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The effect of leguminous cover crops on growth and yield of tomato

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***Abstract*— *Tomato (Lycopersicon esculentum L.) is one of the vegetable fruit crops commonly cultivated around the globe and used mostly as a flavour in cuisines. Cover cropping is a form of sustainable agriculture which helps to maintain soil fertility and reduces the need and the amount of inorganic fertilizer and thus helps the farmer to increase profitability. The objective of this study was to find the effect of the cover crops on growth and yield of tomato. In this experiment legume cover crops were grown in five treatment plots and these were Bare soil, inorganic fertilizer (NPK 15:15:15), Vigna unguiculata (Cowpea), Mucuna pruriens (Mucuna) and Canavalia ensiformis (Canavalia) in 3 blocks. The results showed that tomato plants grown on Canavalia ensiformis plots showed earlier flowering and fruiting than the other treatments. It also showed significantly higher yield than the other treatments (P= 0.006). The study shows that cover crops especially Canavalia ensiformis could be considered as part any farming system that wants to use sustainable farming to improve soil nutrients and reduce cost of farming.*
***Keywords*— Tomato, crop, conventional agricultural practices.**

I. BACKGROUND

The use of cover cropping as a sustainable agriculture practice is not commonly practised in Ghana. Most farmers use conventional agricultural practices which include the use of inorganic fertilizer in quite high quantities, which could lead to ground water pollution.

Vegetable fruits like garden eggs and tomato are cultivated by quite a high number of youth in the Eastern Region of Ghana. Vegetable production is the main source of income for some of these young farmers. This has helped quite a number of these farmers to be successful. Most of the vegetable products are sold in large towns and cities by middle men who buy at the farm gate.

The use of well-managed sustainable agriculture practices could lead to high yield and environmental benefits. The use of cover crops could be for various reasons including recycling nutrients, reduced leaching of nutrients, weed control and improved soil and air quality (Hoorman, 2009). Legume cover crops have the ability to fix atmospheric nitrogen into usable forms in the soil by plants. Cover crops recycle nutrients and reduce the use of inorganic fertilizer. Among the commonly used legume cover crops are *Canavalia* spp., *Crotalaria* sp., cowpea, beans, groundnut, *Mucuna* sp. and Soybean. Legumes have been found to enhance soil fertility and increase crop yields (Abayomi *et al*., 2001). In a similar work, Kang (1992) found that legumes could have multiple uses including use as cover crops, live mulch or food crops. On the African continent, the use of *Mucuna* spp. as cover crop has received some attention. Ile *et al*., (1996) found that growing of *Mucuna pruriens* as a cover crop could reduce the need to apply synthetic nitrogen fertilizer. Ngome *et al*., (2011) found that growing maize and *Mucuna pruriens* together led to increase of maize yield.

Although conventional agriculture has helped provided abundant food to feed people, it has led to reduced soil fertility and excessive use of pesticides (Smil, 1997, Trewavas, 2001) particularly on vegetables and fruits which have negative effects on human and animal health (National Research Council, 1989). Ways to achieve sustainable agriculture include organic farming, use of leguminous cover crops with reduced use of synthetic fertilizer and pesticides use (Fatima *et al* 2012). The use of sustainable agricultural system with sustainable inputs which enhances the environment in terms of air, soil and water has attracted research attention of late (Mattoo and Teasdale, 2010). Including cover crops in crop rotation led to decrease in nitrate leaching and increased ecosystem services (Alonso-Ayuso *et al*., 2018). Recent studies have shown that the use of cover crops led to improvement of C and N stocks in the soil for use by the succeeding crop (Buchi *et al*., 2018, Garcia-Gonzalez-Gonzalez *et al*., 2018, Landricini *et al*., 2019).

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In this study, legume cover crops of *Vigna unguiculata*, *Mucuna pruriens* and *Canavalia ensiformis* were used as cover crops and compared with fertilizer application and bare ground. The objective of this study was to find the effect of the cover crops on growth and yield of tomato (*Lycopersicon esculentum* L. cultivar "Power").

II. MATERIALS AND METHODS

The experiment started with the planting of cover crops in a Randomised Complete Block Design of 5 treatments in 3 blocks. The treatments were Bare Ground (Control) which acted as a check against Fertilizer N.P.K. 15:15:15 application, *Vigna unguiculata* (Cowpea), *Mucuna pruriens* (Mucuna), *Cananalia ensiformis* (Canavalia). The cover crop plots were planted with 25 seeds at a distance of 1m within and between rows. The cover crops were cut down when they reached the flowering stage and used as mulch and incorporated into the soil 2 weeks after transplanting.

Seeds of tomato cultivar "Power" were nursed and transplanted onto the field when 3 weeks old. After one month each treatment was given 10 g of inorganic fertilizer (N.P.K. 15:15:15). Two weeks later, the fertilizer applied plots were given 20 g of the inorganic Fertilizer (N.P.K. 15:15:15). Parameters that were studied were shoot height, flowering time and yield.

Shoot height was measured from the ground level to the terminal bud of an erect branch. Fifty percent flowering time was measured by counting when half (5) of the selected sampled plants had flowered. Yield was determined by the weight and number of fruits per plant on the sampled plants. Analysis of variance was performed using Genstat edition 14.

III. RESULTS

Plant height was highest in the Bare ground (Control) (73.27 cm) and lowest in the fertilizer (NPK 15:15:15) applied plots (66.37 cm) and the difference was not significant (P= 0.055, Fig.1).

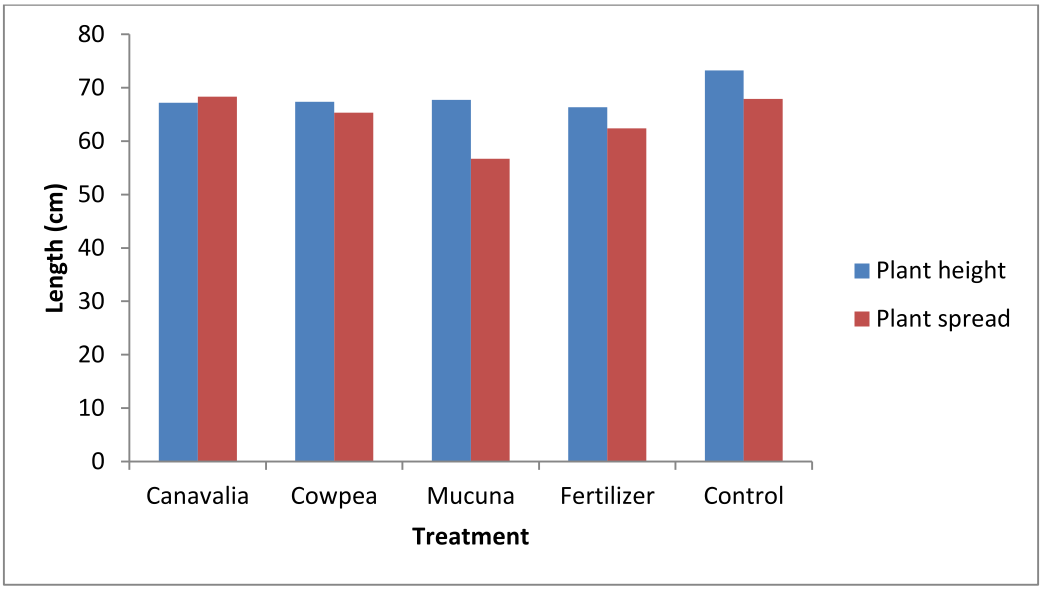

Fig. 1 Plant height and canopy spread of tomato plants on different treatment plots

Canopy spread was widest in *Canavalia*-grown tomato plants (68.3 cm) and smallest in *Mucuna* treated plots (56.7 cm). The differences between them were not significant (p = 0.098).

The number of fruits per tomato plant was highest in *Canavalia* treated plots and lowest in *Mucuna* plots. The treatments of the leguminous plots of tomato plants were not significantly different from that of the Control and the fertilizer applied plots (p = 0.228).

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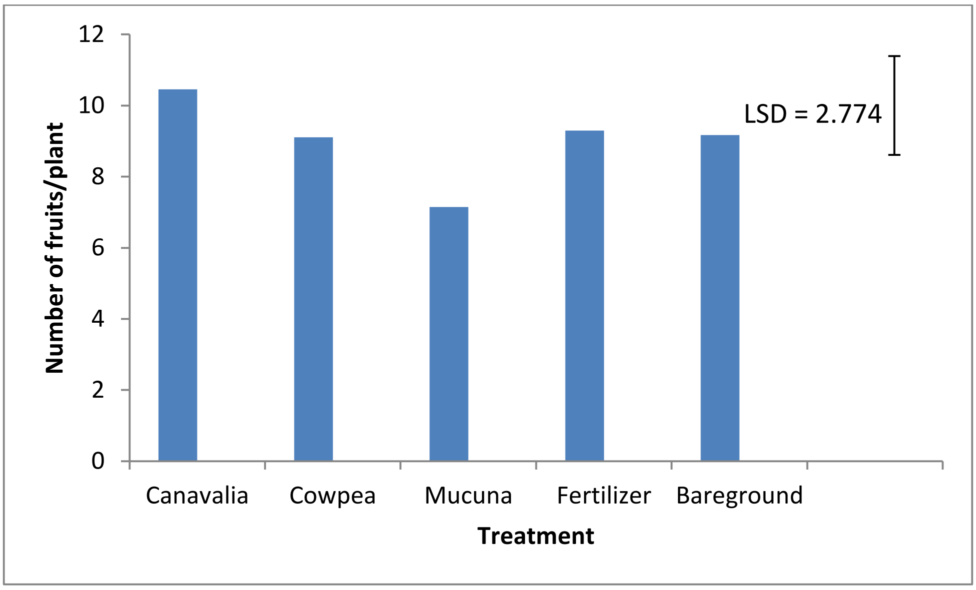

Fig.2 Number of tomato fruits per plant on different treatment plots

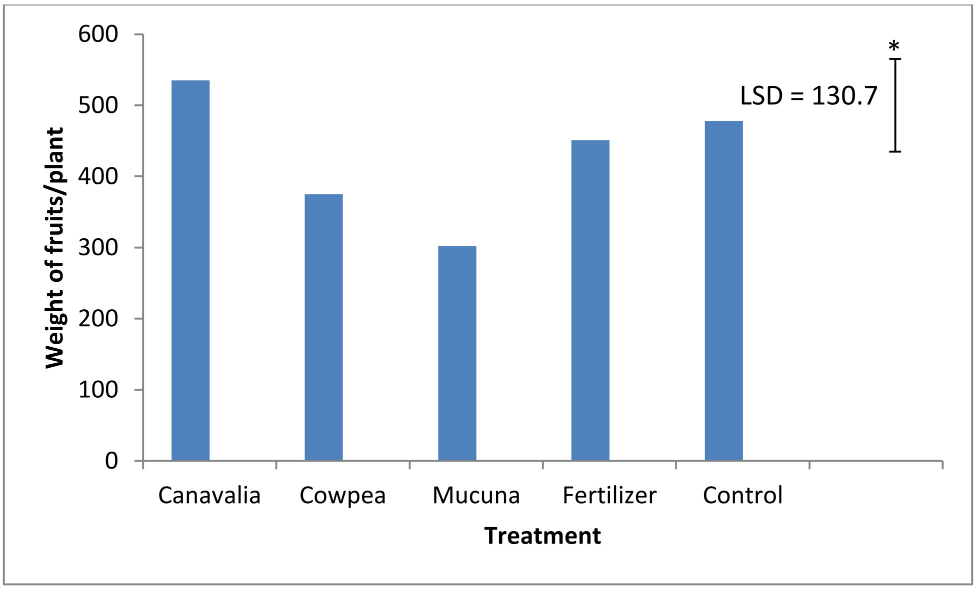

Fig.3 Weight of tomato fruits on different treatment plots

Fruit weight per plant was highest in *Canavalia*-grown tomato plants (535 g) and lowest in *Mucuna*-grown tomato plants (302 g) and there were significant differences between treatments means ($p = 0.006$, Fig. 3).

Mean fruit diameter ranged from 53.2 mm in *Vigna unguiculata*-grown tomato plants to 56.59 mm in the Control plot tomato plants. Treatment means were significantly not different ($p = 0.659$, Fig. 4).

The number of days to 50% flowering was early in *Canavalia*-grown tomato plants (60 days) and extended in *Vigna unguiculata*-grown tomato plants (63.33 days). These were not significantly different from the control and fertilizer applied plots ($P = 0.282$). The number of days to 50% fruiting was similarly lowest in *Canavalia* treated plots (67 days) and highest in *Vigna unguiculata*-grown tomato plants (69.33 days, Fig. 5).

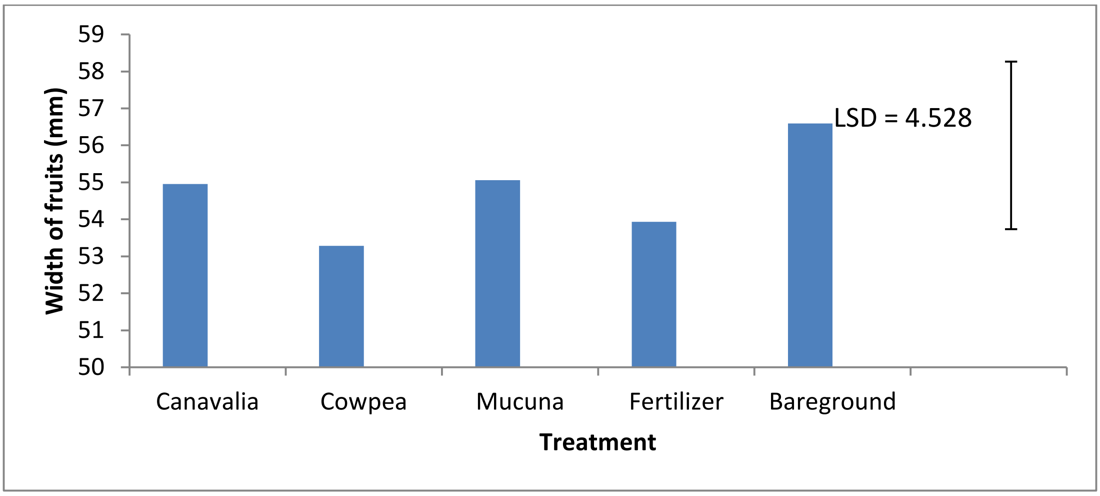

Fig. 4 Width of tomato fruits on different treatment plots

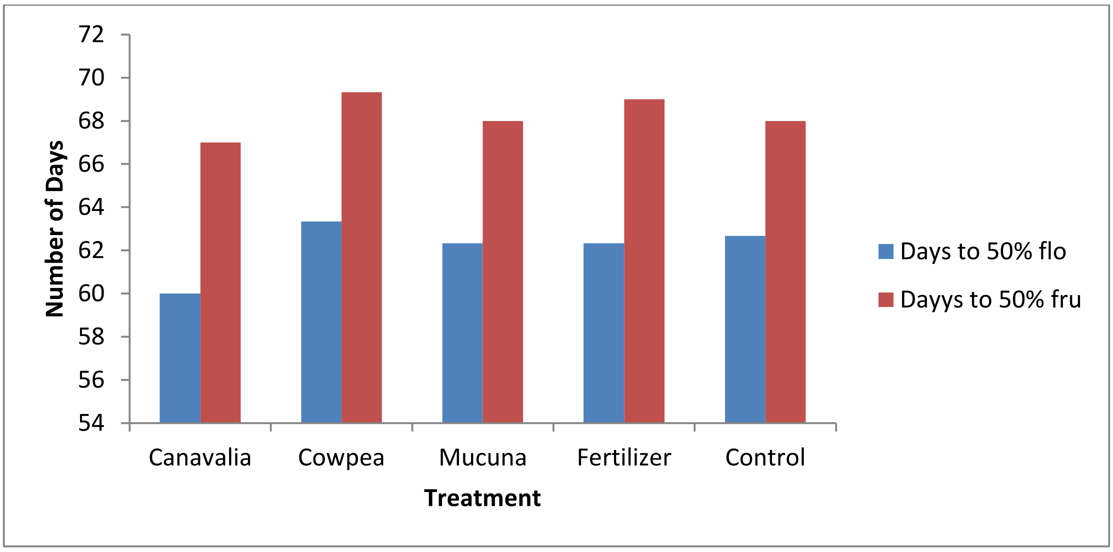

Fig. 5 Number of days to 50% flowering and fruiting of tomato plants on different treatment plots

These results were not significantly different from the control and fertilizer applied plots (p = 0.313).

IV. DISCUSSION

The study showed that the tomato plants grown on cover crops showed lower plant heights than tomato plants grown on bare ground (control). However, the cover crops showed wider canopy spread than the check with Canavalia-grown tomato plants showing the widest plant spread and mucuna-grown tomato plant showing the smallest plant spread.

The yield of tomato plants in terms of weight per plant was significantly higher in the canavalia grown tomato plants than the other treatments. Canavalia-grown tomato plants also showed earlier number of days for 50% flowering and 50% fruiting than the other treatments. The study has shown that cover crops have effect on the yield of tomato and that whereas canavalia ensiformis grown tomato plants showed significantly higher yield than the check, Mucuna pruriens-grown tomato plants showed lower yield than the control.

It was expected that all the cover crops and the inorganic fertilizer application will give higher yields than the bare ground (control) but it was found not to be so. It was only canavalia grown plants that showed higher yield than the check and the other treatments. The amount of inorganic fertilizer used might have not been enough to induce significant growth of the tomato plant. Again, the planting distance of the cover crop could have been a factor of the plant not fixing enough nitrogen in the soil to enhance the plant growth and yield. The cover crops were planted at a distance of 1m within and between rows and this could have been reduced to a shorter planting distance in order to fix higher nitrogen content in the soil.

Tomato plants on *Canavalia*-grown plots were not as high as those on the bare ground-grown (control) tomato plants which would let the farmer not to stake the plants which involves cost to the farmer. It shows that the legume had effect on the shoot height of the tomato plants. Plant canopy spread of tomato plants was widest in *Canavalia*-grown plots and smallest in *Mucuna*-grown plots (Fig. 2). This could be due to higher atmospheric nitrogen fixed to enrich the soil by *Canavalia ensiformis* than the other treatments. The wider spread of *Canavalia ensiformis* resulted in the plant incepting more sunlight for photosynthesis.

Consequently, fruit weight per plant was also highest in *Canavalia*-grown tomato plants as compared to the other plots including the control. In terms of yield *Canavalia* treated plots showed to be superior to the other leguminous plants as explained earlier. This agrees with earlier studies in which legumes have been found to boost soil fertility and improve yields of subsequent crops (Abayomi *et al.*, 2001; Tarawali, 1991).

Not all the leguminous plants used in this experiment promoted growth and yield of tomato as *Canavalia ensiformis*. Tarawani (1994) found out that the benefit of a legume to a subsequent crop depended on the function of the crop used.

Canavalia-grown tomato plants showed the lowest number of days to 50% flowering and fruiting. Although the difference was not significant it induced earlier flowering and fruiting than the bare ground-grown tomato plants as well as the other treatments. This could let *Canavalia*-grown tomato plants have fruits for the early market. It could as well be used to get early matured fruits in the face of climate change.

V. CONCLUSION

This study showed that *Canavalia ensiformis*-grown tomato plants performed better than the control and the other treatments in terms of high yield and also earliness in fruiting. It has been shown that cover crops especially *Canavalia ensiformis* could be considered as part of a farming system that wants organic farm produce using sustainable farming to improve soil nutrients and reduce the cost of farming.

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