GROWTH AND BULB YIELD OF *ALLIUM SATIVUM* L. (GARLIC) IN SANDY LOAM AND SILT LOAM SOILS

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ABSTRACT
The differences in the growth and bulb yield of Allium sativum L. (garlic) in sandy loam and silt loam soils were studied. Vegetative growth of plants in sandy loam was significantly higher than that of plants grown in silt loam. The plant height, number of leaves, fresh weight and dry weight of plants grown in sandy loam was significantly higher than those of plants grown in silt loam. The weight of bulbs produced by plants grown in silt loam (2.52 ± 0.46 g) was significantly higher at $p<0.05$ than that of plants grown in sandy loam (1.57 ± 0.21 g). There was no significant difference in the numbers of cloves per bulb produced by plants from both soil types. Cloves of bulb produced by plants grown in silt loam had significantly higher allicin concentration (2.11 ± 0.17 µg/g fresh clove) than plants grown in sandy loam (1.19 ± 0.33 µg/g fresh clove). This report shows that while garlic plants grew vegetatively better in sandy loam, bulb yield (weight and allicin concentration) was enhanced in silt loam. A luxuriant vegetative growth of garlic appears not to results in a better bulb yield.

Key words: Allicin, Bulb, Garlic, Sandy-loam, Silt-loam

INTRODUCTION
Garlic (*Allium sativum*), belonging to the family Alliaceae, is grown for its clove yield: number per bulb, size and allicin concentration (Ade-Ademilua *et al*., 2009). It is a widely distributed plant used throughout the world not only as a spice and food, but also in folk-medicine ((McGee, 2004, AbouZid and Mohamed, 2011; Barghul and Golparvar, 2015). Garlic is an effective antibiotic, antiviral and antifungal agent, which could be used to prevent nausea, diarrhea, and ease coughs. Garlic is also used to treat malaria, cholera and certain types of cancer. It is probably an immune system enhancer (Randle and Lancaster, 2002; Turner, 2004, Andreatta *et al*., 2005). For medicinal application, higher rates of allicin are more favorable (Huchette *et al*., 2004).

Garlic is a generally sterile, vegetatively propagated crop that has desirable variation for most agronomic and morphological characters. Since morphological characteristics can vary under different agroclimatic conditions, interactions between genotype and environment can complicate the characterization of garlic

clones. Variations in the clove size and allicin quantity, due to difference in location of cultivation, have been reported (Shaaf *et al.*, 2014). Garlic grows best in fertile soils. The amount of fertilizer needed vary with soil type, the amount of organic matter present, the previous crop grown on the soil and the climatic condition during the growing season (Diriba-Shiferaw, 2016). While Baghalian *et al*. (2000) have reported that climatic conditions do not cause variation in garlic, Camargo *et al*. (2005) have shown that the concentration of allicin can vary significantly between cultivars, keeping constant variability attributed to climatic conditions and dormancy state of cloves. Clove number has been found to be genetic while bulb size and colour as well as elemental composition are found to be phenotypic, specific to sites (Volk and Stern, 2009).

One important climatic feature which can affect the pattern of growth in *A. sativum* is the edaphic characteristic. There is scarcity of information on this important plant growth factor; and the present study has attempted to provide an articulate description of the influence of two different types of soils on the development of *A. sativum*. Sandy loam and silt loam soils which were the selected soil types for study of their roles in the development of garlic are presented. The soil types have been found to provide an ideal growth medium texture for garlic (Zaman *et al*., 2011). However, there is no report on the possible effects of using sandy loam as against silt loam in the cultivation of garlic. The study primarily focused on the influence of sandy loam and silt loam soils on leaf growth and bulb yield of *A. sativum* (garlic).

MATERIALS AND METHOD

Northern Nigerian variety of garlic bulbs (*Allium sativum*) were purchased from a retailer at Mile 12 Markets, Lagos. Organic manure (poultry manure) was obtained from Ministry of Agriculture Live stock and Poultry Management, Oko-Oba road Agege. Inorganic fertilizer (N:P:K, 15:15:15) was purchased from Shodex Beautification Landmarks, 251/253 Ikorodu Road, Anthony Lagos.

Experimental Site

The experiment was carried out in a screen house under temperature range of $23^{o}C$ - $28^{o}C$ in University of Lagos Botanical Garden, Akoka Yaba, Lagos.

Soil

Two soil types were collected from the Botanical Garden, University of Lagos and texture sampling carried out according to the method of Saxton *et al.* (1986). One hundred grams of each of the two soil samples and 200 ml distilled water

were poured into 250 ml glass jar covered and sealed with foil paper. Samples were shaken vigorously (in order to homogenize the particle sizes) for five minutes and left for 24 hours to settle. Thereafter, the volumes of silt, clay and sand were recorded. Based on Saxton's algorithm, the bulk density and soil texture were ranked with the U.S. soil textural triangle using percentage content of the three main mineral compounds of the soil; sand, silt and clay. Both soils were confirmed to be sandy loam with sand, silt and clay in ratio 3:1:1 and the other silt loam with sand, silt and clay in ratio 2:2:1.

Planting Procedure

40 jute bags (50 cm in diameter) per set were half filled with sandy loam or silt loam up to 20 cm high. Organic manure was added to boost the fertility of the soils. Fresh, garlic cloves stored under room temperature (untreated), of an average weight 2.49g, were soaked in water for 72 hours (as practiced by local farmers). The cloves were removed from the water and tip of cloves were popped to ease sprouting. These were sown in soil by placing the cloves based down and clove stands erect in soil. Seedlings of same size were selected 14 days after sowing and transplanted into the soils in the planting bags: these were transplanted along with the soils to prevent sudden change of environment of the plants; a plant was transplanted into each bag. Organic manure (0.35 kg) was applied at an interval of 14-days; the organic manure was applied to the plants in rows in the sack and 5.3g of N:P:K (1:1:1) fertilizer was applied to the soil at an interval of three weeks according to Bodnar *et al.* (1998) with the aid of centimeter rule, 10cm was measured from the foot of the plants making a circumference round the plants for application of N:P:K.

Vegetative measurements

Vegetative measurements of plants were taken 120 days after planting. The heights of plants were measured with the aid of a centimeter rule, from the soil level to apex of the leaves. The numbers of remaining green leaves per plant were counted. Plants were carefully uprooted and the bulbs were removed. The fresh weights were determined using Mettler PM 34-K Delta range top loading balance. The weighed fresh plants were placed in a baking paper and placed in oven at 80 ^{0}C for 72 hrs to obtain dry weight. The bulbs harvested from each plant were weighed.

Allicin analysis

Five plants per soil were uprooted and the bulbs harvested. Bulbs were put together and divided into three samples of 2 g of fresh raw garlic. The concentration of allicin of the bulb was analysed using the method of Itakura *et*

al. (2001). Two gram of fresh raw garlic clove was blended and homogenized with 2ml of distilled water and diluted with 8 ml of methanol. The eluate was filtered and allicin content was analysed using Gas Chromatography Mass Spectrometry of Column DB – 17ms, Oven 45^{o}C for 3min , 45 – 240^{o}C at 5^{o}/min, Detector MSD, 200^{o}C transfer line full scan 35 – 215 amu. Wassen garlic drug was used as standard for detecting retention time of allicin. The Standard contains 1600µg of allicin in each tablet which is equivalent to 960g of fresh garlic that is 1.667µg/g of fresh garlic. Average retention time of allicin was 12.761- 12.812 min. The percentage of allicin detected in the standard was 20.727%. The quantity of allicin per gram of fresh garlic in sample was calculated as thus;

$$\frac{\text{(Weight of allicin in standard) µg/g X \% of allicin in sample}}{\text{\% of allicin in standard}}$$

$$= \frac{\text{1.667 µg/g X \% allicin in sample}}{\text{20.727\%}}$$

Statistical Analysis

All measurements and analyses were done in triplicates and data were expressed as means. Statistical test for significance was done with Student's t-test ($p < 0.05$) using GraghPad Prism 6 software and data plotted graphically using Microsoft Excel 2007.

RESULTS AND DISCUSSION

The results of the mean plant heights, number of leaves, plant fresh weights and plant dry weights taken at 120 days after planting are shown in Fig. (1). The height of plants grown in sandy loam was significantly higher ($p<0.05$) than that of plants grown in silt loam at harvest. The mean number of leaves in plants grown in sandy loam was higher than the number of leaves in plants grown in silt loam but the difference was not significant ($p>0.05$). The fresh and dry weights of plants (vegetative) grown in sandy loam was significantly higher than those of plants grown in silt loam at $p<0.05$. Vegetative growth of plants in sandy loam was significantly higher than that of plants grown in silt loam at $p<0.05$.

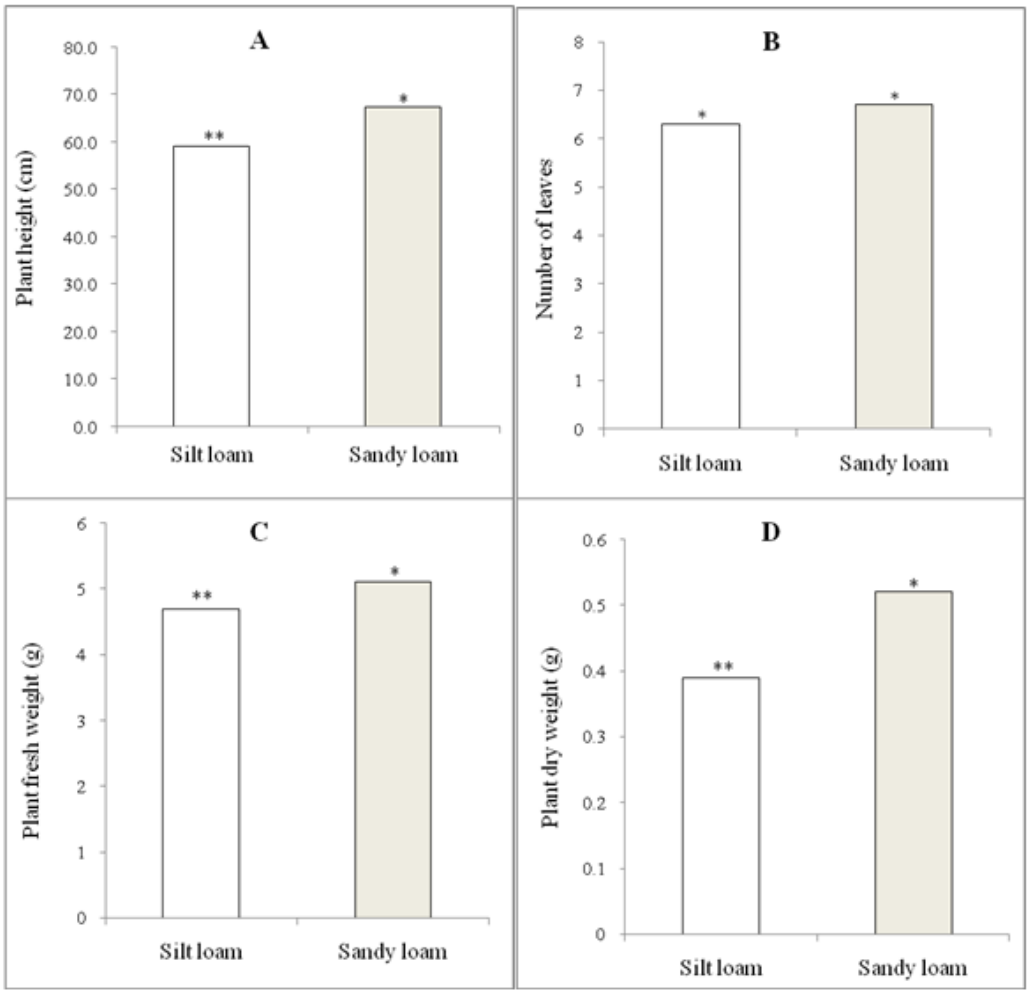

Fig. 1: The plant height (A), number of leaves (B), plant fresh weight (C) and plant dry weight (D) of *Allium sativum* plants grown in silt loam and sandy loam soils. Plotted means in same chart with different number of asterisks are significantly different at $p<0.05$.

The results of the mean weight of bulbs and concentration of allicin in cloves of plants grown in silt and sandy loam soils are shown in Fig. (2). The weight of bulbs produced by plants grown in silt loam (2.52 ± 0.46 g) was significantly higher at $p<0.05$ than that of plants grown in sandy loam (1.57 ± 0.21 g). There was no significant difference in the number of cloves per bulb produced by plants from both soil types; both had an average of 5 cloves per bulb. This is not surprising as clove number has been found to be under strict genetic control while

bulb size is phenotypic, specific to sites (Volk and Stern, 2009). Cloves of bulb, produced by plants grown in silt loam, had allicin content of 2.11± 0.17 µg/g fresh garlic while cloves of bulb produced by plants grown in sandy loam had allicin content of 1.19 ± 0.33 µg/g fresh garlic. Concentration of Allicin has been reported to be affected by both genetic and management practices. According to Mirzaei *et al*. (2007), soil fertility affects allicin concentration. In this study, it appears that allicin concentration is related to weight of bulb/clove, the bigger the bulb/clove, the higher the allicin concentration.

This report shows that leaf growth and bulb yield appear to respond differently to growth conditions. Leaf growth and bulb yield have also been reported to react differently to population density. According to Karaye and Yakubu (2006) leaf growth is higher in less populated stands than populated stands while bulb yield is higher in thick stands than thinner stands. Invariably, a luxuriant growth of garlic does not necessarily translate into a better bulb yield; in fact it might be the contrast.

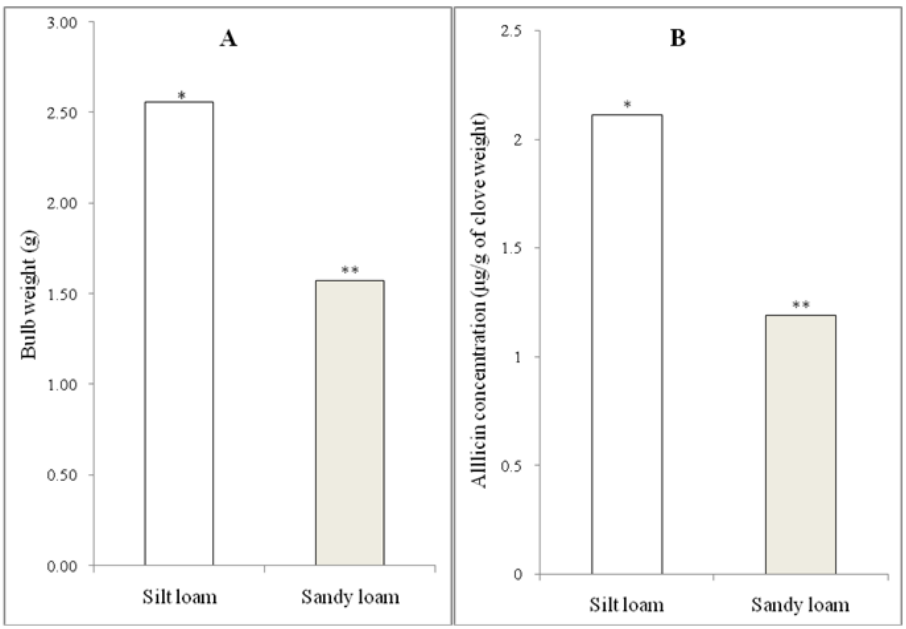

Fig. 2: The bulb weight (A) and concentration of allicin (B) in cloves of plants of *Allium sativum* L. grown in silt loam and sandy loam soils. Plotted means in same chart with different number of asterisks are significantly different at p<0.05.

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