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The role of organic fertilization and arbuscular mycorhizal fungi inoculation on sweet corn growth on rasau series soil

Adzemi Mat Arshad*[1], Haruna Yahaya Rawayau[2]

[1]*Laboratory of Soil Science; School of Food Science and Technology, Universiti Malaysia Terengganu, Kuala Nerus, Terengganu, Malaysia*

[2]*Department of Agricultural Education, Federal College of Education, Katsina, Katsina State, Nigeria*

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Abstract

The objective of this research was to determine the effect of organic and bio fertilization to the growth performance of corn planted on Rasau series soil. A factorial experiment of 5 x 2 Randomised Complete Block Design replicated 4 times was conducted at the glasshouse of Universiti Malaysia Terengganu. The factors include organic manure at 5 levels OM1 (control), OM2 (chicken manure), OM3 (cattle manure), OM4 (horse manure) and OM5 (biochar) and arbuscular mycorrhizal Fungi at 2 levels M1 (with) and M2 (without), the variables measured were plant height, stem girth, leaf height, leaf number, leaf length, leaf width and leaf area at 2, 4, 6 and 8 weeks after planting (WAP). The data collected were analysed using Analysis of Variance (ANOVA) with Statistical Analysis System (SAS) and means separated using Duncan's Multiple Range Test at $p<0.05$. The growth performance of the test crop (sweet corn) in this experiment was significant in the measured parameters with chicken manure (OM2) under mycorrhizal inoculation (M1). The result of this study showed chicken manure when inoculated with AMF can boost sweet corn production on Rasau series soil

* **Corresponding Author:** Adzemi Mat Arshad ✉ adzemi@umt.edu.my

Introduction

Corn is a cereal crop of the grass family (Poaceae), wheat is the first most important cereal crop globally, followed by corn (Jaliya *et al.*, 2008). United States, China and Brazil are the highest corn producers in that order (1st, 2nd and 3rd respectively) (Shultz, 2008).

The crop can grow in different agro-climatic zones of the world, as such being referred to as versatile crop. No other crop has that suitability of growth in different zones like corn, for instance, it can grow from 58° N to 40° S, from below sea level up to higher than 3000m above sea level, from low rainfall of 250mm to 5000mm/annum (Shaw, 1988 and Dowswell *et al.*, 1996).

The importance and use of corn differ from one country to another, as most developed nations use it as livestock feed, before the advent of the new hybrid called sweet corn (*saccharata*), which is now widely accepted and being used as a vegetable in those advanced countries (Morris, 1998). Whereas in the developing nations the use varies, most of African and Latin Nations use it as food, while in the majority of Asian countries it's being cultivated for dual purpose (food and feed). About a quarter of the produced is being consumed globally as food (CIMMYT, 2000).

Animal droppings can replace the inorganic materials use as fertilizer for sustainable crop production, health of consumer, soil health and future cost effectiveness (Adeniyan and Ojeniyi, 2003)

AMF inoculation and organic manure amendment is getting acceptance around the world due to its sustainable tendencies that are becoming clear by the day (Stella *et al.,* 2001).

It is also affirm that biochar amendment positively affects plant growth and yield as it is a source of nutrient which it is capable of releasing, and aid in holding the soil nutrients together (Lehman *et al.*, 2003). The research is aimed towards finding the potential impact of organic and bio fertilization to the growth performance of corn plant under Rasau series soil.

Materials and methods

Glasshouse experiment

The experiment was conducted at the glasshouse of the School of Food Science and Technology, Universiti Malaysia Terengganu in a Randomized Complete Block Design (RCBD) with four replications.

The factors are organic manure; OM1 (control), OM2 (chicken manure), OM3 (cattle manure), OM4 (horse manure) and OM5 (biochar) and arbuscular mycorrhizal Fungi; M1 (with AMF inoculation) and M2 (without), this gives a total of 5x2=10 treatments replicated 4 times to give a total of 40 experimental units.

Sweet corn (*Zea mays saccharata* L.), Var Thai Super Sweet sourced from Bumi Agro, Kuala Terengganu, and was planted at 3 seeds/30kg pot and later thinned to 1 stand/pot. The soil (Rasau) was amended with organic manure according to the treatments 2 weeks prior to planting at the recommended rate of 50t/ha, and inoculated with AMF at planting (10g/pot).

All the growth parameters (viz; plant height, stem girth, leaf length, leaf width, leaf area and leaf number) were taken at 2 weeks interval (2, 4, 6, and 8 Weeks After Planting) from planting to harvest. The data collected were statistically analysed using Analysis of Variance (ANOVA) with SAS software 9.4 and Duncan's Multiple Range Test (DRMT) in separating the means.

Results and discussions

The soil used for this study is classified as sandy loam with soil separates (%) of sand, silt and clay as 56, 30 and 14 respectively, while having pH (H_2O) of 4.8, organic matter 1.62%, total N 0.15%, available P 17.90ppm and exchangeable bases (cmol/kg) K, Na, Mg and Ca 0.10, 0.25, 0.10 and 0.17 respectively as presented in Table 1 above.

Table 1. Physico-chemical properties of Rasau series soil.

Parameter	Values
pH (H_2O)	4.80
Organic matter (%)	1.62
Total N (%)	0.15
Av. P (µg/g)	18.0
Exchangeable bases (cmol/kg)	
K	0.10
Ca	0.17
Mg	0.10
Na	0.25
Mechanical composition (%)	
Sand	56.00
Silt	30.00
Clay	14.00
Textural class (USDA)	Sandy loam

Effects organic manure sources and AMF inoculation on corn plant height under Rasau series soil

From the Analysis of Variance (ANOVA) it shows that at 6, 8 and 10 Weeks After Planting main effect of organic manure source and AMF inoculation are significant for plant height while there was no interactions effect between the two factors ($p<0.05$) as presented in Table 2 below.

Table 2. A two way ANOVA table showing mean values of plant height (cm) at 6, 8 and 10 Weeks After Planting .

Treatments	Weeks After Planting		
	6	6	10
OM	**	**	**
AMF	**	**	**
Interactions			
OM*AMF	ns	ns	ns
CV	6.84	7.59	6.28

NB: OM= Organic Manure; AMF= Arbuscular mycorrhizal Fungi; CV= Coefficient of Variation; ns= not significant; **= significant at 0.01 level.

Main effects of organic manure sources and AMF inoculation on corn plant height

As shown in Table 3 above, the 4 different sources of organic manure are not significantly different from one another, but they all differ significantly from the control (OM1) which has the lowest mean values of 58.19, 81.85 and 85.30 for 6, 8 and 10 weeks after planting respectively, compared to OM2 (chicken manure with the highest mean values of 103.61, 125.70 and 130.39 for 6, 8 and 10 weeks after planting respectively.

This shows the significance of animal manure for corn growth which is in agreement with Ojeniyi *et al,* 2007 and similar results for Amaranth (Katung *et al.,* 2005 and Dantata *et al.,* 2011; Atusa and Elusaiwe, 2013).

AMF inoculation was significant for plant height at 6, 8 and 10 weeks after planting between inoculated (AMF1) and non-inoculated corn (AMF2) as presented in Table 3 above. Corn inoculated with mycorrhiza recorded the highest mean values of 94.1, 116.89 and 123.1 for 6, 8 and 10 weeks after planting respectively compared to the one without inoculation with a mean values of 86.13, 106.76 and 114.10 for 6, 8 and 10 weeks after planting respectively.

Table 3. Effects of arbuscular mycorrhizal inoculation and different sources of organic manure on corn plant height (cm) at 6, 8 and 10 Weeks After Planting (WAP).

Treatments	Weeks After Planting		
	6	8	10
Organic Manure (OM) LSD	9.83	13.54	11.87
OM 1 (control)	58.19b	81.85b	85.30b
OM 2 (Chicken Manure)	103.61a*	125.70a	130.39a
OM 3 (Cattle Manure)	94.67a	116.67a	124.27a
OM 4 (Horse Manure)	94.52a	114.05a	123.12a
OM 5 (Biochar)	99.59a	120.86a	120.86a
Arbuscular mycorrhizal Fungi LSD	4.25	5.85	5.13
AMF 1 (with)	94.10a	94.10a	5.13
AMF 2 (without)	86.13b	106.76b	114.10b

*Means with the same letter within same column of either of the treatments are not significantly different ($p<0.05$); LSD=Least Significant Difference.

This is similar to what Javaid and Riaz 2008; Oseni *et al.,* 2010 reported which states there was significant growth improvement in plants inoculated with AMF.

Conclusion

Organic manure amendment and AMF inoculation shows a significant impact on sweet corn growth, with chicken manure having superiority over other sources of organic manure (cattle, horse and biochar), as it responded well compared to others and control treatment for this study. Based on the findings, chicken manure can be recommended for optimum growth of sweet corn under Rasau series soil, and both other animal manure sources (cattle, horse) and biochar can as well be another option in the absence of the chicken manure for better growth.

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