1}. The highest value of N_2 fixed in the *Vicia faba L.* (114±5.1) kg N ha^{-1} under Tiro-Afeta recorded location three and the lowest value obtained from location 1 (73.3±0.5) kg N ha^{-1} (Table 5).

Values for amounts of N_2 fixed at Dedo location 3 are generally comparable to the values found by (Amanuel *et al.,* 2000) for *Vicia faba L.* in Ethiopian Nitisols (169 to 210 kg N ha^{-1}) and similar found by (Amsalu *et al*., 2014) for *Vicia faba L.* SW Nitisols (137.1 to 177.7 kg N ha^{-1}).

Values for amounts of N_2 fixed of *Glycine max L* were significantly different (P≤ 0.05) under Dedo Tiro-Afeta locations (Table 5). The highest value of N_2 was fixed at Dedo location 3 (150.3±7.7 kg N ha^{-1}), while the lowest value was obtained from location 1 (77.3±7.6 kg N ha^{-1}). The highest value of N_2 fixed in the *Glycine max L* (140.6±6 kg N ha^{-1}) under Tiro afeta recorded location three and the lowest value obtained from location one (99.6±5) kg N ha^{-1} (Table 5).

An estimate of 26-188 kg N / ha in the tropics have been made while *Glycine max L* could fix 15-162 kg N / ha (Giller and Wilson, 1991; Larue *et al*., 1981). Based on the experimental site used, amount of N_2 fixed was in the range of 77.3 to 150.3 kg N / ha under Dedo and 99.6 to 140.6 kg N / ha under Tiro-Afeta in the *Glycine max L* studied. This is higher than the 41-50 kg N / ha reported by (Yusuf *et al*., 2006).

Phosphorus concentrations for *Vicia faba L.* grown in Dedo and Tiro-Afeta were significantly (P≤ 0.05) different (Table 5). The highest value of phosphorous in fababean above ground biomass under Dedo location three recorded (28.7±1.6) kg ha^{-1} and the lowest value recorded under location one (19.2±2.1) kg ha^{-1} in (Table 5). The average P content in the aboveground biomass of f *Vicia faba L.* grown in Dedo soil was similar to the values reported by (Jensen *et al.,* 2009). Phosphorus concentration of *Vicia faba L.* biomass under Tiro-Afeta location three were recorded (22.3±0.7) kg ha^{-1} and the lowest value recorded under location one (12.3±0.8) kg ha^{-1}. When compare concentration of phosphorous in *Vicia faba L.* biomass were recorded under Dedo was higher than Tiro afeta biomass phosphorous concentration. These might be related to the availability of phosphorous exists at Dedo soil results increases the biomass of *Vicia faba L.* which increases phosphorous content. Recent as reported that the highest p concentration recorded for higher biomass production of the fababean. from Dedo soil (Amsalu *et al*., 2014).

Phosphorus concentrations of *Glycine max L* grown in Dedo and Tiro-Afeta were signed (P≤ 0.05) different (Table 5). The highest value of P in soybean biomass under Dedo location 3 (28±1.8 kg ha^{-1}), while the lowest value was recorded on location 1 (17.6±2.6 kg ha^{-1}) as shown (Table 5). *Glycine max L* grown under Tiro-Afeta location 3 recorded the highest value (22.5±0.9) kg ha^{-1}, while the lowest value was recorded location 1 (12.5±0.8) at kg ha^{-1}. A P efficient legume in cropping systems is emerging as an alternative and/or complementary strategy to the mineral fertilizers for sustainable agricultural intensification of low input cropping systems. A complementary strategy to increase soil fertility is the inclusion of P efficient (efficient at producing biomass yield under limited available P conditions, (Wanga *et al*., 2010) grain legumes as bio-fertilizers in traditional cropping systems (Belane and Dakora, 2010), e.g. by growing them in rotation with cereals.

The highest P (28 kg ha^{-1}) was accumulated when soybean was supplied with (12.2 mg P kg^{-1}) in the soil while the minimum of (12.5 kg ha^{-1}) was accumulated in the soil (4.2 mg P kg^{-1}). Supplying *Glycine max L* with 12.2 mg P kg^{-1} resulted in an increased in P concentration due to supply of nutrients and well developed root system resulting in better absorption of water and nutrient. Increase P concentration in the plant is favorable to nodulation and biological nitrogen fixation in legumes.

Plant height, Number of nodule and Nitrogen derived from the atmosphere

ANOVA indicated significant difference (P<0.05), of plant height due to effects of *Vicia faba L* and *Glycine max L* under both Dedo and Tiro-Afeta sites at different locations of plant height at 75 % flowering stages (Table 6). The increase in plant height was only because of location differences was supported by the fact that crops differ with respect to absorption of available nutrients, nitrogen fixation and accumulation of other relevant nutrients (Chabot *et al.,* 1996).The highest height of *Vicia faba L* was recorded under Dedo location 3 (77.3±2.4), while the lowest height under Dedo was recorded location 3 (66.1± 4.6) (Table 6). The highest height of *Vicia faba L* was recorded under Tiro-Afeta location 3 (66.7±2.1) and the lowest height under Tiro afeta location 1 (60.6±4.4) as shown above (Table 6). When compared to the height of *Vicia faba L* under Dedo sites were higher than to Tiro-Afeta sites at all locations because of their general symbiotic competence, greater available phosphorus in the soil which resulted in a reasonable plant height growth.

Though not significant (P≤ 0.05) difference in plant height at same location, especially in Dedo location 1 and 2 also, at Tiro-Afeta location 1 and 2 (Table 6). Due to availability of nitrogen and other nutrients (Hulugelle *et al*., 1986; Crasky *et al*., 1998; Sanginga *et al*., 1996) and absorption of nutrients. The highest height of *Glycine max L* was recorded under Dedo location 3 (40.5±0.8), while the lowest height under Dedo was recorded location 1 (33.8±2.5) as shown above (Table 6). The highest height of *Glycine max L* was recorded under Tiro-Afeta location 3 (38.6± 0.7) and the lowest height under Tiro-Afeta location 1 (30.7±2.1).

The highest number of nodules *Vicia faba L* plant (87.0±5.6) was obtained from Dedo location 3. Whereas the lowest number of nodules per plant (64.5±1.3) were obtained from Dedo location 1 (Table 6). Nodules of Dedo mostly situated near the top (crown) of their roots, with a dominating deep dark red color inside. This confirms beneficial characteristics for nodulation initiation in Dedo soil and a high potential N_2 fixation efficiency of the nodules (Amanuel *et al*., 2000; Habtemichial *et al*., 2007; Lindstrom and Mousavi, 2010).

The results obtained at Tiro-Afeta showed that, there is a highly significant difference (P≤ 0.05) in number of nodules for *Vicia faba L* (Table 6). The highest number of *Vicia faba L* nodules obtained from location 3 (35.1±5.0), while the lowest number of nodules obtained from location 1 (13.8±3.4). Higher number nodules per plant was observed on *Vicia faba L* grown in Dedo than were *Glycine max L* grown Tiro afeta soil.

Results from nodule assessment *Glycine max L* showed significances (P≤ 0.05) difference (Table 6). The highest number of *Glycine max L* nodules per plant (26.6±6.04) under Dedo location 3, where the lowest number of nodules recorded at Dedo location 1 (9±1.32). *Glycine max L* under Tiro-Afeta highest number of nodules were recorded location three (14.5± 1.3), while the lowest number of nodules recorded location 1 (8±2.17). (Singleton *et al*., 1984) reported that, in addition to the nodule formation, deficiency of phosphorus in legume also markedly affects the development of effective nodules and the nodule leghaemoglobin content. It therefore suggests that the presence of sufficient phosphorus in soils as in the soils of experimental field may be beneficial to nodule formation and nitrogen fixation through the prevention of the phosphorus concentration in the plants at the later growth stage. The highest nodule number was obtained from higher phosphorus existed soil as compared to the lower phosphorus existed soil. Nodule number increases with increasing phosphorus in the soil.

Table 6: Mean comparison of plant height, number of nodule and nitrogen derived from the atmosphere for Dedo and Tiro-Afeta under pot experiment.

Location	*Vicia faba L*			*Glycine max L*		
	P.ht	NN	Ndfa	P.ht	NN	Ndfa
DL1	66.1± 4.6^{b}	64.5±1.3^{b}	92.9±0.3^{a}	33.8±2.5^{b}	9±1.32^{b}	88±1.2^{a}
DL2	69.8±6.3^{b}	67.1±2.0^{b}	91.03±0.4^{ab}	36.3±2.6^{b}	10.3±0.57^{b}	86.6±1.7^{a}
DL3	77.3±2.4^{a}	87.0±5.6^{a}	89.2±1.8^{b}	40.5±0.8^{a}	26.6± 6.04^{a}	88.5±0.5^{a}
P Value	**	**	ns	*	**	ns
LSD (0.05)	4.84	5.45	2.85	3.49	7.921	3.303
CV (%)	3.004	3.29	1.37	4.174	22.78	1.66
TaL1	60.6±4.4^{c}	13.8±3.4^{c}	96.4±1.1^{a}	30.7±2.1^{b}	8±2.17^{b}	98.2±1.3^{a}
TaL2	63.6±3.5^{b}	19.6±2.1^{b}	92.3±1.4^{b}	33.6±1.8^{b}	11.2±0.7^{ab}	93.9±1.1^{b}
TaL3	66.7±2.1^{a}	35.1±5.0^{a}	90.3±0.5^{b}	38.6± 0.7^{a}	14.5± 1.3^{a}	91.1±0.4^{c}
P Value	**	**	**	*	*	**
LSD (0.05)	2.91	4.88	2.77	3.83	3.54	2.64
CV (%)	2.01	9.42	1.31	4.913	13.93	1.23

**=highly significant (0.01); *= significant (0.05), ns =non-significant. Plant height= P.ht (cm), number of nodules= NN and %Ndfa= %N derived from atmosphere (mean ± standard deviation) per plant for two crops (*Vicia faba L.* and *Glycine max L.*).

The nitrogen derived from the atmosphere of *Vicia faba L* statistically no significant (P≤ 0.05) different under all Dedo locations, but was significantly different under Tiro-Afeta locations (Table 6). The highest value of nitrogen derived from the atmosphere of faba bean under Dedo location 1 (92.9±0.3), while the lowest value was recorded Dedo location 3 (89.2±1.8) as shown (Table 6).

The highest value of nitrogen derived from the atmosphere of *Vicia faba L* under Tiro-Afeta location 1 (96.4±1.1), while the lowest value was recorded at Tiro-Afeta location 3 (90.3±0.5) as shown (Table 6). These under both Dedo and Tiro-Afeta result shows highest recorded nitrogen derived from the atmosphere under lower initial nitrogen existed in the soil because Soils with a higher N content, generally result in less N_2 fixation by the legume (Jensen *et al.*, 2009).

Among the family of the Leguminosae (Fabaceae), *Vicia faba L* is one of the best N_2 fixers (Amanuel *et al.*, 2000; Jensen *et al.*, 2009). Similarly, another report indicated that up to 96% of the N taken up by the *Vicia faba L* was derived from the atmosphere (Lopez-Bellido *et al.*, 2006).

The nitrogen derived from the atmosphere by *Glycine max L.* was no significant (P≤ 0.05) different under three Dedo locations, but was highly significantly (P≤ 0.01) differences noted at Tiro-Afeta locations (Table 6). The highest value of nitrogen was derived from the atmosphere by *Glycine max L.* under Dedo location 1 (88±1.2), while the lowest value recorded Dedo location 2 (86.6±1.7). The highest value of nitrogen was derived from the atmosphere of *Glycine max L.* under Tiro afeta location 1 (98.2±1.3), while the lowest value recorded Tiro-Afeta location 3 (91.1±0.4). These under Dedo (86.6% to 88%) and Tiro-Afeta (91.1% to 98.2%) result shows highest recorded nitrogen derived from the atmosphere under lower initial nitrogen existed in the soil. Also, as reported by (Solomon *et al.*, 2012) most grain legumes, including *Glycine max L.* can obtain between 50 and 80 % of their nitrogen requirements through biological fixation, but some, like *Vicia faba L* will fix up to 90 %.

Conclusion

Our results showed that a significant effect of variation in Dedo and Tiro-Afeta location on establishment of grain legumes such as *Vicia faba L.* and *Glycine max L.* for soil fertility improvement. The suitability of Dedo soil for *Vicia faba L.* growth, as expected from its physicochemical characteristics, was confirmed by the performance fababean under Dedo locations soils in a screen house experiment.

The value of pH after *Vicia faba L.* and *Glycine max L.* were grown at both Dedo and Tiro-Afeta locations decreased when compared against the from initial pH value. This has mainly been attributed to the large uptake of cations over anions by legume roots during N_2 fixation. The return of legume residues to the soil is unlikely to cause soil acidification.

The concentration of N and P value after *Vicia faba L.* grown at Dedo and Tiro-Afetalocation, soil increased as compared against initial value except Tiro-Afeta location 1. Also the concentration of N and P value after *Glycine max L.* grown at Dedo and Tiro-Afeta location, soil increased as compared to from the initial value.

Acknowledgments. The authors would like to thank transport and financial support from VLIR-UOS in the framework of an Inter University Cooperation program with Jimma University, Ethiopia. Mr Bayu Dume is duly acknowledged for analytical soil laboratory and Mr. Mekonnen Begna is also duly acknowledged for kindly assisting in sample collection in the field and screen house.

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