The Effect of Leguminous Cover Crops on Growth and Yield of Garden Eggs

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ABSTRACT
The use of cover crops is a way of sustainable agriculture in which nutrients are recycled and the use of inorganic fertilizer is reduced. Leguminous cover crops for instance are known to enrich the soil through the fixing of nitrogen in the form of nitrates in the soil for plant use. The objective of the study was to determine the effect of some leguminous cover crops on growth and yield of garden eggs. The study consisted of five treatments, namely Bare ground (control), fertilizer (NPK 15:15:15), Mucuna pruriens, Glycine max and Phaseolus lunatus laid in a randomized complete block design with 3 replicates. Data collected were on vegetative growth and yield parameters. Results showed that plant height of garden eggs was highest in Phaseolus treated plots and this was followed by the Glycine max plots. Phaseolus treated plots had the highest yield in terms of the number of fruits harvested and weight of fruits harvested.

Key words: Cover crops, Garden eggs, Mucuna treated plots, Phaseolus treated plots, Yield.

INTRODUCTION
Garden egg, a vegetable crop, is used in the culinary industry and is important in the nutritional health of people. Garden eggs production is widespread in the Southern part of Ghana and is consumed in most parts of Ghana. It is also an export crop. The production and sale of the crop is an important income generating activity that has helped in reducing unemployment among the youth particularly those engaged in its cultivation and marketing. The production of garden eggs is characterized by the use of insecticides to control pests that infest the crop and also a high input of inorganic fertilizer. Some of the fields used for the cultivation of the crop may be cropped year after year leading to the impoverishment of the soil in these fields and therefore, lower yields. In most instances, farmers counteract the depletion of the soils on their farms by increasing the rates of the agrochemicals they apply to their fields. These practices could have effect on human and animal health (NRC, 2010) as well as air and ground water pollution (Hoorman, 2009). Due to the potential for vegetables produced using these methods to be contaminated, there is an increase in the demand for vegetables produced using organic methods of production. The practice of sustainable agricultural production is however not common in Ghana especially among vegetable farmers. The use of sustainable vegetable production practices such as the use of leguminous cover crops could result in high yields and less damage to surface and ground water and improve food safety.

Leguminous cover crops are known to replenish the soil through the incorporation of nitrates into the soil thus reducing the use of inorganic fertilizer. Aside this, some leguminous cover crops produce high biomass thereby contributing to high carbon to nitrogen ratio (C:N) in the soil through decomposition and denitrification. The legumes also suppress weeds on the ground. Given the effects of conventional agriculture particularly the use of inorganic fertilizers, on air, soil and water quality, leguminous cover crops could serve as a viable sustainable alternative. In intercropped systems, legumes enhance the yield of main crop and also a potential source of soil nutrients (Neamatollahi et al., 2013). Soil carbon and nitrogen content as well as soil and water quality could be improved by using cover crops (Garcia-Gonzalez et al., 2018). A work on Vicia spp. in United States of America found that hairy vetch could increase plant phytoneutrients as well as increasing soil fertility (Mattoo and Teasdale, 2010). The use of organic farming is becoming important given the effect of conventional agriculture on air, water and soil. Although some leguminous cover crop species such as Mucuna pruriens and Canavalia ensiformis are available in Ghana, their effect as cover crops has not been studied. This study therefore seeks answers to the question, do leguminous cover crops promote high yields in garden eggs production?

MATERIALS AND METHODS
The study was conducted at CSIR-Plant Genetic Resources Research Institute Research field (N 06° 17.839, W 00° 27.595, Alt 198.3 m above sea level) in Bunso, Ghana in
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2015. The climate of the area is the semi-equatorial type and the vegetation is the moist-deciduous rainforest. It has a mean minimum annual temperature of 21.4°C and a mean maximum annual temperature of 31.3°C (Aboagye, 2005). The area experiences bi-modal rainfall pattern from April to July and from September to the middle of November. It has a mean annual precipitation of 1455 mm. The dry season starts from the middle of November to March. The study involved clearing of a plot on-station and setting out an experiment in a randomized complete block design (RCBD) in a field trial. There were 5 treatments and 3 replicates. The treatments were control (bare ground), inorganic fertilizer (N.P.K. 15:15:15), Mucuna pruriens, Glycine max and Phaseolus vulgaris as cover crops mulched into the soil. Each treatment plot covered an area of 25 m. There were 2 m space between treatment plots and 5 m space between different blocks. Garden eggs (Solanum gilo) seeds were transplanted onto the field 3 weeks after sowing at a planting distance of 1 m between and within rows.

Data collection included plant height, plant spread, leaf size, flowering time and yield parameters. Fifty percent flowering time was measured by counting when half (5) of the selected sampled plants that had flowered. Yield was determined by weight and number of fruits harvested per plant on the sampled plants.

Data was analyzed using the analysis of variance (ANOVA) test at 5% significant level. Statistical analyses were performed using the Genstat statistical package (14th edition, VSN International).

RESULTS AND DISCUSSION

Vegetative growth

Plant height of garden eggs plants was highest in Phaseolus treated plots (56.68 cm) and this was followed by the Soybean plots (54.65 cm). Both were significantly higher than the plants on the Mucuna treated plots (43.60 cm) and the bare ground (Control plots) (46.05 cm, P < 0.001, Table 1).

Plant spread was similarly widest in garden eggs plants on Phaseolus plots (97.4 cm), followed by Soybean plots (95.1 cm) and both were significantly higher than in the bare ground (Control, P < 0.001, Table 1). Garden eggs plants on Mucuna pruriens treated plots showed the least plant height and spread. Phaseolus treated plants had the largest leaf size (leaf length 20.13 cm, leaf breadth 13.30 cm). This was followed by plants on soybean plots (leaf length 19.31, leaf breadth 13.16 cm). Phaseolus treated plants had significantly bigger leaf size (leaf length and width) than the control (Table 1).

Yield

Weight of harvested garden egg fruits per plant was significantly higher (P<0.001) in Phaseolus plot plants than the Mucuna plot plants. Similarly, number of fruits on Phaseolus grown garden egg plants was significantly higher (P=0.004) than the Mucuna plot plants. Fruit size was bigger in Phaseolus treated plots than the other treatments. Fruit diameter of garden egg plants on Phaseolus and soya bean plots were the highest (48.44 mm) and these were significantly higher than the control/bare ground plants (44.03 mm) which was also the least of the treatments (Table 2).

Table 1: Vegetative characteristics of garden eggs under different treatments.

| Treatment                | Plant height (cm) | Plant spread (cm) | Leaf length (cm) | Leaf width (cm) |
|--------------------------|-------------------|-------------------|-----------------|-----------------|
| Bare ground              | 46.05             | 82.1              | 18.89           | 12.57           |
| Fertilizer               | 49.28             | 85.7              | 18.97           | 12.75           |
| Soyabean                 | 54.65             | 95.1              | 19.31           | 13.16           |
| Phaseolus                | 56.68             | 97.4              | 20.13           | 13.30           |
| Mucuna                   | 43.60             | 79.3              | 18.92           | 12.51           |
| LSD (5%)                 | 6.233             | 9.21              | 0.975           | 0.689           |
| P-value                  | <0.001            | <0.001            | 0.066           | 0.088           |

Table 2: Yield and size of garden egg fruits at various harvest periods under different treatments.

| Treatment                | No. of fruits/plant | Weight of fruits (g) | Fruit length (mm) | Fruit width (mm) |
|--------------------------|---------------------|----------------------|-------------------|------------------|
| Bare ground              | 24.0                | 551                  | 62.42             | 44.03            |
| Fertilizer               | 23.4                | 518                  | 64.06             | 42.40            |
| Soyabean                 | 19.0                | 380                  | 65.88             | 48.44            |
| Phaseolus                | 28.4                | 623                  | 68.17             | 48.44            |
| Mucuna                   | 17.1                | 383                  | 62.15             | 44.59            |
| LSD (5%)                 | 6.196               | 134.1                | 5.480             | 3.538            |
| P-value                  | 0.004               | <0.001               | 0.163             | 0.001            |

The higher vegetative growth (plant height and plant spread) observed in garden eggs plants on Phaseolus treated plots culminated in high yield (number of fruits and weight of fruits). With the exception of leaf length, the other vegetative growth characters were significantly higher than that of the control. The significantly higher spread of the plants in terms of branches and larger leaf sizes would allow higher percentage light interception by these plants. The greater leaf surface exposure to sunlight leads to higher
photosynthetic rate and therefore higher crop yield. The higher vegetative growth of the leguminous cover crop plots over those in the control may be due to fixing nitrogen in the soil and decomposition of the biomass of the leguminous crops (Kintomo et al., 2008). This study is in agreement with a previous study in which cover crop, pea, produced sufficient biomass and nitrogen availability and led to higher yield of the succeeding crop which was maize (Buchi et al., 2018). Similarly, some earlier studies also reported the beneficial effects of cover crops on improving soil fertility and quality (Porpavai et al., 2006, Abdollahi and Munkholm, 2014, Mitchell et al., 2017).

Not all the cover crops used in the study, however, led to an increase in yield. In this study, growing garden eggs plants on Mucuna plots did not lead to increase in yield over the control. This is in contrast to earlier studies which reported that using Mucuna pruriens as a cover crop led to an increase in maize yields (Ile et al., 1996, Carsky et al., 2001, Hauser and Nolte, 2002). This may be explained by the fact that the benefit of a succeeding crop on a cover crop depended on the function of the crop (Tarawani, 1994). It could also be that the Mucuna pruriens could have utilized nutrients in the soil for its high vegetative growth. Again, the beneficial effect of cover crops to succeeding crops depended strongly on their management-choice of species, seeding and the destruction time (Tonitto et al., 2006).

The garden egg plants grown on fertilizer plots did not show high growth and yield. This could be that the amount of inorganic fertilizer used might not have been enough to induce high growth and yield in the garden eggs plants. In contrast to the comparatively low yield of garden egg plants on Mucuna plots, garden eggs plants grown on Phaseolus and soyabean plots showed higher vegetative growth and yield than the control. This could be due to the plants fixing higher nitrogen in the soil for subsequent use by the garden eggs plants. This agrees with an earlier study in which short duration fallows with cover crops and grain legumes showed considerable increase in the yield of succeeding maize crop (Horst and Haardt, 1994). Bucchi et al. (2018) also found that the use of cover crops increased grain yield and that the management of cover crops in a reduced tillage could maintain yield and improve soil fertility in the long run. In rice, incorporation of fieldbean crop residues was found to be superior to any other crop residue incorporation with regard to growth and yield (Radha and Srinivasula, 2011). The use of cover crops will promote a sustainable agricultural system and preserve environmental integrity (McKennel et al., 2018).

CONCLUSION
The study showed that use of Phaseolus as a cover crop resulted in grown garden eggs plants with significantly higher yield than the other treatments. The study also showed that not all cover crops could enhance yield of succeeding crops. It was indicated that whereas using Phaseolus and soybean treated plants resulted in higher yield than the control.

Mucuna pruriens grown garden eggs did not lead to higher yields as compared to the control. It can thus be concluded from the study, that, some leguminous cover crops hold potential for possible use in the sustainable production of garden egg fruits. This could also help the farmer to reduce cost of production

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