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Original Research Article

Evaluation of Nutrient Content of Selected Legumes for Green Manure Sources at Mechara Agricultural Research Center On-station, Western Hararghe, Ethiopia

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Abstract

The experiment was conducted in 2014 cropping season in Daro Labu district at Mechara Agricultural Research Center on-station to evaluate the nutrient content of selected green manure sources that improves soil fertility as agricultural input. During 2014 cropping season, leguminous green manure seed stylose, vetch, lablab, and cowpea were sown on a seed bed. At flowering stage, these green manure sources were cut and chopped and then incorporated to the soil and also *Erythrina abyssinica* were incorporated by cutting his leaf. After decomposition of the incorporated green manures 1kg of soil samples were taken and analyzed for the parameters of pH, EC, available P, texture, CEC, total N, available K, organic carbon, moisture content following standard laboratory procedures. Thus, the analyzed result of green manure shows that; only incorporated vetch and sample taken under root of lablab was better than the check for total N%. Only incorporated vetch shows better result than check for available P. High available potassium was recorded from incorporated Stylose, *Erythrina abyssinica*, cowpea, lablab, and vetch under roots. Thus, the analyzed result of nutrient content of green manure like incorporated vetch, stylose, *Erythrina abyssinica*, cowpea, lablab and under root of lablab and vetch could be integrated with other nutrient management.

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Green manure
Nutrient content
Under root

Introduction

Organic inputs alone will not meet the nutritional needs of crops because they contain a comparatively less quantity of nutrients compared to inorganic fertilizers, the need to integrate the two forms in order to achieve better crop yields. The interaction between organic matter and inorganic fertilizers may lead to either an increase or decrease in nutrients in soil depending on the nutrient and plant material in question (Frankenberger et al., 1985). Low use efficiencies of inorganic fertilizers coupled with their rising costs and the need for organically produced foods has directed the attention of farmers towards organic sources.

Organic manures may increase soil fertility and thus the crop production potential possibly by changes in soils physical and chemical properties including nutrient bioavailability, soil structure, water holding capacity, cation exchange capacity, soil pH, microbial community and activity, etc (Marschner, 1986; Walker et al., 2004; Clemente and Bernal, 2006; Agbede et al., 2008, Muhammad and Khattak, 2009). Soil pH is greatly influenced by addition of organic matter (OM) through different organic amendments and change in pH varies with the nature of OM (Walker et al., 2004).

Some organic materials can increase crop yields due to improved soil through nutrient release during decomposition and mineralization. They may also improve soil physical properties such as moisture retention, bulk density and aeration (Frankenberger et al., 1985). In addition, they generally have greater residual effect on subsequent crops than inorganic nutrient sources due to slow release of their nutrients over time (Szott and Kass, 1993).

Organic fertilization is also important for providing plant with their nutritional requirements without having an undesirable impact on the environment (Njoroge and Manu, 1999). Addition of different sources of organic manures increases the plant growth characteristics namely plant height, number of leaves and shoots per plant, fresh and dry weight of shoots of plants (Nandekar and Swarkar, 1990; Said, 1997). Improved and new production technologies would help increase productivity probably in harmony with the natural ecosystem for a certain extent or for a given period of time, but not effectively everlasting in most cases. They disturb the whole environment or the ecological balance and adversely affect the biodiversity or species composition of the ecosystem. So, think of eco-friendly improved agricultural technologies, which may not disturb or adversely affect, but rather maintain or improve the natural balance of the environment such as preparing compost and use of Green manures were better.

Green manure is a practice of plugging or turning into the soil undecomposed green plant tissues for improving physical structure as well as soil fertility. The green-manure crop supplies organic matter as well as additional nitrogen, particularly if it is a legume crop, due to its ability to fix nitrogen from the air with the help of its root nodule bacteria. The green-manure crops also exercise a protective action against erosion and leaching. Green manure to be incorporated in soil before flowering stage because they are grown for their green leafy material, which is high in nutrients and protects the soil.

This study was, therefore, conducted at Mechara on-station in order to help farmers to understand an environmental friendly fertilizer use and raise their perceptions on increasing soil fertility and yield through using green manures organic fertilizers. Thus this activity was initiated with the objectives of evaluating nutrient content of different Green manure.

Materials and methods

Description of the study area

The field experiment was conducted in Western Hararghe zone of Oromia Regional State, in Daro Labu district, Ethiopia. It is located 434 km to the east of Addis Ababa and 115 km from Chiro (Zonal Capital) to the south on a gravel road that connects to Arsi and Bale Zones. Its latitudinal and longitudinal positions are 40°19.114 North and 08°35.589 East respectively. The area has bimodal type of rain fall distribution with annual rainfall ranging from 900-1300mm (average annual rainfall of 1094mm) and ambient temperature of the district varies from 14 to 26^{o}C with an average of 20^{o}C (Climate data obtained from Mechara Metrological Station, 2009-2014).

The nature of rain fall is very erratic and unpredictable causing tremendous erosion. The major soil type of the area is sandy loam clay which is reddish in color (Report on farming system of Daro Labu and Boke districts, Mechara Agricultural Research Center, unpublished data). The altitude range for Daro Labu is 1350 to 2450 m.a.s.l with area coverage of 434,280ha and the predominant production system in the district is mixed crop-livestock production with peculiar sub-systems. The crops grown in the area ranges from small cereals such as Teff to tree and fruit crops including coffee, mango and avocado.

Selected legumes

Leguminous green manures seeds like stylose, vetch, lablab, and cowpea were sown on a plot size of 2m×2m at Mechara on-station during 2014 cropping season. At 50% flowering stage, all leguminous were cut and incorporated to the soil. But *Erythrina abyssinica* was cut and carry from around the plot and incorporated to the soil at the same time. Then, after decomposition, the soil samples were taken from the incorporated areas and also from the plots which was not incorporated but fix by their roots and analyzed for the parameters of PH, Available P, Texture, CEC, Total N%, available K, OC and C:N ratio.

Standard laboratory procedures for nutrient analysis

pH: in water suspension with soil to water ratio 1:2.5 by pH mater.

EC: in water suspension with soil to water ratio 1:2.5 by electro conductivity meter.

Available P: by Olsen method.

Texture: by hydrometer.

CEC: Cation Exchangeable Capacity by ammonium acetate (1M NH4AC) method.

TN: Kjeldhal method.

Available K: by Morgans Extraction method.

OC: Walkley-Black method was used in soil laboratory.

Results

The analyzed result of soil shows that; only incorporated vetch and under root of lablab was better than the check (without incorporation and fixed) for total N%. Also only incorporated vetch shows better result than check for available P. and high available potassium was recorded from incorporated stylose, incorporated *Erythrina abyssinica*, cowpea, lablab and vetch under roots.

Total nitrogen (TN)

The total nitrogen content was not raised when we compared the total nitrogen in a green manure with TN without green manure application from this study (Fig. 1). However, According to Bruce and Rayment (1982) cited, the range of percent of total nitrogen present in all incorporated and all under root of green manure except under root of vetch contains between 0.15-0.25% which is described as a medium total nitrogen content in a soil.

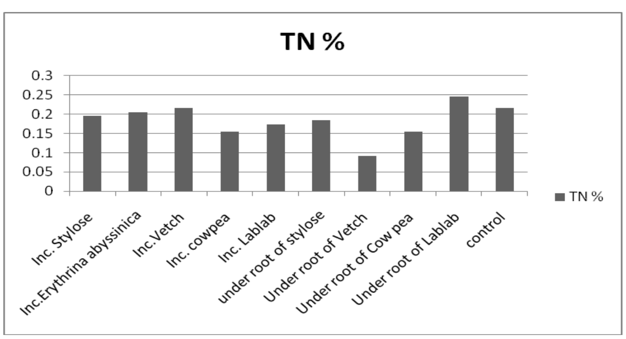

Fig. 1: Total nitrogen content of different green manure source. **N.B.:-** "Inc" Means incorporated, under root: legumes which fix by their root.

Available phosphorus (Av.P)

The soil pH affects the availability of various nutrients, toxic elements and chemical species to plant roots. The pH is therefore a very good guide to some expected nutrient deficiencies and toxic effects (Brady, 1984; McKenzie et al., 2004).

Phosphorus is in various forms in the soil, only some of which are actually available to plants. The form and availability of soil phosphorus (P) is highly pH dependent. The pH level of the study area is observed as strongly acid to moderately acid. Based on the Fig. 2, the availability of phosphorus was limited due to the pH level of the study area which ranges from strongly to medium acid (Figs. 3 and 4).

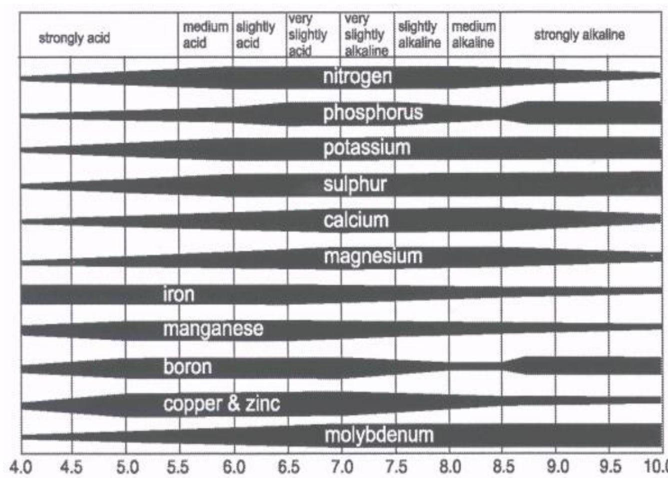

Fig. 2: Effect of soil pH on nutrient availability (**Source:** www.css.wsu.edu/.../Chart-of-the-Effect-of-Soil-pH-on-Nutrient-Availability-...).

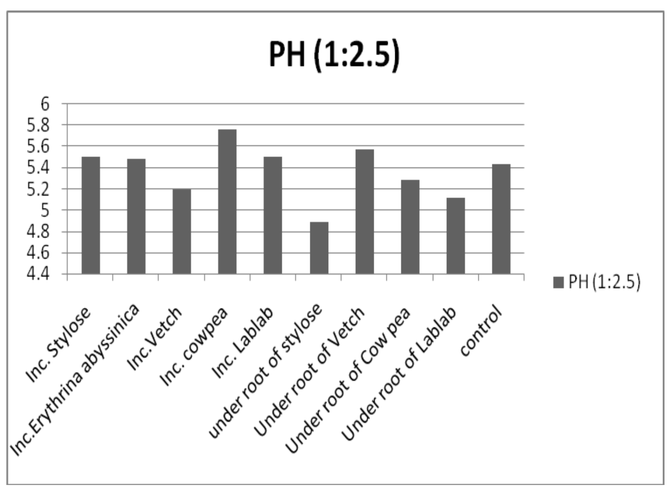

Fig. 3: PH level of soil. **N.B:** "Inc" Means incorporated, under root: legumes which fix by their root.

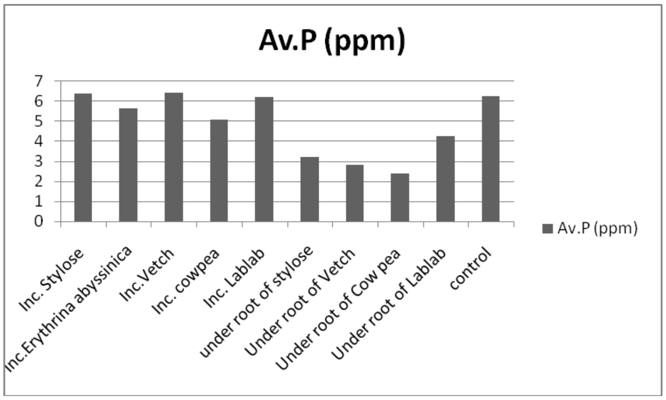

Fig. 4: Total phosphorous content of different green manure source. **N.B.:-** "Inc" Means incorporated, under root: legumes which fix by their root.

Available potassium (Av.K)

Even if the soil of the study areas is acid, available potassium is relatively very high in incorporated stylose, *Erythrina abyssinica*, cowpea and lablab and also under root of vetch as compared with incorporated vetch, under root of stylose, cowpea and lablab and also without manure application. The availability of potassium is highly affected on a pH level of less than 5.5 (Fig. 5). Therefore this study verifies that available potassium is limited on pH level of less than 5.5.

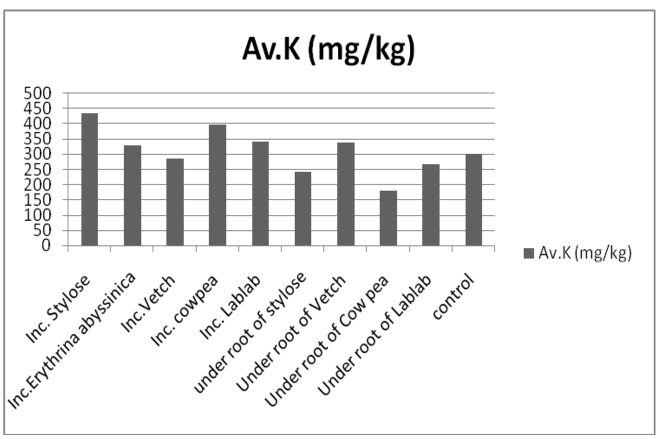

Fig. 5: Total Potassium content of different green manure source. **N.B.:-** "Inc" Means incorporated, under root: legumes which fix by their root.

Organic carbon (OC)

Organic matter is the material in soil that is directly derived from plants and animals, and it supports most important microfauna and microflora in the soil. The organic carbon content of different green manure sources are given in Fig. 6. Through its breakdown and interaction with other soil constituents, it is largely responsible for much of the physical and chemical fertility of a soil (Allison, 1973; Charman and Roper, 2007).

Organic matter and organic carbon are usually expressed as a percentage of the soil by weight. Thus Organic matter is calculated from the levels of organic carbon in the soil. Increased in organic carbon was observed from all incorporated and under root of green manure from this study. In addition this suggestion FiBL (2012) stated that as Growing green manure, mostly legumes, for the amount of biomass they build organic matter. Before flowering they are cut and worked into the soil.

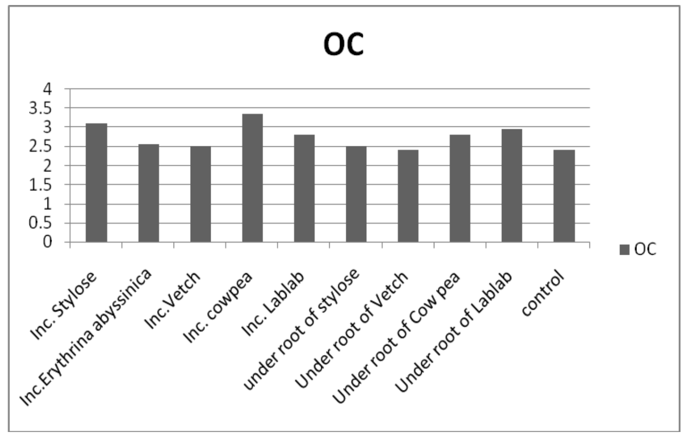

Fig. 6: Total organic carbon content of different green manure source.

Cation Exchange Capacity (CEC)

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. Accordingly, the study identified that CEC was raised by application of green manures (Fig. 7). This result is strongly agreed with previous works. FiBL (2012) reported Soil organic matter increases the ability of the soil to hold onto and supply over time essential nutrients such as calcium, magnesium and potassium – also known as Cation Exchange Capacity (CEC); it improves the ability of a soil to resist pH change – this is also known as buffering effect capacity; accelerates decomposition of soil minerals over time, making the nutrients in the minerals available for plant uptake. This property is important for fertility of soils; because the fertility mostly lies on the intensity of ion exchange in soil. If the CEC of a soil is low, the soil is infertile soil.

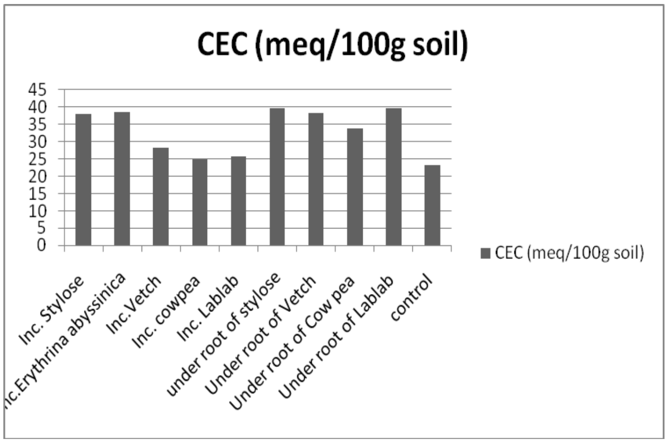

Fig. 7: Cation exchange capacity in a soil. **N.B.:- "**Inc" Means incorporated, under root: legumes which fix by their root.

Conclusion and recommendation

Fertile land and sufficient water are vital for sustaining agriculture and livelihoods. Nutrient management ideally should provide a balance between nutrient inputs and outputs over the long term. In the establishment of a sustainable system, soil nutrient levels that are deficient are built up to levels that will support economic crop yields. To sustain soil fertility levels, nutrients that are removed by crop harvest or other losses from the system must be replaced. Therefore we conclude that green manures analysis result data was below the check result for parameters of macro nutrients (NPK) except under root of lablab which fix by their root and incorporated vetch adds more Nitrogen than check.

Also, incorporated vetch adds phosphorus to the soil by their leaf. But from the result, incorporated vetch and under root of lablab (root of lablab fix nitrogen to the soil) recommended for nitrogen deficiency area, and incorporated vetch is recommended for phosphorus deficiency areas. In areas where potassium is deficient, incorporated stylose, incorporated *Erythrina abyssinica*, Inc. cowpea, Inc. lablab, and vetch under roots could be recommended.

Conflict of interest statement

Authors declare that they have no conflict of interest.

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