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Research Article

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Effect of Compost and Mycorrhizal on Growth and Yield of Soybean (Glycine max (L) merill)

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Abstract

A pot experiment was carried out at the University of Agriculture, college of plant science (co-plant) Abeokuta. Nigeria, using the Complete Randomizes Design (CRD) to study the effect of compost and the different species of mycorrhizae on the growth and yield of soybean (Glycine max). Significant differences were observed between the treatments on some growth and yield parameters of soybeans at the vegetative stage and the reproductive stage. This implies that the treatments applied showed different responses to the crop. The crop performed better in the number of branches, canopy spread, number of leaves, leaf area and plant height for growth parameters, while significant differences was observed in seed weight/pot and seed weight/ha for yield parameters. The study concludes that the growth of soybean was significantly enhanced by the combine inoculation of *Glomus deserticola* (GD) and compost, while the yield was significantly enhanced by the combine inoculation of *Glomus mosseae* (GM) and compost. Also, higher number of spore count and % root infection was recorded in the combine innoculation of *Glomus deserticola* and compost.

Keywords: *Glomus deserticola* (GD); *Glomus mosseae* (GM); Compost; Soybean; Spore count; % Root infection rate

Introduction

Soybean (Glycine max) is a leguminous crop. It belongs to the family *Fabaceae*. The rapid rate and increase in world population has definitely resulted in a growing need for food production. Which can be achieved either by natural or synthetic means. The use of plant residues is the first method used instead of chemical fertilizers and herbicides or reducing their input into agro-ecosystems [1]. Plant residues are left-over materials that remain in the field after harvesting. It biodegrades gradually and can be prepare with organic manure as compost. There are many advantages to plant residues, it is a good source of nutrients for plants, provides carbon source and energy to soil microorganisms, leading to more soil enzyme activity and more nutrients availability to plants [2]. In addition to improving physical chemical and biological properties of the soil. *Arbuscular Mycorrhiza* (AM), it has the potential to associate with more than 85% of all plants species [3]. Many advantages to plants and soil when adding mycorrhizal fungi, it improves water uptake and nutrients especially phosphate, nitrogen and micronutrients. It also protects the plants from biotic and a biotic stresses [4]. Mycorrhiza help plants to obtain P because this element has low solubility [5] and it has been revealed that most of P taken by plants comes from their fungal participant [6]. The availability of mycorrhiza and microorganisms could be increased by the present of cover crop residues in soil especially in low P system [7]. Many studies implement better growth for plants when using mycorrhiza, especially when it combined with organic matter [8]. However, mycorrhiza can affect the growth of some plant species especially none hosting ones like weed, it can be used to control weeds especially with cultivated crops [9].

The objective of the study is therefore to access the growth and yield response of soybean to combine application of mycorrhizal and compost.

Materials and Methods

Location of the experiment

The experiment was conducted in the screen house of the college of plant science and crop production (co-plant) in the University of Agriculture, Abeokuta, Ogun State, Nigeria. Composting materials

Plant residue, maize Stover, soybean residue, leucena leucocephala, animal manure (pig dung), wood ash, water, black nylon, bamboo stick.

Composting procedure

The compost was formulated using the plant residence and pig dung at a ratio of 3:1 that is 3 volume of plant residue to 1 volume of Animal manure. The composting method use is the heap method. A bamboo of about 1.5 m long was erected at the four angles and this was surrounded with a blank nylon to conserve heat and loss of composting materials.

The composting materials were applied in Layers which were spread uniformly with a garden folk within. Each layer consist of an underlying bed of plant residence with pig manure spread on the plant residence and wood ash formed the top portion of the layer. Water was applied to each layer in order to enhance the take-off of the decomposition pr.

Mycorrhizal culturing

Soil sample of the mycorrhizal spore were collected from (IITA) International Institute of Tropical Agriculture, Ibadan. Precisely, *Glomus mosseae* (GM) and *Glomus deserticola* (GD) 60 g each were obtained.

The samples were transferred into a pot. Containing 10 kg sterile soil and maize was planted prior to pot experiment. Soil sample were sterilized by passing through an autoclave for an hour. This is done to destroy all microbes present in the soil sample collected.

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Pot experiment

The experiment was planted in 3 × 2 factorial arrangement in a Complete Randomize Design (CRD) There were 2 factors namely mycorrhizal and compost, 3 mycorrhizal inoculation (*Glomus mosseae*, *Glomus deserticola* and uninnoculated control) 2 levels of compost application 5 tonnes/ha and zero tones/ha) and SSP control replicated 3 times to give a total of 21 units. The variety of soybean planted was (TGX 1448-2F). Three soybean seed were sown in each plastic filled with 10 kg top soil.

Application of treatment

Ten Kilogram of soil was filled into 21 pots and arranged in a complete randomize design, 3 levels of mycorrhizal inoculation comprising O, Gm and Gd were applied. Two levels of composts comprising of 0 and compost amendment were also applied. The control consists of SSP applied at the rate of 1 gram per pot. The experiment was replicated 3 times to give a total of 21 pots.

Data Collection

Plant height, number of leaves, number of branches, canopy spread and leaf area was taken weekly, fresh weight and dry weight of the soybean plant shoot and root was taken at three, six and nine weeks after planting. Nodules number, their fresh weight and dry weight were also collected at six, eight and nine Weeks After Planting (WAP). Soil spore count and root infection percentage were also determine at three and nine WAP. At maturity, seed weight/pot, seed weight/ha, weight of hundred seeds and threshing percentage were also determine.

Result

Properties	Values
% Sand	87.1
% Silt	6.1
% Clay	6.8
Soil textural class	Loamy-sandy
PH (soil water)	5.9
% Organic carbon	0.35
% Nitrogen	0.2
Available phosphorus	9.54
% Organic carbon	0.62
Ca (cmol/kg)	0.47
Mg (cmol/kg)	0.44
K (cmol/kg)	0.51
Na (cmol/kg)	0.5
Exchangeable acidity	0.73
Cation Exchange capacity	1.92
Spore count	34

Table 1: Physiochemical properties of soil used.

Properties	Values
PH	6.7
Total nitrogen (%)	3.53
Organic carbon (%)	40.38
Organic matter (%)	69.62
Available phosphorus (mg/kg)	202.3
Na (cmol/kg)	0.41
Ca (cmol/kg)	2.8
K (cmol/kg)	1.45
Fe (cmol/kg)	89
Zn (cmol/kg)	285
Mg (cmol/kg)	0.65
Mn (cmol/kg)	485
Cu (cmol/kg)	447
CEC (cmol/kg)	11.44

Table 2: Result of analysis of pig compost used.

Treatment	2	3	4	5	6
C	19.63 a	30.73 a	42.57 ab	56.87 bc	88.83 a
M	16.00 b	22.47 b	33.03 c	45.07 c	71.71 bc
D	16.60 b	27.33 a	38.67 c	60.33 ab	79.27 ab
M&C	17.93 ab	26.80 ab	40.80 ab	58.53 bc	76.00 ab
D&C	19.23 a	32.33 a	52.43 a	71.13 a	85.73 a
O	17.53 ab	29.93 ab	40.00 ab	57.17 bc	71.20 bc
SSP	15.93c	25.70 ab	51.53 a	51.93 cd	59.13 c

Table 3: Effect of Mycorrhizal and Compost Application on the plant height at different week interval.

Means with the same letter are not significantly different at 5% level of probability using LSD. (C: Compost M: *Glomus mosseae*, D: *Glomus deserticola*, O: Zero inoculation of compost and mycorrhizal, SSP: Single Super Phosphate, WAP: Weeks After Planting).

Significant difference was observed in the combine inoculation of *Glomus deserticola* and compost at 2, 3, 4, 5 and 6 weeks after planting with a mean value of 85.73 at 6 wap but are also not significantly different from the combine inoculation of *Glomus mosseae* and compost at different week's interval of the plant height of the soybean with a mean value of 76.00 at 6 wap.

More so, sole application of compost also is not significantly different from the combine inoculation of the mycorrhizal and compost which as mean

value of 88.83 at 6 wap but are significantly different from other treatments and the control [10].

Treatments	2	3	4	5	6
C	9.67 ab	11.00 c	12.67 d	16.33 b	23.33 c
M	9.33 ab	11.33 bc	14.33 bc	19.00 b	26.00 bc
D	8.33 b	12.00 abc	15.00 abc	19.67 ab	25.67 bc
M&C	9.00 ab	11.67 abc	15.33 ab	20.67 ab	31.00 ab
D&C	10.00a	13.00a	15.33a	24.00a	37.00a
O	8.67ab	12.67ab	14.67bc	16.67b	22.67c
SSP	8.33b	10.67c	13.67dc	16.33b	24.00c

Table 4: Effect of the inoculation of mycorrhizal and compost on the number of leaves at different weeks interval.

Means with the same letter are not significantly different at 5% level of probability using LSD. (C: Compost M: Glomus mosseae, D: Glomus deserticola, O: Zero inoculation of compost and mycorrhizal, SSP: Single Super Phosphate, WAP: Weeks After Planting).

Combine inoculation of Glomus deserticola with compost show higher significant difference in the number of leaves of soybean recorded at the vegetative stage at different week interval with a means value of 10.00 a at 2 wap and 37.00 at 6 wap but was not significantly different from combine inoculation of Glomus mosseae and compost which as mean value of 9.00 at 2 wap and 31.00 at 6 wap but was significantly different from other treatments and control .

Treatment	2	3	4	5	6
C	2.00 a	3.33 a	4.00 a	4.67 d	6.67 c
M	2.00 a	3.33 a	3.67 a	5.67 bc	7.33 bc
D	2.00 a	3.00 a	4.00 a	6.00 ab	7.33 bc
M&C	2.00 a	3.00 a	4.00 a	5.67 a	9.00 ab
D&C	2.00 a	3.33 a	4.33 a	6.67 a	10.67 a
O	2.00 a	3.00 a	4.33 a	4.67 d	7.33 bc
SSP	2.00 a	3.33 a	4.00 a	5.00 dc	6.67 c

Table 5: Effect of inoculation of mycorrhizal and compost on the number of branches at different week interval.

Means with the same letter are not significantly different at 5% level of probability using LSD. (C: Compost M: *Glomus mosseae*, D: *Glomus deserticola*, O: Zero inoculation of compost and mycorrhizal, SSP: Single Super Phosphate, WAP: Weeks After Planting).

Treatments	1st flowering	50% flowering	N uptake	P uptake
C	40.00 bc	42.33 ab	0.41 ab	2.33 ab
M	40.00 bc	42.66 ab	0.27 ab	1.90 ab
D	39.67 c	41.33 ab	0.20 ab	2.52 ab
M&C	39.33 c	43.00 a	0.24 ab	1.92 ab
D&C	39.67 c	40.00 b	0.44 a	3.22 a
O	42.00 a	41.00 ab	0.12 b	0.55 b
SSP	41.67 ab	41.67 ab	0.16 ab	1.99 ab

Table 6: Effect of the inoculation of mycorrhizal and compost on the number of days to flowering the nutrient uptake at flowering.

There were no significant difference in the number of branches of soybean inoculated at 2, 3, 4 wap for all the treatments that is sole application and combine application of the mycorrhizal and compost but at 5 and 6 wap significant difference was observed in the combine inoculation of *Glomus deserticola* and compost and *Glomus mosseae* and compost and are significantly different from other treatments and uninoculated control.

Means with the same letter are not significantly different at 5% level of probability using LSD. (C: Compost M: *Glomus mosseae*, D: *Glomus deserticola*, O: Zero inoculation of compost and mycorrhizal, SSP: Single Super Phosphate, WAP: Weeks After Planting).

Significant difference was observed in the control in the number of days to 1st flowering and 50% flowering which was not significantly different from combine inoculation of *Glomus mosseae* and compost at 50% flowering and sole application of mycorrhizal, compost and SSP at 50% flowering. No significant difference was observed among the treatment in the N and P uptake at 50% flowering except control but combine inoculation of *Glomus deserticola* and compost as a mean value of 0.44 and 3.22 for N and P uptake respectively which are higher than other treatments.

	Fresh shoot weight (g)			Dry shoot weight (g)		
Treatment	3	6	9	3	6	9
C	4.42 a	6.13 ab	15.93 bc	0.40 b	1.71 b	5.26 a
M	1.87 b	6.43 ab	17.66 b	0.35 b	1.71 b	5.15 a
D	2.13 b	6.37 ab	14.65 b	0.37 b	1.78 b	3.43 b
M & C	2.01 b	4.62 c	20.16 a	0.31 b	1.09 b	5.92 a
D & C	3.78 b	7.36 a	13.06 c	0.67 a	2.17 a	3.82 b
O	1.77 b	7.36 a	12.09 cd	0.33 b	1.84 b	3.09 b
SSP	1.93 b	5.65 bc	12.31 cd	0.42 b	1.54 b	3.17 b

Table 7: Effect of the inoculation of Mycorrhizal and compost on the fresh shoot weight and dry shoot weight at different week interval.

Means with the same letter are not significantly different at 5% level of probability using LSD. (C: Compost M: *Glomus mosseae*, D: *Glomus deserticola*, O: Zero inoculation of compost and mycorrhizal, SSP: Single Super Phosphate, WAP: Weeks After Planting).

	Spore count		Root infection	
Treatment	**3**	**9**	**3**	**9**
C	32.00 d	33.67 c	31.00 abc	44.67 c
M	39.00 b	40.67 c	30.33 abc	59.00 b
D	36.00 c	37.67 cd	30.30 abc	76.67 a
M & C	41.33 ab	59.67 b	35.00 a	76.67 a
D & C	42.00 a	71.33 a	34.33 ab	79.33 a
O	32.33 d	33.67 c	29.00 bc	36.33 d
SSP	31.00 b	34.67 de	27.33 c	36.33 d

Table 8: Effect of Mycorrhizal and compost application on the spore count and % root infection at 3 and 9 wap.

At 3 wap sole application of compost significantly enhanced the fresh shoot weight of soybean but at 6 and 9 wap combine application of mycorrhizal and compost and also sole application of compost and mycorrhizal significantly enhanced the fresh shoot weight of soybean while the dry shoot weight was significantly enhanced by the combine inoculation of *Glomus deserticola* and compost at 3 and 6 wap and sole application of compost and *Glomus mosseae* and combine inoculation of *Glomus mosseae* and compost also significantly enhanced the dry shoot weight of soybean at 9 wap. Means with the same letter are not significantly different at 5%level of probability using LSD. (C: Compost M: *Glomus mosseae*, D: *Glomus deserticola*, O: Zero inoculation of compost and mycorrhizal, SSP: Single Super Phosphate, WAP: Weeks After Planting. A great significant difference was observed in the combine inoculation of *Glomus deserticola* and compost and combine inoculation of *Glomus mosseae* and compost in the spore count and %root infection both at 3 and 9 wap but are significantly different to other treatment except for sole application of *Glomus mosseae*, *Glomus deserticola* and sole application of compost in the % root infection. The Table below shows that there is significant difference among all the yield component observed. Seed weight was higher in sole application of *Glomus Deserticola* (GD),*Glomus mosseae* (GM) combine with compost (GM & c) but were comparable to other treatments. Sole inoculation of *Glomus mosseae* (GM), combine inoculation of *Glomus mosseae* with compost (GM & c) and *Glomus deserticola* with compost (GD & c) produced higher seeds weight than control but were comparable to other treatments.

Treatments	Seed/Weight pot(g)	Seed Weight/ha/kg	Weight of 100 seeds (g)
C	10.97 ab	2456.0 ab	9.40 ab
M	11.83 ab	2650.3 ab	11.63 ab
D	13.97 a	3128.0 a	12.10 a
M&C	14.10 a	3157.7 a	12.67 a
D&C	12.53 ab	2807.0 ab	12.30 a
O	9.70 b	2173.0 b	8.60 b
SSP	10.32 ab	2312.0 ab	9.57 ab

Table 9: Effect of Mycorrhiza and compost on yield components.

Means with the same letters are not significantly different at 5% level of probability using LSD (C: Compost, M: *Glomus mosseae*, D: *Glomus deserticola*. O: Zero inoculation of compost and mycorrhizal, SSP: Single Super Phosphate, WAP: Weeks After Planting.

Discussion

The result of the study reveals the effectiveness of the combine inoculation of mycorrhizal and compost and sole application of the two crucial treatments.

Combine inoculation of Glomus deserticola and compost significantly supported the growth of the soybean plant which is in support of that mycorrhizal fungi usually enhanced the plant in the uptake of nutrient in the soil and improve plant growth most especially when the root of plant cannot intercept the available nutrient in the soil also at 50% flowering the combine inoculation of *Glomus deserticola* and compost also enhanced the uptake of N and P in the soil compare to other treatments which is support of that AM fungus colonization often leads to increase in nutrient in the soil both micronutrient and macronutrients.

Various investigation on the combine inoculation of AM fungi with compost as reveal that if quality of the compost is high it can often give substrate which can be adequate for mycorrhizal plant and also the yield was significantly enhanced mostly by the combine inoculation of *Glomus mosseae* and compost which is contrary to a conclusion in an experiment that Thus, at present it is not clear whether compost additions and mycorrhizal fungus inoculation are complementary measures to increase yield and yield stability in organic operations.

Conclusion

The study reveals that the treatment has effects on the growth and yield parameters of soybean inoculated. This implies that soybean responded to the treatments, the crop performed best in number of branches, numbers of leaves, leaf area and plant height with the combination of compost and *Glomus deserticola* (GD & c). This occurred as a result of high phosphorus uptake due to the presence of Glomus deserticola and slow release of phosphorus in compost.

The Study concludes that the combination of the treatments *Glomus deserticola* and compost (GD & c) contribute to the growth of soybean while the yield of soybean was enhanced by *Glomus mosseae* combine with compost (GM & c).

Recommendation

I will recommend that it may be necessary in future to conduct the trial in a field situation. Moreso, with adequate mycorrhizal innoculant available to farmers at affordable price and from authorized distributor in a specific location.

Also, a good briefing on the importance of the mycorrhizal innoculant and compost preparation should be implemented in farmers training both at commercial and subsistence level as these, will minimize the cost compare to chemical fertilizer leading to profit maximization.

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