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EFFECT OF *ALBIZIA LEBBECK* PODS USED AS SOIL AMENDMENT ON THE GROWTH OF *SOLANUM AETHIOPICUM* (GARDEN EGGS).

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ABSTRACT

In the array to assess the suitability of using amendments from nitrogen fixing trees in agroforestry, the response of *Solanum aethiopicum* to *Albizia lebbeck* pod amendment was investigated in a plant house experiment at the University for Development Studies-Nyankpala campus. The objective of this study was to determine the effect of different levels of *A. lebbeck* pods used as soil amendment on the growth of *S. aethiopicum*. Different amounts of the powdery form of *A. lebbeck* pods were mixed with 6kg of well-drained soil in four treatment levels; T_0 (control- 6kg soil with no amendment), T_1 (0.130kg pod amendment in 6kg soil), T_2 (0.195kg pod amendment in 6kg soil) and T_3 (0.260kg pod amendment in 6kg soil) which were put in 1.132 m^3 plastic buckets and arranged in a randomized complete block design. *Albizia lebbeck* pod amendment applied at T_1, T_2 and T_3 significantly promoted certain growth parameters relative to T_0 (control). However, exact effects depended on the particular growth parameter measured. For example T_2 and T_3 significantly increased number of leaves and leaf area index, but not plant height. Effects of T_2 and T_3 on mean leaf number were similar but different from $T_{1.}$ Mean heights of plants grown in T_1 and T_3 were higher (although not statistically significant) than T_2 and $T_{0.}$ Although certain growth parameters were more affected than others, application of *A. lebbeck* pod amendment generally improved growth performance of *Solanum aethiopicum*, making it suitable for use as soil amendment for the cultivation of garden eggs.

Keywords: Soil amendment, *Albizia lebbeck*, *Solanum aethiopicum*, plant growth and soil amendment.

INTRODUCTION

The present traditional forms of land use management by farmers such as shifting cultivation is no longer promising to restore soil fertility status due to high population growth, pressure on land for farming, dependency on erratic rain fed agriculture with high frequency of drought and other socio-economic purposes which are endemic constraints that need technological intervention for sustainability (Asafo-Agyei, 1995). The length of the traditional bush fallow is also not long enough to restore soil fertility status under the present socio-economic conditions of farmers, but the advantages inherent in bush fallow could be restored if proper farming practices are substituted with bush fallow (Asafo-Agyei, 1995). Among these proper farming practices are the application of inorganic fertilizers and organic resources such as crop residue, green manure, animal manure and compost.

The use of inorganic fertilizer to increase crop yields has become an important option for improving soil fertility and productivity. Although high crop yield can be obtained with the use of inorganic fertilizers, reliance on inorganic fertilizer tends to favour farmers with large acreage (Meelu *et al.*, 1994). Also, the use of inorganic fertilizers is costly in terms of the energy resources to produce it and high rate of use (notably ammonium sulphate) leads to environmental problems (Young, 1997). Majority of smallholder farmers on the other hand lack the financial resources to purchase sufficient fertilizer to replace soil nutrients lost to harvested crop products (Jama *et al*., 2000). Soil fertility on these smallholder farms has therefore declined and yield of staple food crops are typically low (Gyamfi *et al.*, 2001). For these reasons, only few farmers endowed with resources such as cattle and land with off-farm income can afford to buy inorganic fertilizers (Sanchez, 1987). This option however, has both economic and environmental implications. Majority of farmers are not able to afford the high cost of inorganic fertilizers and the few farmers who apply it do so at sub-optimal level due to high cost of these fertilizers. There is therefore the need to find alternative sources of maintaining the productivity of the soil.

Organic sources of nutrients are often proposed as alternatives to commercial mineral fertilizers due to the numerous disadvantages of inorganic fertilizers. Makumba *et al.* (2007) states that the inability of most resource-poor farmers to afford mineral fertilization has made organic amendment a viable alternative source of soil fertility replenishment in low-input smallholder farming systems. However, traditional organic materials such as crop residues and animal manure cannot by themselves reverse soil fertility decline because they are usually not available in sufficient quantities on most farms and their processing and application is labour demanding (Palm *et al.*, 1997). Some organic materials also have competitive uses such as fodder for livestock. It is however important to note that, some of these unused traditional organic resources grow near our smallholder farms. These resources have relatively high nutrient content but little is known about their potential as nutrient sources to improve soil fertility and crop yield. Tree biomass used as soil amendment for crop production also offers long term solution to soil problems as compared to inorganic fertilizer that has relatively temporary impact on soil fertility. There are many tree resources especially the leguminous ones such as *Gliricidia sepium, Albizia lebbeck, Albizia zygia, Leucaena leucocephala* and *Azadirachta indica* that can be used as amendments to improve the fertility of soil.

Albizia lebbeck is a leguminous and deciduous tree species of 15 - 30m tall and a diameter between 50cm to1m (DFSC, 2000). The nitrogen, phosphorus and potassium concentration in *Albizia lebbeck* is relatively high compared to other nitrogen fixing trees as it supports grasses and other species that grow under its canopy (Lowry *et al*., 1991). The nitrogen concentration in *Albizia lebbeck* biomass is also higher than the critical level of 2.0 - 2.5 percent below which net mineralization of nitrogen would be expected. The phosphorus is higher than the 0.25% for P mineralization (Palm *et al*., 1997). The application of *A. lebbeck* leaf litter on crop fields is reported to have significant influence on yields as it supplies as much as 75kg Nha^{-1} increasing yields (203-422%) in Sorghum (Tilander, 1993). The use of organic resources improves all aspect of soil fertility by contributing to soil organic matter. Soil amendment improves soil physical properties, such as water retention, permeability, water infiltration, drainage, aeration and structure with the goal being to provide a better environment for root growth (Davis and Whiting, 2013). Soil amendment must be thoroughly mixed into the soil and not merely buried for effectiveness. The objective of this research was to assess the effect of *Albizia lebbeck* seed pods used as soil amendment for the growth of *Solanum aethiopicum* by mixing the soil with the powdery form of the pods.

MATERIALS AND METHODS

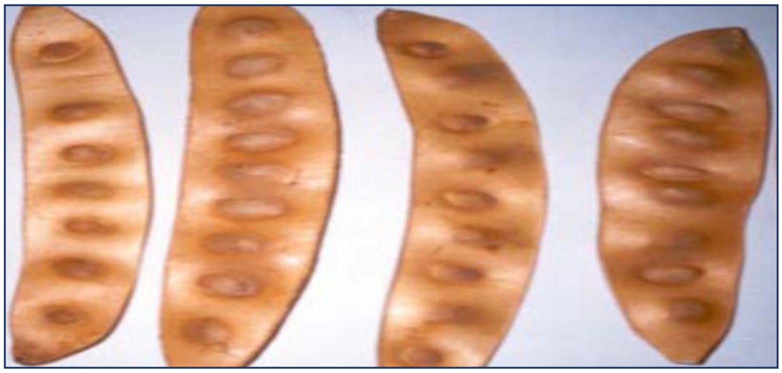
Study area

The experiment was conducted at the plant house of the University for Development Studies-Nyankpala campus. The site is located in the Guinea Savanna zone of Ghana. It lies within latitude 9º 25 N to 10º 4E and longitude 0º 58 N to 1º 12 W at an altitude of 183m above sea level (SARI, 1997). The area has a unimodal rainfall pattern with an annual rainfall of 1034.4mm distributed uniformly from April to late November (SARI, 2004). The temperature for the area also ranges from 22ºC during the rainy season and reaches a maximum of 34ºC during the dry season.

Experimental design and layout

Dry pods of *A. lebbeck* (plate.1) were collected and with the help of a milling machine the dry pods were ground into powdery form. Three different weights of pod powder; 0.130kg, 0.195kg and 0.260kg were measured with an electronic balance and each mixed with 6kg of well-drained sandy loam soil. This gave four treatments of 0.130kg pod to 6kg soil (T_1), 0.195kg pod to 6kg soil (T_2), 0.260 pod to 6kg soil (T_3) and 6kg soil with no pod amendment (T_0, control). 1.132 m^3 plastic buckets were filled with pod-soil mixture and with soil with no pod amendment. The soil was left for two weeks to allow decomposition to take place after which 5 weeks old *Solanum aethiopicum* seedlings were transplanted into them.

Plate 1: Photograph of *Albizia lebbeck* pods



The four treatments were arranged in a randomized complete block design (RCBD) with four blocks. Two (2) seedlings were put in each plastic bucket. The layout is shown in Table 1 below.
Seedlings were watered twice a day, every other day and were sprayed with ''Insector T45'' pesticide to prevent any pest infestation. Weeding was also carried out by hand picking every two weeks. Data on plant height, number of leaves produced per week and the leaf area index were taken.

Table 1. Layout of the experiment

Block 1	**Block 2**	**Block 3**	**Block 4**
T_0	T_3	T_2	T_1
T_1	T_0	T_3	T_2
T_2	T_1	T_0	T_3
T_3	T_2	T_1	T_0

Data Analysis

The leaf area index was calculated using the equation below, after Sexena and Singh (1965);
$LAI = 0.75 \times L \times B$……………… (1) Where LAI is leaf area index, 0.75 is a constant, L is length of leaf and B is breadth of leaf which were both measured with a ruler.

All data collected were subjected to analysis of variance (ANOVA) using Genstat statistical software while treatments were differentiated using Least Significant Difference (LSD) at 5% probability level.

RESULTS AND DISCUSSIONS

Plant Height

There was a general increase in plant height after transplanting (week 1) to end of the experiment (week 9) for all the treatment levels (Fig. 1). Mean differences in height among treatments were not significant ($p = 0.11$) at the end of the experiment. However, amendment applied at T_1 recorded the highest mean height of 17.55cm while the control (T_0) recorded the lowest mean height of 13.15cm (Fig. 1).

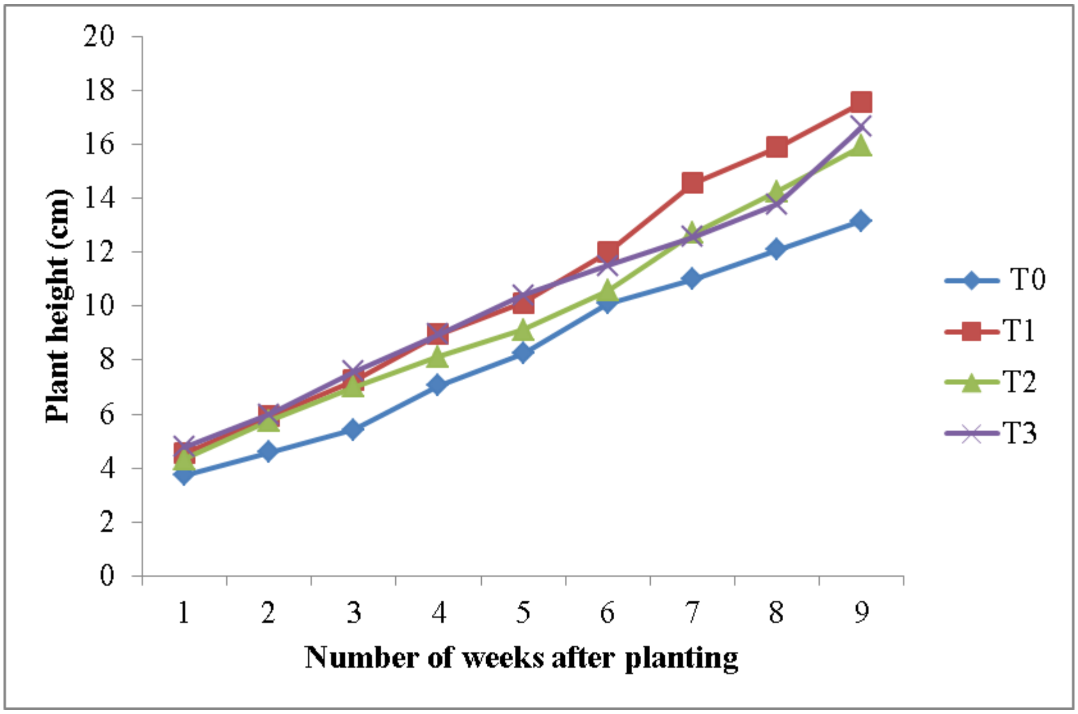


Fig 1: Effects of *Albizia lebbeck* pod amendment on the plant height.

The increase in height was greater in the amendment applied at levels T_1, T_2 and T_3 than the control (no amendment). This could be ascribed to the fact that, the added amendment increased the supply of plant nutrient in the soil for the roots to get access to those available (Brady, 1990). This confirms the suggestion that higher availability of nutrients increases succulent growth (Janick, 1986). It may therefore be for this reason that plant height increased slowly through the experimental period. This is however contrary to findings of Ofori (2010), where the highest recorded heights were 57cm and 33cm at levels 7728kg/ha and 0kg/ha respectively. This inconsistency may be the result of field experiment (Ofori 2010) versus plant house experiment (this study).

Number of leaves produced

Observations made on the number of leaves produced by *Solanum aethiopicum* showed an increase from week 1 to week 9 (Fig. 2). By week 5 mean differences among treatment levels were already significant ($p = 0.01$), with T_1, T_2 and T_3 producing more leaves relative to the control (Fig. 2). These differences were still significant ($p = 0.04$) by the end of the experiment. The amendments applied at levels T_2 and T_3 recorded the highest mean number of leaves (23) and the control (T_0) recorded the least (19).

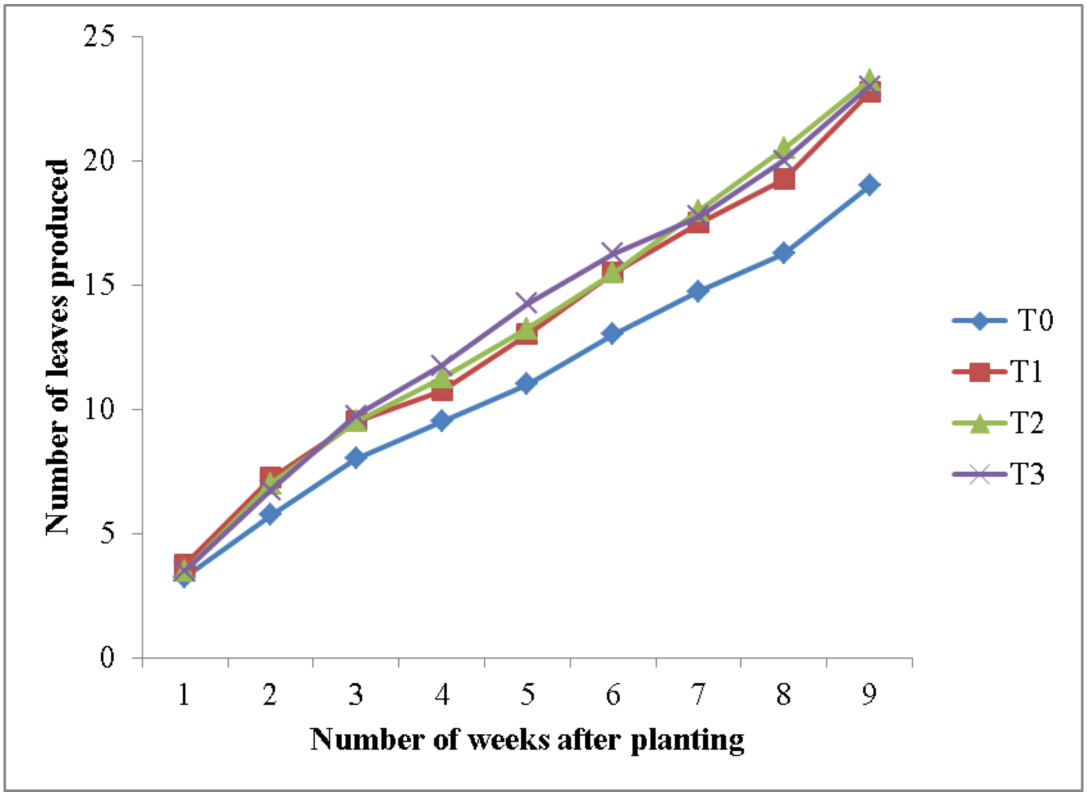


Fig 2: Effects of *Albizia lebbeck* pod amendment on the number of leaves produced.

Plants that received amendments applied at levels T_2 and T_3 recorded higher number of leaves than plants that received amendments at levels T_1 and the control (T_0). This may be due to sufficient amount of nitrogen as a result of the decomposition of the applied amendment at T_2 and T_3 which affirm the fact that, higher nitrogen concentration increases succulent growth (Janick, 1986).

Leaf Area Index (LAI)

There was a slow initial response to treatments until week 4 (Fig. 3). After week 4, mean LAI at T_1 T_2 and T_3 were higher (absolute figures) relative to the control (T_0), culminating in borderline significance ($p = 0.058$) by the end of the experiment (week 9), with T_3 recording the highest mean value of 176cm^2 while the control recorded the lowest mean value of 83cm^2.

Overall, the control (T_0) had the lowest growth performance among all the treatment levels which may be due to low nutrient content in the soil that was used for the experiment (although no nutrient analysis was done). Nutrient deficient soils result in retarded growth of plants (Hausenbuiller, 1972; Rice *et al.*, 1993). Also, plants that received amendments at T_2 and T_3 were not significantly different in height, number of leaves produced and the leaf area index. This may imply that, plants with amendment at T_2 received enough nitrogen for growth; hence the excess in nitrogen received by plants with amendment at T_3 did not result in significant difference in height, number of leaves produced and the leaf area index.

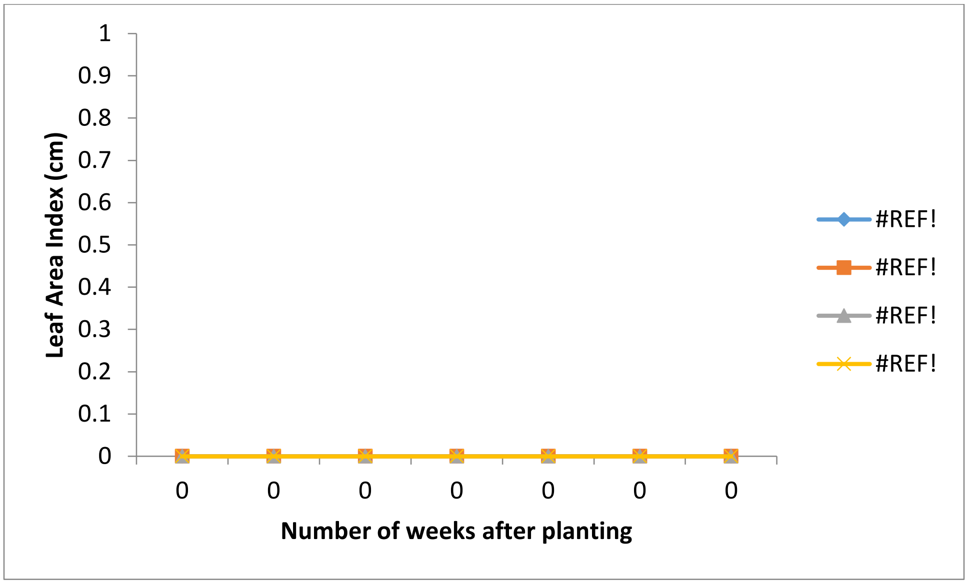


Fig 3: Effects of *Albizia lebbeck* pod amendment on the plant leaf area index.

CONCLUSIONS AND RECOMMENDATIONS

The application of *A. lebbeck* pod amendment improved growth over the control treatment. Treatment effects on growth of *S. aethiopicum* at levels, T_2 and T_3 were statistically similar, which is an indication that quantities of *A. lebbeck* pods amendment required to improve growth is not so much. Therefore, *A. lebbeck* pods amendment is recommended for use by farmers, as it has great prospects for use in soil fertility improvement.

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