THE EFFECT OF ORGANIC MANURING AND PHOSPHORUS ON GROWTH AND FORAGE YIELD OF LABLAB BEAN

(Lablab purpureus (L.) Sweet)

BY

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TO:
My beloved mom...
My sisters...
My family...
My Friends...
Souls of uncles Amal, Abdu and Willim...
And for everyone who stood behind me so I can be the one whom I am right now.....
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**ABSTRACT**

An experiment was carried out for one season in March (2005) in the Experimental Farm of the Faculty of Agriculture at Shambat to investigate the response of Lablab bean (*Lablab purpureus* (L.) Sweet) to organic manuring and phosphorus. The treatments comprised two types of fresh organic manure: farmyard manure (FYM) and chicken manure (CHM) at rates of (10 and 5 t/ha) respectively, and three phosphorus levels (0, 50, 100 P₂O₅ kg/ha) in the form of triple super phosphate (48% P₂O₅). Organic manures were broadcasted before sowing (about one month from sowing) and the land was given three irrigations. The super phosphate fertilizer was applied at sowing. The design was Split-plot design with four replications. The organic manure treatments were assigned to the main plots and phosphorus treatments to the sub plots. Parameters studied included:

1. **Vegetative Parameters:**
   - Number of branches/plant.
   - Shoot and root fresh weight/plant. (g)
   - Shoot and root dry weight/plant. (g)
   - Number of nodules/plant.
   - Dry weight of nodules/plant. (g)

2. **Yield Parameters**
   - Fresh forage yield (t/ha).
   - Dry forage yield (t/ha).
3. Plant chemical composition:
   - Leaf nitrogen content. (%)
   - Leaf phosphorus content. (%)

4. Soil chemical characteristics before and after the experiment had been grown:
   - The moisture saturation percentage. (%)
   - The soil pH.
   - The electrical conductivity (ECe). (mmohs/cm)
   - The percentage of Ca +Mg. (meq/L)
   - Soil sodium content. (meq/L)
   - Sodium adsorption ratio (SAR).

Results showed that application of organic manures and phosphorus increased all the studied growth and forage yield parameters but the increase was significant in some parameters (number of branches/plant, shoot fresh and dry weight, root fresh and dry weight, yield fresh weight, and some soil characteristics) and not significant in others.
ملخص الطرح

أجرت تجربة حقلية لموسم واحد في عام 2005 لدراسة استجابة اللوبية التليف للامضية العضوية والسماد الفوسفاتي.

تمت اضافة السماد العضوي مباشرة بدون تخمير بمعدل 10 طن للهكتار من روث البقر، و5 طن للهكتار من زرق الدواجن. كما تم إضافة سماد الفسفور في صورة سوبر فوسفات ثلاثي (48% فسفور) بثلاثة مستويات: 0, 50, 100 كجم فسفور للهكتار. السماد العضوي تمت اضافته قبل شهر من الزراعة. اما السماد الفسفوري فقد تمت اضافته مباشرة مع الزراعة. تمت دراسة تأثير المعاملات المختلفة على النمو الخضري والانتاجية وكذلك على التركيب الكيميائي للفلف وبعض خصائص التربة.

التصميم المتبع لهذه التجربة هو تصميم القطع المنتشرة حيث وضعت معاملات السماد العضوي في القطع الرئيسية ومعاملات الفسفور في القطع الفرعية.

شملت القياسات التي تمت دراستها الآتي:

- قياسات النمو الخضري وهي: عدد الأفرع الخضرية للنبات، الوزن الرطب والجاف للمجموع الخضري والمجموع الجذري، عدد العقد البكتيرية، الوزن الجاف للعقد الجذرية في النبات.

- انتاجية العلف: الوزن الرطب للعلف، الوزن الجاف للعلف.

- التحليل الكيميائي لتحديد محتوى العلف من البروتين والفسفور.

- التحليل الكيميائي والفيزيائي لبعض خصائص التربة.

أوضح النتائج أن اضافة السماد العضوية وسماد الفوسفور أظهرت تأثيراً إيجابياً على كل نتائج المقاييس المأخوذة في التجربة والمذكورة أعلاه وتبين التأثير مابين المعنوي في بعض القياسات (عدد الأفرع الخضرية، الوزن الرطب والجاف للمجموع الخضري، الوزن الرطب والجاف للمجموع الجذري، الوزن الرطب للعلف، بعض الخصائص الفيزيائية للتربة) وغير المعنوي في البعض الآخر.
CHAPTER ONE

INTRODUCTION

The importance of legumes as food crops lies primarily in their high protein content that averages 20-25%, and because of their nitrogen fixing ability, which is beneficial to other crops grown with or after them. The origin of lablab beans (*Lablab purpureus* (L.) Sweet) is Africa (Kenya) but the crop is widely grown in the tropics of Africa, India, Australia, the Caribbean, Central America, Middle East, Pacific Ocean and South America (Philpotts, 1969; Ishag, 1994).

Due to its potential for use as a vegetative cover, soil improvement qualities, ability to fix nitrogen and control weeds, the grain legume lablab bean is an important species in the tropics. Green pods and unripe seeds are very popular in India and are used as flavouring. Seeds are also used in traditional medicine but they contain toxins and cyanide poisoning has been reported from seeds of coloured varieties. The crop is also grown as fodder crop.

Lablab bean is an old established crop in the Sudan and is inter-planted with sorghum or maize along the Nile in the Northern States (Ahmed, 1978), and maize-lablab intercropping system is the best for simultaneous production of maize and green fodder, and for improving soil chemical properties. It used to be grown in Gezira Scheme as part of the rotation with cotton, as soil improving crop. The green fodder yield of the crop ranged from 15.5-24.6 t/ha and the total grain yield
ranged from 514-1378 kg/ha in Gazira Scheme (Ishag, 1994). The crop is also used as a cover crop for weed control and to check soil erosion.

The use of organic manures is considered to be the cheapest source of nitrogen for crops compared to inorganic sources such as urea. In India it is generally suggested that 25% of the nutrient needs of agriculture can be met by utilizing various organic sources such as farmyard manure, crop residues, urban and rural wastes. It is estimated that by 2010, 1.8, 2.10 and 2.34 million tons of N, P$_2$O$_5$ and K$_2$O from human excreta, animal dung and crop residue, respectively, will be utilized as organic manures in India. Most of livestock dung is used as cooking fuel in India, but even ashes could be utilized as manure to return most of the K, Ca, Mg, Fe, Mn, Zn and some P and B to the soil.

Phosphorous is the most important nutrient for successful establishment of legumes as it increases growth and improve crop performance. Bradly (1974) mentioned that the most important functions of phosphorous include its favorable effect on the following aspects:

- Flowering and fruiting including seed formation.
- Crop maturation.
- Root development, particularly of the lateral and fibrous roots.
- Strengthens straw in cereal crops thus helping to prevent lodging.
- Crop quality especially of forage and vegetable crops.
- Resistance to certain diseases.
Phosphorus was reported to increase dry matter, seed yield, crude Protein and the digestibility of lablab bean (Verma, 1968).

Some studies have been conducted on lablab bean as a forage crop in Sudan. Abd Allah (2001) studied the effect of phosphorus fertilizer on lablab bean. Verma, (1975) studied the effect of spacing and phosphate fertilizer on forage and seed yield of lablab. Perez and Rolo (1998) studied the effect of phosphorus and potassium rates on seed yield of lablab bean. Noor et al., (1990) studied the effect of inorganic fertilizer and organic manure on the yield of lablab bean. Murtagh (1972) studied the seedbed requirements for lablab. Mahadi and Atabani (1992) studied the response of Brady rhizobium-inculated soybean and Lablab bean to inoculation with vesicular mycorhizae. Ibrahim (1994) studied the performance of irrigated lablab bean cultivars on semi-arid tropics. However, there is a paucity of information concerning the nutrition of lablab bean particularly its response to organic manuring.

The main objectives of this study were therefore to:
1. Study the effects of organic manuring and phosphorus on growth and yield of Lablab bean.
2. Study the effect of the treatments on some chemical composition of the plant.
3. Study the effects of the treatments on some physical and chemical properties of the soil.
CHAPTER TWO
LITERATURE REVIEW

2.1. Introductions:

The most Common names of *Lablab Purpureus* are: lablab bean and hyacinth bean. Other names include: bonavist bean, “loba afen” (Sudan, Egypt). Lablab bean is cultivated in many tropical and sub-tropical areas and is an important food in many parts of Asia, especially South India. The culinary types are popular in Asia where they are widely consumed as vegetable, being eaten boiled similar to French beans, or used in curry. Sometimes the immature green seeds are extracted from the pods and eaten as a vegetable, either boiled or roasted. In Egypt, the lablab bean is sometimes used as a substitute for broad bean. In Asia, the immature and mature seeds are utilized as a pulse. In Sudan, immature seeds are eaten boiled. The pods and seeds can also be used for livestock feeding. Lablab bean may also be grown as a green manure or as a forage crop (Murphy and Colucci, 1999), with fodder yields ranging from 3.47-4.69 t/ha (Gowda, 1990. Meelu et al., 1992). Lablab bean leaves are also rich in protein (up to 28%) and among legumes, they are one of the best sources of iron (155mg/100g). Dried seed contains about 25% protein, 1.7% fat, 68.9% carbohydrate and 7.8% fiber. Amino acid content is moderately well balanced with an appreciable amount of lysine content.
2.2. Environmental requirements:

2.2.1. Soil

Lablab bean grows on a wide range of soils from deep sand to heavy clays, provided drainage is good, and with pH range from 4.5-7.5. It has low salinity tolerance which causes leaf chlorosis, reduces growth and may cause plant death. Lablab does not always nodulate well with native strains of *Rhizobia*, it is recommended to be inoculated with the appropriate lablab *Rhizobium* strain. (Abd Allah, 2001)

2.2.2. Moisture

Lablab is adapted to annual rainfall regimes of 650-3,000mm, but it can grow where rainfall is less than 500 mm; it is drought tolerant when established, but cannot withstand prolonged dry periods. The plant is capable of extracting soil water from at least 2 meters depth even in heavy textured soils and will tolerate short periods of flooding but it is intolerant to poor drainage and prolonged inundation. (Abd Allah, 2001)

2.2.3. Temperature

The plant tolerates high temperature, but the average daily temperature for growth is 18-30°C; it can also grow at low temperatures (down to 3°C) for short periods. The plant is susceptible to frost. (Abd Allah, 2001)
2.2.4. Reproductive Development

Lablab bean is a short-day plant, with early and late flowering types with some landraces flowering as early as 55 days after sowing. The plant is self pollinated with some out-crossing but observations suggest that this is usually minimal. Being an annual or weak perennial, lablab flowers and sets seed in the first season of growth. Three harvests are possible from annual types but the crop will not stand heavy grazing. As forage, the crop should be utilized before flowering. (Khalid, 1999).

2.3. Crop Cultivars

Lablab bean is characterized by many taxonomic variations. About 39-50 varieties are recognized based on:

1. Variability of the size, shape, and colour of pods (green, white, purple or purpled margins), fleshy or fibrous.
2. Size, shape or colour of seeds (white to yellow to black or reddish purple).
3. Flower characteristics, size of corolla.

Little work has been done on improving this crop in Sudan. Numerous trials at the Gazira Research Station for more than 25 years produced no strain good enough to replace the main selected type originally grown at the beginning of the scheme (Pursglove, 1969).
In the Sudan, four lablab cultivars namely Brazilian, High Worth, Local and Rongai, gave the best yield of both forage and grain, and proved to be well adapted. The local varieties produced the lowest forage and grain yields (Ishag, 1994). Ibrahim (1999) evaluated six lablab genotypes; there were significant differences in five characters, namely, plant height, seeds per pod, days to flowering, number of reproductive branches per plant and pods per reproductive branch. On the other hand, no significant differences were detected for other studied characters, which were days to maturity, pods per plant, 100-seed weight and yield per plant and per hectare in addition to days to flowering.

2.4. Lablab Forage Yield

In the United States, lablab fodder yield ranges from 2-10 t/ha (Duke, 1981). However, Skerman et al., (1988) reported 25 t/ha of green material after four to six months in Colombia. In Brazil 40 t/ha were obtained for pure stand and 35 t/ha for mixed maize and lablab (Mohammed, 1999). Magoon et al., (1974) reported fresh fodder yields of 2.3 to 7.5 t/ha in the first cutting and 2.2 t/ha in the second cutting in India. In Australia, the highest dry matter yield of lablab under irrigation ranged from 6.7-14 t/ha (Mulldoon, 1986). However, English (1986) reported that with good growing conditions lablab produced 8 t/ha (D.M).

In Sudan, the average productivity is about 2.6 t/ha dry matter (Abu-Gada, 1981; Mustafa et al., 1999). However, Osman and Osman (1981) reported from 1.47 to 2.46 t/ha dry matter in saline soil of Soba.
Once established, lablab is highly drought resistant often staying green during the dry season (Schaaffhausen 1963b).

Dry matter yield per hectare varies with rainfall, soil conditions and time of seeding, but work in Australia suggests that 4000 kg of DM per ha with a maximum leaf production of two tons DM per ha is not unusual (Mayer et al., 1986; Cameron 1988). The ratio of leaf to stem varies with cutting and curing procedures, from 30:70 to 45:55, respectively.

2.5. Fertilization

Nutrient use efficiency is an important factor determining fertilizer needs. For example N use efficiency is only 30-50%, thus about two-three times of fertilizer N has to be applied in relation to its uptake by a crop. While it is common to grow lablab without fertilizer applications, sowing in sandy soils often requires application of nitrogen, phosphorus and sulphur and it benefits from application of lime in very acid soils. (Abd Allah, 2001)

2.6. Organic Agriculture

According to the FAO/WHO (2002) “Organic agriculture is a holistic production management system which promotes and enhances ecosystem health, including biological cycle and soil biological activity .The primary goal of organic agriculture is to optimize the health and productivity of inter-dependant communities of soil life, plant, animals and people”
Organic agriculture aims at:
- Achieving a closed nutrient cycle on the farm if it is possible *i.e.* the farm is to establish its own feed and nutrient basis.
- Preservation and enhancing soil fertility.
- Keeping animals in particularly welfare oriented manner.

Organic agriculture is currently gaining increasing popularity as an alternative strategy to chemical fertilizers and is receiving more attention world-wide, due to the fact that organic manures possess a longer lasting effect and if properly managed can out yield the recommended doses of chemical fertilizers (Mahadi, 1993).

### 2.6.1. Organic Matter Management

Organic matter management practices promote soil water conservation and can reverse environmental degradation. Livestock therefore could provide a variety of animal products to their local economy and manure for improving soil fertility (Kosset, 1999). Addition of organic matter to the soil significantly increases the organic carbon content, stored nutrients and maintains the soil fertility for long term (Clark, 1999).

Comparison of soil characteristics during 15-years period show that soil fertility was enhanced in the organic systems, while it decreased considerably in conventional systems. Nitrogen content and organic matter levels in soil increased markedly in manure-fertilized fields. Moreover, the conventional system had the highest environmental impact (Drik Wter, 1998). Improving the quality of the soil
through organic practices can encourage the soil to hold moisture more efficiently than conventionally managed soil. The higher content of organic matter also makes organic soil less compact so that the root systems can penetrate more deeply. These results highlight the importance of organic farming and its potential in crop production (Rodale Institute, 1999).

Significant increases were found in soil health indicators such as nitrogen mineralization potential and microbial abundance and diversity, in organic fields. The increased soil health in organic farms resulted in considerably lower disease incidence (Drik Wter, 1998). Microbial activity and general soil health is a measure of soil fertility. In analysis of organic farming systems in Europe, Stolze et al., (2000) has found that organic farming increased microbial activity by 30-100% and microbial biomass by 20-30%.

Organic farming systems rely to the maximum extent feasible upon crop rotation, crop residues, animal manure, legumes, green manures; mechanical cultivation and approved mineral bearing rocks to maintain soil productivity and to supply plant nutrients (Robyn, 2000). There is also some evidence to suggest that nitrate leaching may be less under organic than under conventional systems.

Legumes (vetch, faba bean and lupine) contain large amount of nitrogen (50-140 kg N-gain/ha) that is released to the soil upon cultivation. The same crops when allowed to mature contribute more organic matter than a green manure crop (oats) (Robyn, 2000). Studies using organic nitrogen source to improve forage production are limited.

The animal manure is abundantly available so it is considered as a cheap source of nitrogen for crop fertilization compared to inorganic source such as urea.
2.6.2. Response of Crops to Farmyard Manure

FYM is commonly applied to land to be planted with crops before sowing at the rate of 20-30 tons per hectare (Rounanet, 1987). Sharma and Sharma (1988) reported that organic manures have important functions in meeting fertilizer needs of crops. Rounanet (1987) stated that a ton of cattle manure provides an average of 6 kg of Potassium, 5 kg of nitrogen and lime and 0.5 kg sulphur. Cooke (1982) reported that in general 25 tons per hectare of farmyard manure add to the first year crop about 40 kg nitrogen, 20 kg phosphorus and 80 kg potassium per hectare. The other role of farmyard manure, besides improving soil fertility is the improvement of soil structure by changing the physical properties of the soil. Parsad and Singh (1980) reported that continuous use of farmyard manure and NPK fertilizer for twenty years improved the physical properties of sodic loam soils. Kobayshi and Nagatomo (1983) found that application of 20, 50 or 100 tones farmyard manure/ha resulted in increasing availability of moisture to the crops. However, manure didn’t affect leaf number, plant fresh weight, and total root number in maize. They also found that yield varied with year and in some years yield increased with increasing rate of farmyard manure.

When manures are in mixture with fertilizers, yields are generally higher than equivalent amounts of fertilizers alone. Gupta et al., (1983) found that the application of farmyard manure combined with urea increased moisture retention characteristics and decreased bulk density of the soil and gave higher straw yield compared to farmyard manure alone in pearl millet. The application of farmyard
manure alone or in combination with urea to salty soils increased fresh and dry forage yield, and improved forage quality in sorghum (Abu Suwar 1994). Khalid (1999) reported that application of organic amendment has small effect on germination percentage and salt redistribution, but there was an increase in plant height, leave area index, forage yield and dry matter yield of forage sorghum. In general, weekly irrigation and application of farmyard manure proved to be the best treatment.

2.6.3. Response of Crops to Chicken Manure

The nutrient composition of poultry manures varies with type of poultry, the feed ratio, the proportion of litter to dropping, the manure handling systems and the type of litter. Poultry manure is an excellent source of nutrients and can be incorporated into most fertilizer programs. The value of poultry manure varies not only with its nutrient composition and availability, but also with management and handling. Except for nitrogen, the availability of most nutrients in poultry manure is constant. Nitrogen can occur in several forms each of which can be lost when subjected to different management or environmental conditions. Nitrogen in poultry wastes comes from uric acid, ammonia salts and organic (faecal) matter (Zublena, 1993).Chicken manure contains as much nitrogen as farmyard manure, but it is richer in potassium and phosphorus (Cooke, 1982). Chicken manure significantly increased yield and shoot nitrogen content of fenugreek plants (Abdelgani et al., 2003). Moreover, application of Chicken manure together with *Rhizobium* inoculation was found to increase nitrogen content and yield of
Maximum nutrient benefit from chicken manure was achieved when it was incorporated into the soil immediately. Incorporation minimized nitrogen losses to the air and/or in runoff and allowed soil microorganisms to start decomposing the organic matter in the manure. To minimize nitrogen losses, manure should be applied as near as possible to planting time or the crop growth stage during which nitrogen is most needed. For coarse textured soils, manure should be applied frequently and at low rates throughout the growing season because such soils have higher water infiltration rate and low ability to hold nutrients. Unused nitrogen can therefore be lost by leaching (Barker, 1997).

The organic Nitrogen must be converted to ammonium or nitrate before plants can utilize it. Approximately 75% of the total nitrogen will be available to the crop during the year of application. The nutrient composition of chicken manure consists mainly of nitrogen, phosphorus, potassium, magnesium, sulfur and some micronutrients. It has considerable amounts of organic matter. It also has an important role in regulating soil pH (Mullins et al., 2002).

2.7. Soil Phosphorus

Crop production is limited over enormous areas of the world by phosphorus supply (Russell, 1973). Phosphorus deficiency can be difficult to diagnose. Humphery
(1978) reported that phosphorus deficient plants often exhibit purple or red
discoloration of the older leaves especially on veins and this extends to the stems.
Growth is stunted and the deficiency is more easily seen in seedlings than old
plants.
Phosphorus occurs in soils in organic insoluble forms and inorganic soluble forms.
The organic phosphorus may be mineralized by microbial activity to be soluble
and available for plants. The rate of phosphorus released is affected by organic
natural source and some other factors such as pH, temperature, cultivation
practices and C/N ratio (Lomuja, 1992). The chemical forms of organic
phosphorus include a range of inositol phosphate esters, phospholipids and nucleic
acids probably all occurring in complex forms (Wild, 1988). Most of the soil
inorganic phosphates are present in form of soluble soil compounds such as mono,
di, tri and octa calciumphosphate, fluoroapatite and chloro apatite in alkaline soils,
and ferric and hydroxy aluminum phosphate in acidic soils. The solubility of
phosphorus from Ca, Al and Fe compounds are also close to each other in soil pH
range 6.0-7.0. Below this range, Al and Fe phosphates are precipitated and above
this range, various calcium phosphates are formed. It was reported that calcium
phosphate becomes insoluble under alkaline conditions and phosphorus deficiency
results at pH more than 8.0 (Lomuja, 1992). The soil solution however, can only be
an adequate source of phosphorus if the crop can remove the phosphorus from
these diluted solutions at adequate rates. The minimum concentration of
phosphorus needed for good plant growth is difficult to measure. It depends on
plant species, the degree of dissociation of phosphate anion and microbiological
environment of the root (Russell, 1973). Thus, the available phosphorus supply of soil depends upon the amount and forms of phosphorus present in the soil.

2.7.1. Phosphate Fertilizers

The main source of phosphate fertilizers are rock phosphate. Phosphorus from organic deposits such as guano mainly from sea birds and to a less extent from bats is also utilized as a readily available phosphorus source for crops (Wild, 1988). Phosphatic fertilizers help to increase crop yield and decrease the uptake of harmful nutrients such as sodium.

The primary source of phosphorus, mineral rock phosphate, contains up to 80% apatite, usually in the form of fluoro apatite. These mineral phosphates have only limited use as a fertilizer as the apatite crystal has a very low solubility, so it is necessary to break up these crystalline forms before they can be used as a fertilizer. This is done either by treatment with mineral acids or by high temperature skittering processes. The most widely used process in the past was to treat the rock phosphate with enough sulfuric acid to convert the apatite to the water soluble monocalcium orthophosphate monohydrate. This is the super phosphate of commerce (Russell, 1973).

Since the 1930s, increasing amounts of the water soluble phosphate fertilizers have been produced from treating the rock phosphate with sufficient sulfuric acid to convert the phosphate to phosphoric acid, which may be added to more rock phosphate to give much more concentrated super phosphate containing up to 85%
monocalcium phosphate, with 21% water soluble phosphate. Further groups of phosphates are based on the water insoluble dicalcium phosphate (Russells, 1973).

### 2.7.2. The Uptake of Fertilizer Phosphorus by Crops

The concept illustrated by the ion uptake processes from soil, especially in relation to more efficient use of fertilizer, is that the rate of uptake of phosphorus by plants is approximately proportional to the concentration of phosphorus in nutrient solutions. The proportionality constant between rate of uptake by roots and phosphorus concentration decreased six folds as the phosphorus increased. Bouldine and Sample (1969); Bell and Black (1970) reported that the soil-plant system is never in an equilibrium. The movement of roots in the soil, the removal of phosphorus, the complex pattern by which phosphorus in solution was renewed from the solid phase, diffusion and mass flow contributed towards an ever-changing supply of phosphorus to the plant. Roots growing in freshly fertilized soil contacted a highly heterogeneous zone near granules of fertilizer and large gradients occurred in pH and phosphorus concentration.

Mattingly (1965) reported that the micro-environment around granules of fertilizer was likely to be composed of saturated solution of initial reaction products, such as dicalcium phosphate dehydrate and this solution becomes an important source of phosphorus for the plants. Nye (1968) showed some connection between the concentration, quantity and diffusion rate of phosphorus. Conditions such as poor drainage or the presence of a restrictive (pan) horizon in the soil profile, which restricted root growth, might require the addition of greater amounts of phosphorus...
fertilizer. Low soil temperature also affects the ability of the plant to absorb phosphorus, and phosphorus that is more available was necessary for cool-season plants than for warm–season plants. Fried and Shapiro (1960) concluded that phosphorus absorption by plant roots could be divided into three stages: the release of phosphate from the soil phase into the soil solution, diffusion of phosphorus to the root surface, entrance to the root and translocation from the root into other parts of the plant. Rate-limiting factors might occur during any of these steps, which limit the uptake of phosphorus by plants, and the rate at which the various reactions occur is characteristic of the particular plant-soil system. Pandey (1981). Russell (1973) and Wild (1988) reported that low uptake could be a consequence of:

- Adding the fertilizer to soil of high phosphate content.
- Plant growth limited by some factors other than phosphate supply.
- Inaccessibility of phosphorus to roots for some reasons.
- Adsorbing the phosphate by soil so that the concentration in solution remains very low.
- The adsorbed phosphate being converted into non labile form.

### 2.7.3. Effects of Phosphorus on Growth

The fertilizer requirement of lablab is not greatly different from cowpea or velvet beans (Luck, 1985) and other legumes. Addition of phosphorus significantly increased the number of plants per unit area, leaf area, and leaf to stem ratio of clitoria (Abdullah, 1999). Zotor (1968) reported the same result in some pasture
crops. In contrast, Ahmed (1988) found that phosphorus had no effect on number of branches in cowpea. Ahmed (1978) observed significant differences in leaf number and plant weight in lablab and other leguminous crops. Growth parameters and seed yield components of alfalfa were increased by phosphorus application (Mohammed, 1994; Mustafa, 1996). As the plant matured, Seatz (1963) argued, thus most of the Phosphorus within the plant was translocated into the seeds and fruits.

2.7.4. Effect of Phosphorus on Forage Yield

Phosphorus affects dry matter yield of legumes and may increase digestibility of dry matter (Hauque and Mohamed, 1986). In an experiment on some leguminous crops in Shambat, Ahmed (1978) reported that on those depleted soils the response of leguminous crops to phosphatic fertilizer was most striking and in the soil that didn’t contain any phosphorus yield was low to the extent that there was no crop to harvest. In a trial at Taree (Australia) dry matter yields of lablab bean pasture given 0, 250, 500 and 1000kg super phosphate/ha were 0.85, 2.38, 2.5 and 3.77 t/ha, respectively. Phosphorus content of the pasture increased from 0.12% with no phosphorus to 0.2% with 100kg super phosphate/ha (Bradly et al., 1974).

In another field trial in Cuba, Perez and Rolo (1998) reported that *Lablab purpureus* v. Rongai given zero, 25, 50 kg P$_2$O$_5$/ha and 0, 50, 75 kg K$_2$O/ha gave the highest yield with 25 kg P$_2$O$_5$ +75 kg K$_2$O/ha. Patel *et al.*, (1995) studied the effect of sowing space and super phosphate application on lablab bean yield and
they found that the highest yield was with 40 cm row spacing and application of 50 kg P₂O₅/ha.

2.7.5. Effect of Phosphorus on Forage Quality

Leguminous plants in general have higher crude protein content than grasses. The crude protein content of most legumes commonly falls in the range of 15-25% with higher values being recorded in favourable situations (Butlur and Baily, 1973). Phosphorus often increases nitrogen or crude protein content and phosphorus concentration or uptake by the plant in herbage (Hauque and Mohammed, 1985). Osman (1974) reported the same result in clover. Mustafa (1996) found that phosphorus resulted in significant increase in crude fiber content in alfalfa.
CHAPTER THREE

MATERIALS AND METHODS

3.1. Study Site:

3.1.1. Location

The experiment was conducted for one season in March 2005 in the Experimental Farm of the Faculty of Agriculture at Shambat, Khartoum North (latitude 15°40’ N and longitude 32° 32’ E), in order to study the response of Lablab bean (*Lablab purpureus* (L.) Sweet) to organic manuring and phosphorus.

Oliver (1965) reported that climate of the study area is semi-arid with hot summer only part of which is rainy during the period of July to September; the annual rainfall is about 160mm which varies greatly in intensity and distribution with the peak in August. The mean maximum temperature is about 39°C during the season. Relative humidity is low (19-29%) especially in the long dry period (October to May). Appendix (1)

3.1.2. Soil

Saeed (1968) reported that the soil at the experimental site is a heavy montmorillonitic calcareous clay soil with about 54% clay and low infiltration rate. The soil pH is 8.05 (Appendix 2).
3.2. Treatments

Manure treatments were 10 t/ha and 5 t/ha for farmyard manure (FYM) and chicken manure (CHM), respectively, where as phosphorus treatments were 0, 50 and 100kg P$_2$O$_5$ /ha, designated as P0, P1 and P2, respectively. Triple super phosphate (48% P$_2$O$_5$) was used as source of phosphorus.

3.3. Land Preparations and Experimental Design

Before planting, the land was disc ploughed, harrowed, leveled and ridged at 60cm. The experimental area was divided into plots. Each main-plot was divided into 3 sub-plots with an area of 4 x 5m each.

The experiment was laid out in Split-plot design, with four replications. The main plots were assigned to organic fertilizers and the sub-plots to phosphorus treatments. Organic manures were broadcasted before sowing (about one month from sowing) and the land was given three irrigations. The super phosphate fertilizer was applied at sowing in a 5cm furrow at one side of the ridge. The seeds of a local lablab bean variety were used in the experiment. Seeds were sown on 15$^{th}$ March 2005 in holes 30cm apart at rate of three seeds per hole. Irrigation was applied at weekly intervals. Plots were hand weeded once before sowing after that they were weeded when necessary. Roger pesticide was applied once at the seedling stage after three weeks of sowing to control the white fly (Bemicia tabaci).

3.4. Parameters Measured

The following parameters were measured during the course of study:
3.4.1. Vegetative Growth Attributes

All vegetative parameters were determined on three plants randomly taken from the outer two ridges and at the ends of the two middle ridges in each plot. Measurements were taken weekly, starting after one month from sowing and until harvest. The plants were dug out, cleaned from mud and taken to the laboratory for determination of the following vegetative parameters:

3.4.1.1. Number of Vegetative Branches/plant

Determined by counting branches of the plants in the above sample and mean branch number/plant was obtained.

3.4.1.2. Shoot Fresh Weight (g)

In the laboratory, the plants samples were washed with tap-water to get rid of any adhering mud and then they were air dried. Then shoots and roots were separated and shoots were weighed using Mettler type sensitive digital balance (220 V- 50 Hz), and mean shoot fresh weight was obtained.

3.4.1.3. Shoot Dry Weight (g)

The shoots of plant samples were sun dried for 1-2 weeks and then weighed and mean shoot dry weight was obtained.
3.4.1.4. Root Fresh Weight (g)

Roots of plants in the above sample were weighed and mean root fresh weight was determined.

3.4.1.5. Root Dry Weight (g)

Roots of the above plant samples were oven-dried for 48 hours at 80°C in Heavaus type drying oven, and weighed to obtain mean root dry weighed.

3.4.1.6. Number of Root Nodules/plant

Root nodules were separated from the roots of the above sample and then they were counted and mean number of nodules/plant was obtained.

3.4.1.7. Nodules Dry Weight (mg)

Nodules separated from the above plant samples were put on a Petri-dish and then oven-dried for 48 hours at 80°C and weighed to determine mean nodules dry weighed.
3.4.2. Yield Parameters

3.4.2.1. Fresh Forage Yield (t/ha)

This parameter was determined at the end of the experiment. Plants in an area of 1m² in the two middle ridges in each plot were cut about 20cm above the ground and weighed immediately in the field using a hand spring balance to obtain fresh forage yield. From that total fresh forage yield/ha was calculated.

3.4.2.2. Dry Forage Yield (t/ha)

The plants used for determining fresh forage yield were sun dried for 3 weeks and then weighed to obtain dry forage yield. From that total dry forage yield/ha was calculated.

3.4.3. Chemical Analysis

3.4.3.1. Plant Chemical Analysis (%)

Dry plant samples (2.5g) were taken from each treatment and ground by a mill to be used for determining the following:

3.4.3.1.1. Leaf Nitrogen Content (%)

Leaf nitrogen content was determined by micro-Kjeldahl Method. A sample of 0.2
g of dry plant material from each treatment was used for this purpose (Appendix 4).

3.4.3.1.2. Leaf Phosphorus Content (%)

This parameter was determined according to Chloride Reduction Method described by Grimshaw et al., (1998), using a sample of 1.5 g from each treatment for this purpose (Appendix 5).

3.4.3.2. Soil Chemical Analysis:

3.4.3.2.1. Moisture Saturation Percentage (%)

This parameter was determined by using the extract from a saturated soil paste, using a sample of 200-300 g air-dry soil from each plot taken from 30cm depth (Appendix 6).

3.4.3.2.2. Soil pH

This parameter was determined using 1:1 (soil: water) suspension using a pH-meter (Appendix 7).

3.4.3.2.3. Electrical Conductivity (mmohs/cm)

This parameter was determined using 1:1 (soil: water) suspension (Appendix 8).
3.4.3.2.4. Calcium and Magnesium (meq/L)

This parameter was obtained by extracting the soil by water and determining Ca and Mg concentration in the extract by titration with EDTA (Richards, 1954) (Appendix 9).

3.4.3.2.5. Soil Sodium Content (meq/L)

This parameter was determined by using the extract from a saturated soil paste, Na in the extract was then determined by flame photometer. Appendix (10)

3.4.3.2.6. Sodium Adsorption Ratio

This parameter was determined by using the following equation

\[
SAR = \frac{Na \, (meq/L)}{\sqrt{Ca + Mg \, (meq/L)^2}}
\]

3.5. Statistical Analysis

ANOVA was conducted on the data accordance with split-plot design. Means were separated by using Duncan’s Multiple Range Test (DMRT), (Gomez and Gomez, 1984).
4.1. Growth Parameters

4.1.1. Number of Branches/plant

The results in Table (1) show that at 30 days, FYM produced a slight and insignificant increase in number of branches as compared to CHM. At 45 days, CHM produced greater numbers of branches than FYM, but again the difference was not significant while at 75 days CHM produced significant increase in the number of branches than FYM. As for P treatments, the response was significant at 30 days where P0 showed greater number of branches than other P levels. At 45 days P2 application caused a slight increase in number of branches than the other P levels but the difference was not significant, while at 75 days P1 showed greater number of branches than other P levels. On the other hand at 30 days the combination of FYM and P0 produced a significant increase in number of branches, but with no clear trend while at 45 and 75 days the interaction of P and organic manures had no significant effect on number of branches.
Table (1): Effect of FYM, CHM and Phosphorus on Number of Branches/plant

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Plant Age (days)</th>
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</thead>
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<td></td>
<td></td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>FYM</td>
<td>P0</td>
<td>4.8a</td>
<td>5.2a</td>
<td>8.6a</td>
<td>Mean</td>
<td>4.2a</td>
<td>5.4a</td>
<td>9.9b</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>P1</td>
<td>3.5b</td>
<td>5.3a</td>
<td>11.9a</td>
<td>Mean</td>
<td>3.5b</td>
<td>6.7a</td>
<td>14.6a</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>P2</td>
<td>4.4ab</td>
<td>5.6a</td>
<td>9.5a</td>
<td>Mean</td>
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<td>6.6a</td>
<td>16.1a</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CHM</td>
<td>P0</td>
<td>4.5ab</td>
<td>5.4a</td>
<td>13.4a</td>
<td>Mean</td>
<td>3.8a</td>
<td>6.2a</td>
<td>14.7a</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>P1</td>
<td>3.5ab</td>
<td>6.7a</td>
<td>14.6a</td>
<td>Mean</td>
<td>3.8ab</td>
<td>7.3a</td>
<td>15.3a</td>
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</tr>
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<td></td>
<td>P2</td>
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<td>6.6a</td>
<td>16.1a</td>
<td>Mean</td>
<td>3.4b</td>
<td>7.2a</td>
<td>16.1a</td>
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<td>Mean</td>
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<td>Mean</td>
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<td>12.8a</td>
<td></td>
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<td></td>
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<td></td>
<td>3.5b</td>
<td>5.9a</td>
<td>13.2a</td>
<td>Mean</td>
<td>3.9ab</td>
<td>6.1a</td>
<td>12.8a</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3.9ab</td>
<td>6.1a</td>
<td>12.8a</td>
<td>Mean</td>
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<td></td>
<td></td>
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SE±

<table>
<thead>
<tr>
<th>O.M =</th>
<th>0.23</th>
<th>0.42</th>
<th>1.32</th>
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<tbody>
<tr>
<td>P =</td>
<td>0.28</td>
<td>0.51</td>
<td>1.62</td>
</tr>
<tr>
<td>O.M x P =</td>
<td>0.39</td>
<td>0.72</td>
<td>2.29</td>
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</tbody>
</table>

Means followed by the same letter(s) within a row or column are not significantly different at 0.05 according to DMRT.
4.1.2. Shoot Fresh Weight (g)

The results showed that CHM produced consistent increase in shoot fresh weight as compared with FYM the increase being significant at 30 days. As for P treatments, P2 showed greater shoot fresh weight than other P levels at all stages but the differences were not significant. The interaction of P and organic manures had no significant effect on shoot fresh weight at 45 and 75 days, while at 30 days the combination CHM and P2 showed significant increase in shoot fresh weight compared to the other treatments. (Table 2)

4.1.3. Shoot Dry Weight (g)

The results in Table (3) show that at 30 and 75 days CHM produced a slight and insignificant increase in shoot dry weight as compared to FYM. At 45 days FYM produced significant increase in shoot dry weight in comparison to CHM. As for P treatments, P2 showed a slight and insignificant increase in shoot dry weight at 30 and 45 days, while P0 showed greater shoot dry weight than other P levels at 75 days but the difference were not significant. The interaction of P and organic manures had no significant effect on shoot dry weight at 30 and 75 days, while at 45 days the combination FYM and P2 showed significant increase in shoot dry weight compared to the other treatments.
Table (2): Effect of FYM, CHM and Phosphorus on Shoot Fresh Weight (g/plant):

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Plant Age (days)</th>
<th>Mean</th>
<th>Plant Age (days)</th>
<th>Mean</th>
<th>Plant Age (days)</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
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<td>45</td>
<td></td>
<td>75</td>
<td></td>
</tr>
<tr>
<td>FYM</td>
<td>P0</td>
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<td>P0</td>
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<td>P1</td>
<td>17.9ab</td>
<td>P2</td>
<td>20.6a</td>
</tr>
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<td>CHM</td>
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<td>P1</td>
<td>96.0a</td>
<td>P2</td>
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<td>Mean</td>
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<td>15.0a</td>
<td>16.7a</td>
<td>85.8a</td>
<td>92.0a</td>
<td>98.7a</td>
</tr>
</tbody>
</table>

\( \text{SE} \pm \)
\[
\begin{align*}
\text{O.M} & = 1.3 & 8.6 & 23.24 \\
\text{P} & = 1.6 & 10.6 & 28.46 \\
\text{O.M x P} & = 2.2 & 14.9 & 40.3
\end{align*}
\]

Means followed by the same letter(s) within a row or column are not significantly different at 0.05 according to DMRT.
Table (3): Effect of FYM, CHM and Phosphorus on Shoot Dry Weight (g/plant):

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Plant Age (days)</th>
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<th>45</th>
<th>75</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>P0</td>
<td>P1</td>
<td>P2</td>
<td>Mean</td>
</tr>
<tr>
<td>FYM</td>
<td></td>
<td></td>
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<td>2.8a</td>
</tr>
<tr>
<td>CHM</td>
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<td>3.4a</td>
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<td>Mean</td>
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<td>2.8a</td>
<td>3.2a</td>
<td>20.6a</td>
</tr>
</tbody>
</table>

SE±
- O.M = 0.20
- P = 0.25
- O.M x P = 0.35

Means followed by the same letter(s) within a row or column are not significantly different at 0.05 according to DMRT.
4.1.4. Root Fresh Weight (g)

The results in Table (4) show that at 30 days CHM produced a slight increase in root fresh weight as compared to FYM. At 45 and 75 days FYM produced greater root fresh weight than CHM, but the difference was not significant. As for P treatments, P2 showed greater root fresh weight than other P levels at 30 and 75 days, while at 45 days P1 application caused a slight increase in root fresh weight than other P levels, but such effects were not significant. At 45 and 75 days the interaction of P and organic manures had no significant effect on root fresh weight, while at 30 days the combination CHM and P0 produced significant increase in root fresh weight compared to other combinations.

4.1.5. Root Dry Weight (g)

The results showed that at 30 days FYM produced a slight increase in root dry weight as compared to CHM. At 45 days FYM showed significant increase in root dry weight as compared to CHM, while at 75 days CHM manure showed a slight and insignificant increase in root dry weight as compared to FYM. As for P treatments, the response was inconsistent and insignificant. P2 showed greater root dry weight than other P levels at all the stages. The interaction of P and organic manures had no significant effect on root dry weight at 30 days, while at 45 days the combination FYM and P2 showed significant increase in root dry weight as compared to the other combinations, and at 75 days CHM and P2 showed significant increase in root dry weight as compared to other combinations. (Table 5)
Table (4): Effect of FYM, CHM and Phosphorus on Root Fresh Weight (g/plant):

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Plant Age (days)</th>
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<th>45</th>
<th>75</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td>P0</td>
<td>P1</td>
<td>P2</td>
<td>Mean</td>
</tr>
<tr>
<td></td>
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</tr>
<tr>
<td></td>
<td>CHM</td>
<td>P0</td>
<td>P1</td>
<td>P2</td>
<td>Mean</td>
</tr>
<tr>
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<td>0.5ab</td>
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<td>0.7a</td>
<td></td>
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<tr>
<td></td>
<td>Mean</td>
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</tr>
<tr>
<td></td>
<td>2.5a</td>
<td>3.5a</td>
<td>2.9a</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

SE±

- O.M = 0.04
- P = 0.05
- O.M x P = 0.07

Means followed by the same letter(s) within a row or column are not significantly different at 0.05 according to DMRT.
Table (5): Effect of FYM, CHM and Phosphorus on Root Dry Weight (g/plant):

<table>
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<tr>
<th>Treatment</th>
<th>Plant Age (days)</th>
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<th>45</th>
<th>75</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
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<td>P1</td>
<td>P2</td>
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</tr>
<tr>
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</tr>
<tr>
<td></td>
<td>CHM</td>
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<tr>
<td></td>
<td>0.9ab</td>
<td>0.8ab</td>
<td>1.1a</td>
<td></td>
<td>0.9a</td>
</tr>
<tr>
<td></td>
<td>2.2ab</td>
<td>2.0ab</td>
<td>2.4ab</td>
<td></td>
<td>2.2a</td>
</tr>
<tr>
<td></td>
<td>Mean</td>
<td>0.3a</td>
<td>0.3a</td>
<td>0.3a</td>
<td>0.3a</td>
</tr>
<tr>
<td></td>
<td>0.8a</td>
<td>0.7a</td>
<td>0.9a</td>
<td></td>
<td>0.9a</td>
</tr>
<tr>
<td></td>
<td>1.9a</td>
<td>2.0a</td>
<td>2.7a</td>
<td></td>
<td>2.3a</td>
</tr>
</tbody>
</table>

SE±
- O.M = 0.02
- P = 0.02
- O.M x P = 0.03

Means followed by the same letter(s) within a row or column are not significantly different at 0.05 according to DMRT.
4.1.6. Number of Nodules/plant

The results showed that at 30 days and 45 days CHM produced a slight and insignificant increase in number of nodules as compared to FYM, while at 75 days FYM produced a slight and insignificant increase in number of nodules than CHM. As for P treatments, the response was inconsistent and insignificant. At 30 days P2 showed greater number of nodules than other P levels while at 45 days P0 caused a slight increase in number of nodules than other P levels. P1 showed greater number of nodules than other P levels at 75 days. The interaction of P and organic manures had no significant effect on number of nodules. (Table 6)

4.1.7. Nodules Dry Weight (g)

The results in Table (7) showed that at 45 days FYM produced greater nodules dry weight than CHM, but the differences was not significant, while at 75 days there was no difference between organic manures in this respect. At 45 days P0 caused a slight increase in nodules dry weight than other P levels, at all the stages. The interaction of P and organic manures had no significant effect on nodules dry weight.
Table (6): Effect of FYM, CHM and Phosphorus on Number of Nodules/plant:

<table>
<thead>
<tr>
<th>Treatment</th>
<th>30</th>
<th>Plant Age (days)</th>
<th>45</th>
<th>75</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P0 P1 P2 Mean</td>
<td>P0 P1 P2 Mean</td>
<td>P0 P1 P2 Mean</td>
<td>P0 P1 P2 Mean</td>
</tr>
<tr>
<td>FYM</td>
<td>2.9a 1.8a 3.1a 2.6a</td>
<td>4.8a 4.4a 2.8a 4.0a</td>
<td>2.4a 4.6a 3.3a 3.4a</td>
<td></td>
</tr>
<tr>
<td>CHM</td>
<td>1.5a 0.8a 2.1a 1.4a</td>
<td>5.1a 4.2a 4.8a 4.7a</td>
<td>1.1a 2.1a 2.5a 1.9a</td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>2.2a 1.3a 2.6a 4.9a 4.3a 3.8a</td>
<td>1.8a 3.4a 2.9a</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

SE±
- O.M = 0.4
- P = 0.5
- O.M x P = 0.7

O.M = 1.4
P = 1.8
O.M x P = 2.5

Means followed by the same letter(s) within a row or column are not significantly different at 0.05 according to DMRT.
Table (7): Effect of FYM, CHM and Phosphorus on Nodules dry weight (g/plant):

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Plant Age (days)</th>
<th>45</th>
<th>75</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P0</td>
<td>P1</td>
<td>P2</td>
</tr>
<tr>
<td>FYM</td>
<td>0.3a</td>
<td>0.2a</td>
<td>0.2a</td>
</tr>
<tr>
<td>CHM</td>
<td>0.02b</td>
<td>0.2a</td>
<td>0.03a</td>
</tr>
<tr>
<td>Mean</td>
<td>0.2a</td>
<td>0.2a</td>
<td>0.1a</td>
</tr>
</tbody>
</table>

SE±
- O.M = 0.07
- P = 0.09
- O.M x P = 0.12
- O.M = 0.03
- P = 0.02
- O.M x P = 0.04

Means followed by the same letter(s) within a row or column are not significantly different at 0.05 according to DMRT.
4.2. Yield Parameters

4.2.1. Fresh Forage Yield (t/ha)

The results in Table (8) show that CHM produced a slight and insignificant increase in fresh forage yield as compared to FYM. As for P treatments, the response was inconsistent, P0 showed a slight and insignificant increase in fresh forage yield than other P levels. Moreover the interaction of P and organic manure had a significant effect on fresh forage yield with the combination of FYM and P1 giving the highest forage yield.

4.2.2. Dry Forage Yield (t/ha)

The results in Table (8) show that CHM produced greater forage dry yield than FYM, but again the difference was not significant. On the other hand P1 application caused a slight increase in dry forage yield than the other P levels, but the effect was not significant. The interaction of P and organic manures had no significant effect on dry fodder yield.

4.3. Chemical Analysis

4.3.1. Plant Analysis

4.3.1.1. Leaf Nitrogen Content (%)

The results showed that CHM produced a slight and insignificant increase in leaf nitrogen content than FYM, but again the differences was not significant. On the
Table (8): Effect of FYM and CHM and Phosphorus on Yield Fresh and Dry Weight (t/ha):

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Fresh Weight</th>
<th></th>
<th></th>
<th></th>
<th>Dry Weight</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P0</td>
<td>P1</td>
<td>P2</td>
<td>Mean</td>
<td>P0</td>
<td>P1</td>
<td>P2</td>
<td>Mean</td>
</tr>
<tr>
<td>FYM</td>
<td>20.2ab</td>
<td>22.2a</td>
<td>13.6b</td>
<td><strong>18.7a</strong></td>
<td>7.8a</td>
<td>8.5a</td>
<td>4.7a</td>
<td><strong>6.9a</strong></td>
</tr>
<tr>
<td>CHM</td>
<td>21.0ab</td>
<td>18.5ab</td>
<td>18.7ab</td>
<td><strong>19.4a</strong></td>
<td>6.7a</td>
<td>7.6a</td>
<td>7.2a</td>
<td><strong>7.1a</strong></td>
</tr>
<tr>
<td>Mean</td>
<td><strong>20.6a</strong></td>
<td><strong>20.4a</strong></td>
<td><strong>16.2a</strong></td>
<td>7.2a</td>
<td><strong>8.0a</strong></td>
<td><strong>5.9a</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

SE±

<table>
<thead>
<tr>
<th></th>
<th>O.M =</th>
<th>1.5</th>
<th></th>
<th></th>
<th>P =</th>
<th>1.8</th>
<th></th>
<th></th>
<th>O.M x P =</th>
<th>2.6</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Means followed by the same letter(s) within a row or column are not significantly different at 0.05 according to DMRT.
Table (9): Effect of FYM, CHM and Phosphorus on Plant nitrogen and phosphorus contents (%):

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Nitrogen content</th>
<th>Phosphorus content</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P0</td>
<td>P1</td>
</tr>
<tr>
<td>FYM</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1.8a</td>
<td>2.4a</td>
</tr>
<tr>
<td>CHM</td>
<td>2.6a</td>
<td>2.4a</td>
</tr>
<tr>
<td>Mean</td>
<td>2.2a</td>
<td>2.4a</td>
</tr>
</tbody>
</table>

\[\text{SE\pm} \]

\[
\begin{align*}
\text{O.M} & = 0.22 & & 0.01 \\
\text{P} & = 0.27 & & 0.01 \\
\text{O.M x P} & = 0.38 & & 0.02 \\
\end{align*}
\]

Means followed by the same letter(s) within a row or column are not significantly different at 0.05 according to DMRT.
other hand P1 application caused a slight increase in leaf nitrogen content than the other P levels, but the effect was not significant. Moreover the interaction of P and organic manures had no significant effect on leaf nitrogen content. (Table 9)

4.3.1.2. Leaf Phosphorus Content (%) 

The results in Table (9) showed that FYM produced a slight and insignificant increase in leaf phosphorus content as compared to CHM. As for P treatments, P0 showed greater leaf phosphorus content than other P levels but the difference was not significant. Moreover the interaction of P and organic manures had no significant effect on leaf phosphorus content. (Table 9)

4.3.2. Soil Analysis 

4.3.2.1. Soil Moisture Saturation Percentage (%) 

The results showed that FYM produced a slight and insignificant increase in soil Moisture saturation percentage as compared to CHM. As for the P treatments, P2 showed greater soil saturation percentage than other P levels but the difference was not significant. On the other hand the interaction of P and organic manures had a significant effect on soil saturation percentage with the combination of FYM and P2 giving the highest value. (Table 10)
4.3.2.2. Soil pH

The results in Table (10) show that FYM produced a slight and insignificant increase in soil pH than CHM, but again the difference was not significant. As for P treatments, P2 showed a slight increase in soil pH than the other P levels, but the effect was not significant. On the other hand the interaction of P and organic manures had no significant effect on soil pH.

4.3.2.3. Soil Electrical Conductivity (ECE) (mohs/cm)

The results showed that application of organic manures had no significant effect on soil electrical conductivity. As for P treatments P2 showed a significant increase in soil electrical conductivity than other P levels. Moreover the interaction of P and organic manures had a significant effect on soil electrical conductivity with the combination of FYM and P2 showing highest values than the other treatments. (Table 10)

4.3.2.4. Soil Ca + Mg Content (meq/L)

The results in Table (11) show that CHM produced a slight and insignificant increase in soil Ca + Mg content than FYM, but the difference was not significant. On the other hand P2 and P1 caused a significant increase in soil Ca + Mg content than P0. Moreover the interaction of P and organic manure had a significant effect in Ca + Mg soil content with the combination of FYM and P2 and CHM and P1 giving the highest value.
### Table (10): Effect of FYM, CHM and Phosphorus on Some Soil Characteristics:

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Moisture Saturation Percentage %</th>
<th>pH</th>
<th>Soil Electrical conductivity (mmohs/cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P0</td>
<td>P1</td>
<td>P2</td>
</tr>
<tr>
<td><strong>FYM</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>55.4b</td>
<td>56.8ab</td>
<td>58.6a</td>
</tr>
<tr>
<td><strong>CHM</strong></td>
<td>56.5ab</td>
<td>56.6ab</td>
<td>57.2ab</td>
</tr>
<tr>
<td><strong>Mean</strong></td>
<td>55.9a</td>
<td>56.7a</td>
<td>57.9a</td>
</tr>
</tbody>
</table>

**SE±**

| O.M = | 0.33 | 0.06 | 0.02 |
| P =   | 0.4  | 0.07 | 0.03 |
| O.M x P = | 0.5 | 0.09 | 0.04 |

Means followed by the same letter(s) within a row or column are not significantly different at 0.05 according to DMRT.
4.3.2.5. Soil Sodium (Na) Content (meq/L)

The results showed that FYM produced a slight and insignificant increase in soil sodium (Na) content than CHM, but again the difference was not significant. As for P treatments, the response was inconsistent with P0 which causing a slight increase in soil sodium content than the other P levels, but the effect was not significant. Moreover the interaction of P and organic manures had no significant effect on soil sodium content. (Table 11)

4.3.2.6. Soil SAR

The results in Table (11) show that FYM produced a slight but insignificant increase in soil SAR than CHM, but again the difference was not significant. On the other hand P1 application caused a slight increase in soil SAR content than the other P levels, but the effect was not significant. Moreover the interaction of P and organic manures had no significant effect on soil SAR.
Table (11): Effect of FYM, CHM and Phosphorus on Soil mineral Content:

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Ca + Mg (meq/L)</th>
<th>Sodium Content (meq/L)</th>
<th>SAR</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>P0</td>
<td>P1</td>
<td>P2</td>
</tr>
<tr>
<td>FYM</td>
<td>5.2bc</td>
<td>4.5bc</td>
<td>7.5a</td>
</tr>
<tr>
<td>CHM</td>
<td>4.3c</td>
<td>7.2a</td>
<td>5.9ab</td>
</tr>
<tr>
<td>Mean</td>
<td>4.7b</td>
<td>5.8a</td>
<td>6.7a</td>
</tr>
</tbody>
</table>

SE±
- O.M = 0.17
- P = 0.21
- O.M x P = 0.3

Means followed by the same letter(s) within a row or column are not significantly different at 0.05 according to DMRT.