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The potential impact of different organic manure sources and Arbuscular Mycorrhizal Fungal Inoculation on growth performance of sweet corn grown on BRIS soil

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Abstract

This study aimed towards determining the effect of different sources of organic manure and mycorrhizal inoculation on the growth performance of corn planted on BRIS soil. A 5 x 2 factorial experiment was conducted at the glasshouse of Universiti Malaysia Terengganu using Randomized Complete Block Design (RCBD) replicated 4 times to determine the potential impact of organic and bio fertilization on corn grown under BRIS (Rhu Tapi series) soil. The factors include Organic Manure at 5 levels (OM_1=Control, OM_2=Chicken Manure, OM_3=Cattle Manure, OM_4=Horse Manure and OM_5=Biochar) and Arbuscular Mycorrhizal Fungi at 2 levels (M_1=with and M_2=without). The variables measured were plant height, stem girth, leaf number, leaf length, leaf width and leaf area from 2 Weeks After Planting (WAP). The growth performance of the test crop in this experiment was significant in the measured parameters, with chicken manure (OM_2) under Mycorrhizal inoculation (M_1) performed better when the data collected were analysed using Analysis of Variance (ANOVA) with Statistical Analysis System (SAS), and means were separated using Duncan's Multiple Range Test at $p<0.05$. The result of this study shows chicken manure when inoculated with AMF can boost sweet corn production on BRIS soil which is low in nutrient content.

Keywords: Manure; AMF Inoculation; Growth, Corn; Rhu Tapi; BRIS

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1. Introduction

Corn is a cereal crop of the grass family (Poaceae), currently under cultivation worldwide. The plant is a source of food to mankind and feeds to animals and as well serves as raw material to many manufacturing industries in the production of materials such as corn starch, corn syrup, vegetable corn oil, and of recent use as biofuel (Remison, 2005).

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 58^0 N to 40^0 S, from below sea level up to higher than 3000m above sea level, from low rainfall of 250mm to 5000mm/annum (Shaw, 1988; 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, but with the breeding of new hybrid (*saccharata*) the crop is now being used as vegetable especially in advanced countries (Morris, 1998). Whereas, in the developing nations, the usage of it 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 (Doebley, 1990).

The third worlds' better means of achieving soil fertility improvement is organic fertilizer. Because it is affordable and readily available among the dwellers, of which animal droppings is an option (Adekiya and Agbede, 2009). The use of organic manure has helped farmers from total reliance on synthetic materials in soil fertility improvement (Schelge, 2000).

Chicken manure is known to significantly improve many growth parameters of crops (Hassan, 2002), nutrient content and nutritive value of plants (Adam, 2004). Poultry manure significantly enhances the performance of many plants and soil as found by Adeniyan and Ojeniyi (2005). Animal manure that is also popular around the globe is cow manure, as such have been in use to improve soil fertility (Kapkiyai *et al.,* 1999) and it is also known to improve crop yield and yield parameters (Jokela, 1992). Cow manure is highly rich in essential nutrients for plant growth and performance. In an attempt by researchers to find the significance of organic manures in plant growth and yield, a work by Senjobi et al. (2010) study poultry manure, sheep manure and found them to influence growth performance and yield of plants

Soil amendment with organic fertilizer and bio-fertilizer (AMF) forms part of new soil fertility management (Stella *et al.,* 2001). Integration of biochar with AMF has shown some positive result as the biochar serves as medium for AMF hyphae and also prevent any attack from soil micro-organisms that may be harmful to their colony as such aid the symbiosis between plant host and the fungus (Warnock *et al.,* 2007). It is also affirm that biochar 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, as a way of exploring organic farming that is gaining popularity due to its significance in soil fertility management and safe consumption of produced.

2. Materials and methods

2.1. Glasshouse experiment

The experiment was conducted at the glasshouse of the School of Food Science and Technology (Pusat Pengajian Sains Technologi dan Makanan (PPSTM)), in a Randomized Complete Block Design (RCBD) with four replications. The factors are; Organic Manure (OM_1=Control (no OM), OM_2=Chicken Manure, OM_3=Cattle Manure, OM_4=Horse Manure and OM_5 Biochar) and Arbuscular Mycorrhizal Fungi (M_1= With and M_2= 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 procured from Bumi Agro, Kuala Terengganu, and was planted at 3 seeds/30kg pot and later thinned to 1 stand/pot. The soil (Rhu Tapi) 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) using SAS software 9.4 and Ducan Multiple Range Test (DRMT) in separating the means.

3. Results and discussions

The soil used for this study is classified as sandy with soil separates (%) of sand, silt and clay as 67.35, 2.52 and 30.13 respectively, while having pH (H_2O) of 4.6, organic matter 0.99%, total N 0.09%, available P 10.40ppm and exchangeable bases (c mol p^+/kg) K, Na, Mg and Ca as 0.01, 0.08, 0.02 and 0.20 respectively as presented in Table 1.

3.1. Effects of different sources of organic manure and AMF inoculation on corn growth.

From the Analysis of Variance (ANOVA) it shows that at 6 Weeks After Planting main effect of organic manure source and AMF inoculation are significant for plant height, stem girth, and leaf number while interactions occur significantly for leaf length, leaf width and leaf area as shown in table 2.

3.2. Main effects of organic manure source and AMF inoculation on corn growth at 6 WAP

Chicken manure (OM_2) shows significant difference ($p<0.01$) between other sources of organic manure for plant height, stem girth and leaf number with highest mean values of 96.20, 9.51 and 9.00 for plant height, stem girth and leaf number respectively, though having (OM_2) higher mean than biochar (OM_5) but not significantly different. The lowest mean values were recorded for control (OM_1) having 46.13, 4.55 and 7.62 for plant height, stem girth and leaf number respectively as shown in table 3. This shows the significance of chicken manure for corn growth which is in agreement with Ojeniyi *et al.* (2007) and similar results on growth of Amaranth (Katung *et al.,* 2005 and Dantata *et al.,* 2011; Atusa and Elusaiwe, 2013).

Table 1. Physico-chemical properties of BRIS soil

Parameters	Values
pH (H_2O)	4.6
Organic Matter (%)	0.99
Total N (%)	0.09
Av. P (ppm)	10.40
Exchangeable Bases (c mol p^+/kg)	
K	0.01
Na	0.08
Mg	0.02
Ca	0.20
Mechanical Composition (%)	
Sand	67.35
Silt	2.52
Clay	30.13
Textural Class	Sandy

Source: Experimental Study 2016

AMF inoculation was significant for plant height and stem girth but not significant for leaf number between inoculated (M_1) and non-inoculated corn (M_2) as presented in Table 3. Corn inoculated with mycorrhiza recorded the highest mean value of 86.58 compared to the one without inoculation with a mean value of 81.50 ($p<0.01$) for plant height, as for stem girth, the inoculated treatment has a mean value of 8.54 which is significantly different from corn without Mycorrhizal treatment with mean value 8.04. For leaf number the mycorrhiza treated corn plant has a mean value of 8.50 and higher than the non-treated (8.35) but not significantly different. This is similar to what Javaid and Riaz 2008; Oseni *et al.* (2010) reported which states there was significant growth in plants inoculated with AMF and giving emphasis on the nature of how it's hyphae helps in exploring the soil Av P, as seen in fig 1 (structure of AMF colonization on corn root).

Table 2: A two way ANOVA table showing mean values of different growth parameters at 6 Weeks After Planting (WAP)

Treatments	Plant Height (cm)	Leaf Width (cm)	Leaf Length (cm)	Stem Girth (mm)	Leaf Area	Leaf Number
OM	**	**	**	**	**	*
AMF	**	**	**	**	**	ns
Interactions						
OM*AMF	ns	*	*	ns	*	ns
CV	**3.98**	**5.08**	**4.33**	**5.21**	**8.59**	**8.50**

*NB: OM= Organic Manure; AMF= Arbuscular Mycorrhizal Fungi; CV= Coefficient of Variation; ns= not significant, *=significant at 0.05 level; **= significant at 0.01 level*

Table 3. Effects of Arbuscular Mycorrhizal inoculation and different sources of organic manure on growth of corn at 6 weeks after planting

Treatments	Plant Height (cm)	Stem Girth (mm)	Leaf Number
OM1 (Control)	46.41c	4.55c	7.62b
OM2 (Chicken manure)	96.20a	9.51a	9.00a
OM3 (Cattle manure)	92.77ab	9.17ab	8.12ab
OM4 (Horse manure)	87.99b	8.67b	8.50ab
OM5 (Biochar)	98.84a	9.57a	8.35a
LSD	**5.33**	**0.69**	**1.14**
M_1 (with)	86.58a	8.54a	8.50a
M_2 (without)	81.50b	8.04b	8.35b
LSD	**2.30**	**0.30**	**0.50**

NB: Means with the same letter within same column of either of the treatments are not significantly different

Table 4. Effects of interaction between different organic manure source and AMF inoculation on corn leaf length, width and area

Treatments	Leaf Length (cm)	Leaf Width (cm)	Leaf Area
OM_1M_1	29.21d	2.90c	64.15d
OM_1M_2	27.75d	2.80c	58.32d
OM_2M_1	67.88a	6.73a	343.32a
OM_2M_2	63.20ab	6.20a	294.03ab
OM_3M_1	64.01ab	6.27a	301.81ab
OM_3M_2	61.53ab	6.10a	281.74b
OM_4M_1	60.03b	6.12a	275.73b
OM_4M_2	50.19c	5.00b	188.30c
OM_5M_1	65.91ab	6.60a	327.96ab
OM_5M_2	62.83ab	6.17a	292.04ab

NB: Means with the same letter within same column of either of the treatments are not significantly different

3.3. Interaction effect between organic manure sources and AMF on corn growth at 6 WAP

The ANOVA result shows a significant interaction between organic manure source and AMF inoculation for leaf length, leaf width and leaf area and presented in table 4 which shows corn amended with chicken manure and AMF inoculation (OM_2M_1) has superiority over others for leaf area with the highest mean value of 343.32 but not significantly different from chicken manure without AMF inoculation (OM_2M_2) with mean value 294.03. This is in line with other studies that suggest AMF has less influence in the presence of optimum nutrients for plant growth (Wu *et al.,* 2010). Also for leaf length and leaf width the interaction was significant with chicken manure and AMF having the highest mean value in both parameters, but as well not significant from chicken manure without AMF (OM_2M_2). But the result shows horse manure with AMF inoculation (OM_4M_1) has superiority over horse manure without AMF inoculation (OM_4M_2). This is in agreement with the findings of Posada and Siverding (2014).

4. Conclusion

Organic manure amendment and AMF inoculation shows a significant impact on sweet corn growth, with chicken manure having superiority with highest mean value of leaf number (9.00) and significantly different from the control and horse manure with 7.62 and 8.50 mean values respectively, but biochar also did well in terms of plant height and stem girth at 6WAP with a mean value of 98.84, and 9.57 respectively but not

significantly different from Chicken manure which also has a favourable mean value of 96.20 and 8.67 for plant height and stem girth in that order.

AMF inoculation also was promising from the results obtained, as it was statistically significant ($p<0.05$) compared to non inoculated treatment, with highest mean value of 86.85, 8.54 and 8.50 for while non inoculated treatment have 81.5, 8.04 and 8.35 for plant height, stem girth and leaf number respectively.

Based on the findings from the interaction effects, chicken manure or biochar inoculated with AMF can boost sweet corn growth performance under BRIS soil can be recommended for optimum growth of sweet corn under BRIS soil, and biochar can as well be another option in the absence of the chicken manure for better growth.

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