DRY MATTER PRODUCTION BY MAIZE (*Zea mays* L.) PLANTS IN RESPONSE TO THE IMO-COMPOST

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INTRODUCTION

Large amounts of agricultural residues produced have created serious problems such as difficulties in transportation and handling due to very low density and abrasive nature of the materials. Production of paddy (PH) and corn (CS) residues are mostly discharged into landfill and open burning and only a small quantity is used for energy generation and other applications such as composting. Legros and Petruzzelli (2001) stated that composting agricultural residues is not a new process, but is one which has regained focus around the world. This is because environmental issues are forcing the reduction in the use of raw residues and have rediscovered that there are good scientific reasons why compost is a better source of nutrients for agricultural crops. The use of agricultural residues as amendments to improve soil organic matter level for long term soil fertility and productivity is gaining importance in compost production and the continuous increase in fertilizer price call for this alternative technique for managing these valuable resources. According to Cherif et al. (2009), application of indigenous microorganisms (IMO) strains in composting is an effective way to enhance composting process compared to the normal composting process. This is due to the heat generated during composting from IMO strains especially the mesophilic and thermophilic types of microbes help in the destruction of pathogenic microorganisms which constitute a health hazards. The objectives of the study were to: (1) produce organic fertilizer from composted paddy husk (PH) and corn stalk (CS) by mixing with IMO strains, and (2) determine the dry matter production on maize by application of IMO-compost.

MATERIALS AND METHODS

Composting process

The two selected agro-industrial wastes; paddy husk (PH) and corn stalk (CS) and were collected from the university farm and were air dried and ground (approximately 2 mm in size) for composting in white polystyrene box with a size of 30 x 15 x 25 cm. Composting process were allowed to propagate until the temperature of the compost equalled to ambient temperature after 34 days. The compost was produced by mixing IMO (IV) sources from steamed white rice (SWR), aerated fish pond water (AFPW) and kitchen waste (KW). The study had the following treatments:

- T1: $IMO(IV)_{SWR}$ (30%) + PH (40%) + Chicken Dung (30%),
- T2: $IMO(IV)_{SWR}$ (30%) + CS (40%) + Chicken Dung (30%),
- T3: $IMO(IV)_{AFPW}$ (30%) + PH (40%) + Chicken Dung (30%),
- T4: $IMO(IV)_{AFPW}$ (30%) + CS (40%) + Chicken Dung (30%),
- T5: $IMO(IV)_{KW}$ (30%) + PH (40%) + Chicken Dung (30%),
- T6: $IMO(IV)_{KW}$ (30%) + CS (40%) + Chicken Dung (30%)

Compost physico-chemical analysis

Kjedhal method was used to determine total N (Bremner, 1965). Decomposition was calculated after ignition of the dry sample at 550°C for 8 hours (Tan, 2005). Compost total P was extracted using the single dry ashing method followed by blue method (Murphy and Riley, 1962). Cations were extracted using the leaching method (Cottenie, 1980) and their concentrations determined using Atomic Absorption Spectrometry (AAS). Compost CEC was determined by the leaching method followed by steam distillation (Tan, 2005). The pH of the compost was determined in 1:4 compost:distilled water suspension and KCl using a glass electrode (Peech, 1965). The HAs extraction was carried out by the method of Stevenson (1994) and refined by the method of Ahmed *et al.* (2004).

Site description, soil sampling and experimental design

The soil used is sandy clay loam and was typical of Bekenu series (*Haplic Acrisols*) and was sampled in an undisturbed area of Universiti Putra Malaysia, Bintulu Sarawak Campus, Malaysia using an auger from 0 to 20 cm depth. The coordinate of sampling site is latitude 0.3°12.241 N and longitude 113°04.270 E. The soil samples were air dried, pounded, and sieved to pass 2.0 mm size for pot experiment under shelter rain house. The pot experiment was conducted under rain shelter house at the Universiti Campus, using randomized complete block design (RCBD) with four replications. Soil moisture was maintained at 60% field capacity. The Sweet Corn variety maize (*Zea mays* L.) (D56) was used as the test crop. The fertilizer requirement was 60 kg N, 60 kg P_2O_5, and 40 kg K_2O (130.44 kg ha^{-1} urea; 130.44 kg ha^{-1} TSP; 66.67 kg ha^{-1} MOP). The fertilizer requirement was scale down to per-pot basis equivalent to 4.84 g of urea, 4.91 g TSP (triple superphosphate), and 2.48 g of MOP (muriate of potash). The eight treatments devised for this experiment were as follows:

T0: No fertilizer,
T1: NPK recommended rate (4.84g urea, 4.91 g TSP, 2.48 g MOP),
T2: 77.96 g IMO_{SWR-PH} compost + 1.41 g TSP + 0.72 g MOP,
T3: 74.54 g IMO_{SWR-CS} compost + 0.64 g TSP + 0.00 g MOP,
T4: 57.90 g $IMO_{AFPW-PH}$ compost + 2.35 TSP + 0.29 g MOP,
T5: 38.72 g $IMO_{AFPW-CS}$ compost + 2.48 g TSP + 0.15 g MOP,
T6: 59.59 g IMO_{KW-PH} compost + 2.32 g TSP + 0.28 g MOP, and
T7: 51.41 g IMO_{KW-CS} compost + 2.01 g TSP + 0.04 g MOP

All treatments were applied on the day 10 after germination, but plants with T1 application were fertilized on day 28 because the compost contributed to a slow release of nutrients in T2, T3, T4, T5, T6 and T7. The plants were monitored until the tassel stage since it is the maximum growth stage for the plant before it goes to productive stage. At tasseling (day 50), the plants were harvested and partitioned into leaves, stems, and roots. The remaining roots in the soil were removed carefully and cleaned using tap and distilled water. The plant parts (leaves, stems, and roots) were placed in brown paper then oven dried at 60°C until constant weight and their dry matter were determined.

RESULTS AND DISCUSSION

Physico-chemical of IMO compost

Table 1. shows the relatively high values of selected chemical properties in IMO-compost content from paddy husk (PH) and corn stalk (CS) residues. These suggested the high quality of IMO-compost for plant growth and also development.

Table 1.: Chemical characteristics of IMO-Compost used for maize planting

Characteristics	T1	T2	T3	T4	T5	T6
pH_{water}	7.93^{c}	8.40^{ab}	8.16^{bc}	8.27^{abc}	7.96^{c}	8.58^{a}
pH_{KCl}	7.35^{b}	8.29^{a}	7.47^{b}	8.10^{a}	7.47^{b}	8.25^{a}
Total N (%)	3.80^{a}	3.66^{a}	3.85^{a}	5.75^{a}	3.75^{a}	4.33^{a}
Total P (%)	0.89^{bc}	1.13^{a}	0.88^{bc}	1.24^{ab}	0.86^{c}	1.12^{abc}
TOC (%)	31.71^{a}	36.73^{a}	33.25^{a}	25.13^{a}	32.09^{a}	30.16^{a}
C:N ratio	8.37^{a}	10.06^{a}	8.93^{a}	4.44^{a}	8.63^{a}	7.60^{a}
C:P ratio	36.11^{a}	32.38^{a}	38.37^{a}	20.04^{a}	38.38^{a}	27.09^{a}
CEC (cmol kg^{-1})	66.00^{b}	64.00^{b}	62.67^{b}	83.33^{a}	59.33^{b}	89.67^{a}
Ash (%)	45.33^{a}	36.67^{a}	42.67^{a}	56.67^{a}	44.67^{a}	48.00^{a}
OM (%)	54.67^{a}	63.33^{a}	57.33^{a}	43.33^{a}	55.33^{a}	52.00^{a}
HA (%)	3.97^{c}	9.70^{ab}	5.47^{c}	11.60^{a}	4.33^{c}	8.40^{b}
Macronutrients						
K (%)	1.12^{b}	2.27^{a}	1.11^{b}	2.43^{a}	1.14^{b}	2.21^{a}
Ca (%)	0.97^{b}	1.33^{a}	1.01^{b}	1.43^{a}	1.03^{b}	1.34^{a}
Mg (mg kg^{-1})	3453.30^{c}	5076.70^{a}	3566.70^{bc}	5230.00^{a}	3533.30^{bc}	4696.70^{ab}
Micronutrients						
Na (mg kg^{-1})	1720.00^{b}	2476.70^{a}	1986.70^{ab}	2493.30^{a}	1800.00^{b}	2380.00^{ab}
Fe (mg kg^{-1})	2220.00^{abc}	3670.00^{a}	931.70^{bc}	2006.70^{abc}	676.70^{c}	2778.30^{ab}
Cu (mg kg^{-1})	923.30^{d}	1220.00^{b}	1073.30^{c}	1426.70^{a}	1193.30^{bc}	1480.00^{a}
Zn (mg kg^{-1})	175.00^{cd}	281.67^{ab}	111.67^{d}	308.33^{a}	140.00^{cd}	211.67^{bc}

Different letters within a column indicate significant difference between means using Tukey's Test at $p = 0.05$

Dry weight of plant parts at day 50 after germination

Dry weight of leaf, stem and root for T3, T5 and T7 was significantly higher than that of T1, T2, T4 and T6, while the plants of T0 were stunted due to no fertilization (Table 1). This was also partly because IMO-compost was made from corn stalk (CS) residues which have higher nutrient composition and humic acid (HAs) compared to IMO-compost from paddy husk (PH) residues. Akanbi and Togun (2002) reported mature compost from corn stalk (CS) residues and chicken dung (CD) which contained more nutrients and hence suitable as compost materials and fertilizers. The effects of IMO strains in compost from corn stalk (CS) on growth of maize are mainly derived from morphological and physiological changes of plant roots (Plate 1) through the production of phytohormones, which lead to an enhancement of water and nutrient uptake.

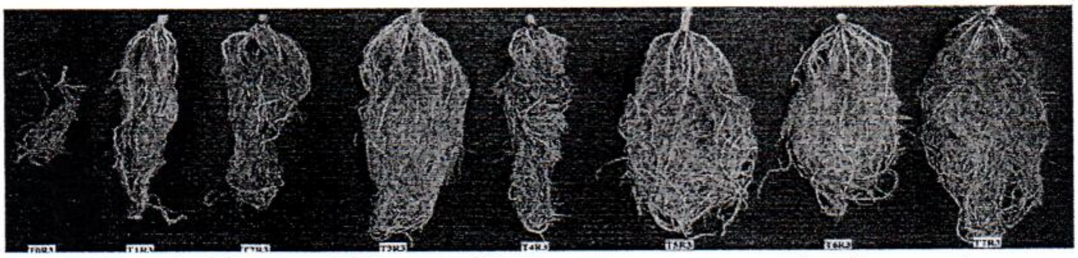

Plate 1: Effects of different IMO-compost on root development

Table 1: Dry weight of leaves, stems and roots of maize plants at day 50 after germination

Treatment	Dry Weight of Plant (g plant^{-1})			
	Leaves	Stems	Roots	Total
T0	4.38^{d}	1.40^{g}	1.26^{g}	7.04^{f}
T1	16.35^{bc}	18.74^{f}	5.36^{f}	40.45^{c}
T2	15.74^{bc}	19.53^{e}	6.14^{e}	41.41^{e}
T3	20.29^{a}	25.21^{a}	14.43^{a}	59.93^{a}
T4	16.40^{bc}	21.49^{d}	7.50^{d}	45.38^{d}
T5	16.61^{b}	23.54^{b}	9.56^{c}	49.72^{c}
T6	16.48^{bc}	22.54^{c}	7.57^{d}	46.59^{d}
T7	16.79^{b}	24.20^{b}	11.57^{b}	52.56^{b}

Different letters within a column indicate significant difference between means using Tukey's test at $p = 0.05$

CONCLUSION

In terms of dry weight production, T3 had significant effect compared to control treatment (T0) of maize (*Zea mays* L.) sweet corn variety (D56) indicating it as a suitable organic soil amendment.

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REFERENCES

Ahmed, O. H., M. H. A. Husni., A. R. Anuar., M. M. Hanafi. and E. D. S. Angela. 2004. A modify way of producing humic acid from composed pineapple leaves. *Journal of Sustainable Agriculture,* 25: 129-139.

Akanbi, W. B., and A. O. Togun. 2002. The influence of maize-stover compost and nitrogen fertilizer on growth, yield and nutrient uptake of amaranth. *Scientia Horticulturae,* 93: 1-8.

Bremner, J. M. 1965. Total Nitrogen. In: Method of soil analysis, Part 2, Black CA, Evants, D.D., Ensminger, L.E., White, J.L., Clark, F.E., Dinauer, R.C., (Eds.), American Society of Agronomy, Madison, Wisconcin. Pp: 1149-1178.

Cherif, H., F. Ayari., H. Ouzari., M. Marzorati., L. Brusetti., N. Jedidi., A. Hassen. and D. Daffonchio. 2009. Effects of manucipal solid waste composts, farmyard manure and chemical fertilizers on wheat growth, soil composition and soil bacterial characteristics under Tunisian arid climate. *European Journal of Soil Biology,* 45: 138-145.

Cottenie, A. 1980. Soil testing and plant testing as a basis of fertilizer recommemdation. FAO Soils Buleti. 38: 70-73.

Legros, J. P., and G. Petruzzalli. 2001. The status of Mediterranean soils. International Conference of Soil and Biowaste in Southern Europe, Rome, Italy.

Murphy, J., and J. P. Riley. 1962. A modified single solution method for the determination of phosphate in natural waters. *Analytica Chimica Acta,* 27: 31–36.

Peech, H. M. 1965. Hydrogen-ion activity. In: Method of soil analysis, Part 2. Black, C.A., Evants, D.D., Ensminger, L.E., White, J.L., Clack, F.E., Dinauer, R.C., (Eds.), American Society of Agronomy, Madison, Wisconsin. Pp: 914-926.

Stevenson, F. J. 1994. Humus chemistry: Genesis, composition, reactions. (2nd Ed.) John Wiley and Sons, New York. Pp: 36.
Tan, K. H. 2005. Soil sampling, preparation, and analysis (2nd Ed.). Boca Raton, Florida, USA.