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ASSESSING THE QUALITY OF COMPOSTS AVAILABLE IN THE OPEN MARKET IN SRI LANKA THROUGH PLANT GROWTH STUDIES

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ABSTRACT

Compost is the end product of the aerobic microbial decomposition of organic matter, such as animal manures, plant residuals and domestic wastes, under controlled conditions. Several official and private organizations in different countries have established standards and specifications for compost quality to improve crop production and to protect public health and environment. The assessment techniques for the stability and quality of composts are based on physical, chemical and biological properties of the compost. The most common direct assessment strategies include the measurement of properties and indirect methods include the measurement of growth parameters using fast growing crop plants such as *Zea mays*. No such effort or similar assessment has been practiced in Sri Lanka. Therefore, the main objective of the present study is to evaluate the efficiency of compost as a soil amendment using growth parameters to obtain a base line data set. Eight compost varieties that are available in the open market were chosen for this study. The growth parameters such as plant height, stem girth, number of leaves and wet biomass were measured using *Zea mays* as the test plant for a period of 6 months at Pohorawatta compost site in the western province of Sri Lanka. The results obtained were analysed statistically and found out that compost can be used as a positive soil amendment based on all measured parameters. Out of all compost varieties, Mihisaru Segregated became the best performed compost indicating its highest effectiveness in improving plant growth. Therefore, further studies on the compositions, properties, type of sources and the method of composting are extremely required to explain the observed performances.

Keywords: Compost Quality, soil amendment, plant height, stem girth, wet biomass

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INTRODUCTION

Compost is the end product of the aerobic microbial decomposition of organic matter, such as animal manures, plant residuals and domestic wastes, under controlled conditions [1]. Compost quality is a general terms describing the degree of compost stability and maturity. Stability is often related to microbial activity and refers to the resistance of compost organic matter to further degradation, whereas maturity is usually associated with plant growth potential or phytotoxicity and describes the fitness of compost for land application [1,2]. Many tests have been proposed for assessment of compost stability and maturity and they focus on physical, chemical and biological properties of the compost. The most common direct assessment strategies include the measurement of properties and indirect methods include the measurement of growth parameters using fast growing crop plants such as Zea mays L. [3].

Composts have been shown to enhance soil fertility and quality and to improve crop productivity. However, application of unstable or immature composts may have adverse effect on plant growth and environment and public health [4]. Research conducted by Lima *et al.,* [5] proved the beneficial action of compost on the physical–chemical properties of the soil and on the plant development. Ramadass and Palaniyandi [6], concluded that the amount of nitrate nitrogen and ammonium nitrogen content were found significantly maximum in enriched compost applied soil. In addition, soil available phosphorous, potassium and micronutrients content were found to be higher under the enriched compost applied soil. Pant *et al.,* [7] demonstrated that compost quality impacted on nutrient extraction efficiency, microbial activity, phytohormons and total nutrient content of the extracts. Conservation agriculture promotes minimum mechanical soil disturbance, maintenance of soil organic cover, and the use of crop rotations and associations that are suited to local environments. To this end, the utilization of cheaper, most available and accessible fertilizer in crop production will be pertinent. Cow dung, poultry dropping, pig dung and refuse composts are among several organic materials which have been recommended to farmers in West Africa as soil amendments for increasing crop yield [8].

Several official and private organizations in different countries have established standards and specifications for compost quality to improve crop production and to protect public health and environment [9,10]. Examples of fairly developed compost standards are those produced by California Compost Quality Council [11] and British Standards, PAS-100-2005 [12].

Numbers of different methods are available for making composts. There are open systems (windrow and aerated static pile) which are relatively simple to operate and low cost, and a number of contained systems which have options for moving the material, supplying forced air,

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and operating on a continuous or batch system [13]. In Saudi Arabia, several large feedlots are composting their manure for the agricultural market. These compost facilities engage a range of technologies, from simple static piles to automated in-vessel systems. Composts are then packed in a 25-50 L bags and sold in the market to farmers for land application. Recently, the Gulf countries established the law of organic fertilizers, which propose some specifications and regulations for compost quality [14]. However, several important compost maturity indices such as germination index, nitrification index and compost respiration rate are not specified in GCST. Moreover, there are neither mechanisms nor organizations responsible for the evaluating the compost quality in Saudi Arabia, which may result in low quality that are harmful to public health, plant and environment.

The quality of compost and its suitability for agricultural application depend upon physical and chemical parameters such as water-holding capacity, porosity, pH, electrical conductivity, C/N ratio (Fig 1), available nutrients and the absence of toxic substances (Table 1). Over the past few years, the dialogue between compost producers and the agricultural community has increased reflective of the interest in determining compost's many applications. Mature compost provides a stabilized form of organic matter and has the potential to enhance nutrient release in the soil more than the raw organic wastes [15].

Table 1:Somephysico-chemical properties of composts used for the study(Source-Western Province Waste Management Authority, 2014)

Compost name	pH	EC (dS/m)	Moisture	Org. C%	Total N%	P_2O_5 %	K_2O	C:N
Agalawaththa	8.6	6.91	15	37.79	0.36	1.3	1.7	28.6
Mathugama	7.8	2.1	36	35,9	0.08	1.3	1.8	38.1
Madurawela	8.5	4.48	23	41.3	1.55	2.2	2.4	26.7
Beruwala	8.1	4.9	24	39.5	1.55	1.3	2.5	25.5
Mihisaru segregated	8.3	5.25	21	52.26	1.77	1.4	1.7	29.5
Horana	8.9	8.2	8	31.51	1.16	1.3	2.1	27.2
Dikovita	7.3	2.6	36	28.17	1.22	1.4	0.6	23.1

However, the specific production benefits of compost on yield and product quality need to be demonstrated to move from "dialogue" to usage. To our knowledge, no report has been available or no study has been conducted concerning the quality assessment of the compost produced in Sri Lanka. Accordingly, little information is available about maturity and stability indices of local composts even though many promotion schemes are underway to persuade people to make compost from domestic solid waste as a strategy to overcome the solid waste menace. Further, the performance must be assessed first before deciding on suitable indices to assess the quality of compost and to develop acceptable set of standards. Therefore, the main objective of the present study is to identify the best compost type from among the commercially available compost varieties in Sri Lanka using growth characteristics of fast growing plant *Zea mays* L.(Variety TF222) to obtain baseline data set on the performance of available compost before deciding on evaluation criteria.

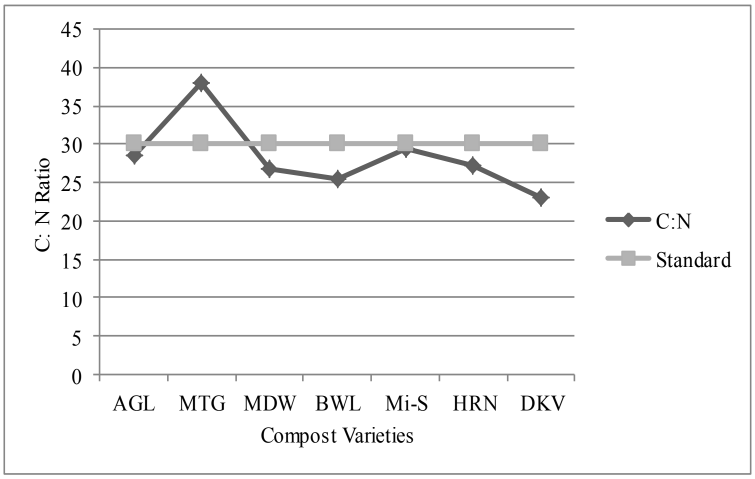

Fig. 1– C:N ratio of the varieties of Compost available in the Sri Lankan market and used for this study

MATERIALS AND METHODS

The siteselected to carry out the experiment was Phorowatta Mihisaru compositing facility of the Western Province. It was selected due to the close proximity to the other composting sites considered in this study for sample collection and transportation. This site was located about 35km south of Colombo. When consider the experiment layout, it was designed according to the complete randomized design (CRD) in the pot experiment with three replications from each treatment. The large garbage bags which carry the waste to the site were washed thoroughly and dried to use as potting bags. Compost samples from Agalawaththa (AGL), Mathugama (MTG), Madurawela (MDW), Beruwala (BWL), Horana (HRN), Dikovita (DKV) areas and two samples named as Mihisaru segregated (Mi-S) and Mihisaru mixed (Mi-M)from the study site were selected as commonly used commercially available and high demanding compost varieties in Sri Lanka (Fig 2).

The soil taken from the land was used to mix with each compost samples in 1:1 ratio resulting nine different soil compost combinations. The potting bags were filled with 16 litres volume of

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above soil compost mixture. The pots were placed according to the recommended spacing with 90cm between two rows and 60cm distance within a row. Maize variety of TF-222 (107 days of harvesting time) recommended by the Department of Agriculture was selected for this study. Three to four seeds were planted in the center of the potting bags. About week after planting, only one healthy plant was left undisturbed in the pot while removing the other plants. Three replicates were prepared from each treatment and only soil was used for the control.

Watering was done daily considering the natural rain fall to the area for the purpose of maintaining the soil water in the field capacity. Pots were placed to get the maximum sun light of at least 6 hrs per day. The basic requirements for the plant growth were provided for all planting pots equally and no fertilizer, growth hormone or pesticides were applied.

The following measurements were taken 8 Weeks After Planting (WAP).

a. Stem girth

b. Number of leaves

c. Plant height

And also after panicle initiation (60-75 days after planting), the wet biomass of the plants were measured and recorded. The collected data were analysed using SAS statistical software package.

Figure 2: Well grown maize plants 4- 5weeks after planting

RESULTS AND DISCUSSION

Table 2: The measurements of plant height, stem girth, number of leaves and wet biomass after panicle initiation 8 weeks after planting

Name of the Compost variety	Plant Height (Mean Values in cm)	Stem Girth (Mean Values in cm)	No .of leaves (Mean Values)	Wet Biomass after panicle initiation (Mean Values in g)
Agalawaththa	89.33±11.68	7.33±0.58	13.33±1.00	336.67±1.00
Mathugama	77.66±4.04	7.66±0.58	14.70±1.13	425.00±38.84
Madurawela	81.33±2.52	8.00±1.00	14.33±1.15	376.67±50.29
Beruwala	74.33±2.89	7.66±0.58	13.33±0.58	303.33±109.81
Horana	70.66±6.66	6.33±1.15	13.66±0.58	225.00±13.65
Dikovita	76.66±13.20	7.66±0.58	14.33±1.53	440.67±80.03
Mihisaru-segregated	55.33±17.62	6.00±1.73	12.66±1.00	220.00±31.64
Mihisaru-mixed	87.00±20.00	8.66±0.58	16.33±2.08	493.67±70.00
Control–only soil	64.00±7.00	5.33±0.58	14.33±1.15	225.00±62.42

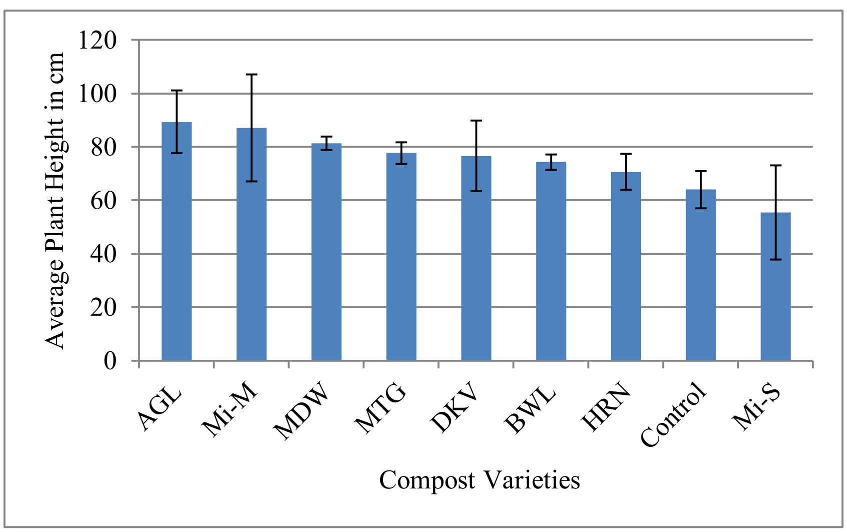

Figure 2: Mean Height of Plants measured at 8 WAP with different compost types

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The highest plant height at 8 WAP was given by Agalawaththa Compost (89.3 cm) followed by Mihisaru Mixed Compost (87.00 cm) and Madurawela Compost (81.33 cm) respectively(Table 2). The lowest plant height was recorded for Mihisaru Segregated Compost where it showed a lower value than the control(Fig. 2).The increase of height is attributed to the availability of mineral nutrients as reported by Jigme *et al*. [16] and the high Electrical Conductivity value given for Agalawatta compost could be an indication of availability of nutrients for the uptake by the plant. Umesha *et al*., [17] also reported that high levels of minerals are available in compost and could be an active soil amendment. Further, the composting process for Agalawatta may have been the best effective process to have such a good growth or the raw materials available in the waste may be easily degradable material as reported by Manios [18]. The raw materials that can be used to produce high quality composts are mainly the residues of local cultivations and agricultural industries (Manios, 2004). In the present study, the given C:N ratio for Agalawatta (28.6) is well within the ideal limits for proper composting process.

The results for stem girth revealed that the Mihisaru Mixed compost (8.66 cm) showed the highest stem girth out of all tested. The second highest value was recorded by Madurawela (8 cm), Mathugama (7.66 cm), Beruwala (7.66 cm) and Dikovita (7.66 cm) respectively(Fig.3).

Therefore, it is evident that Mihisaru Mixed contains more nitrogen sources that are useful in increasing peripheral cell growth leading to higher stem girth as reported by Ogbonna *et al*, [19]. Olowoake *et al.,*[20] also stated that the increased stem growth is a good indicator for soil fertility in maize plants.The highest value for Mihisaru-mixed for the stem girth may be reflecting that this soil amendment might have supplied the adequate nutrients needed (particularly nitrogen which enhances vegetative growth of plants) at this growth stage.

The advantages of compost fertilizer in crop production include ready availability of materials for their preparation, gradual release of nutrients without being wasted through leaching, increased soil drainage, aeration, water holding capacity, nutrient holding capacity and being environmentally friendly. These have made compost application popular among farmers [21]. Therefore, the present results would be highlighting that Mihisaru mixed compost may have all those attributes to become the first based on stem girth.

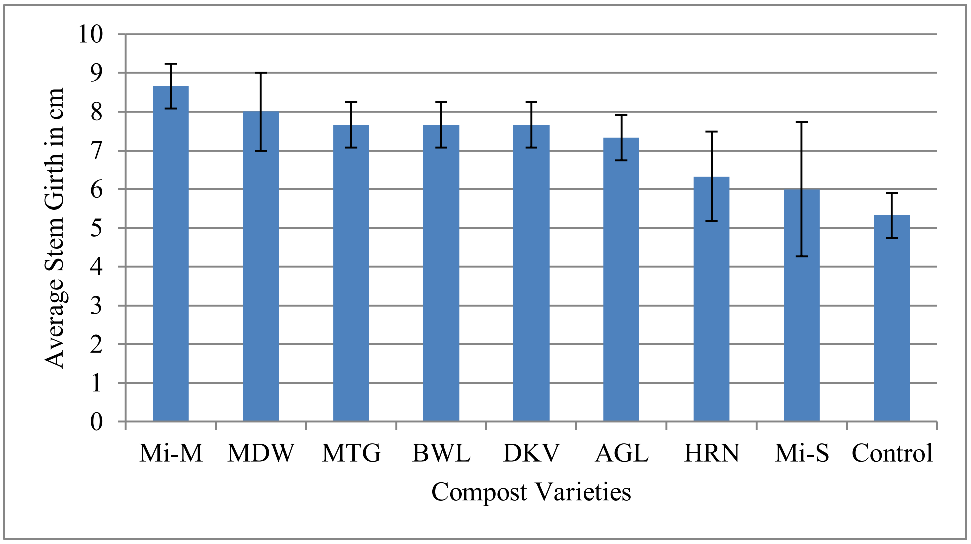

Figure 3: Mean Stem Girths of plants measured at 8 WAP for different compost varieties

The highest number of leaves was resulted by Mihisaru mixed (16.33 nos) compost addition followed by Mathugama (14.70 nos) compost. The Madurawela and Dikovita showed similar values(14.33 nos.). The least growth was shown by Mihisaru segregated (13.00 nos) (Fig.4).

When analysing the number of leaves at 8 WAP, it showed that Mihisaru mixed might be having more useful nutrients that are responsible for leaf initiation than that of other compost varieties. The results further highlighted that some compost amendments were less performing than the control indicating possible negative physiological impacts also. On the other hand, the relatively slow mineralization of the composts and other organic fertilizers limits the effective nitrogen utilization [22]. Leaf development is primarily a function of having N in the plant.

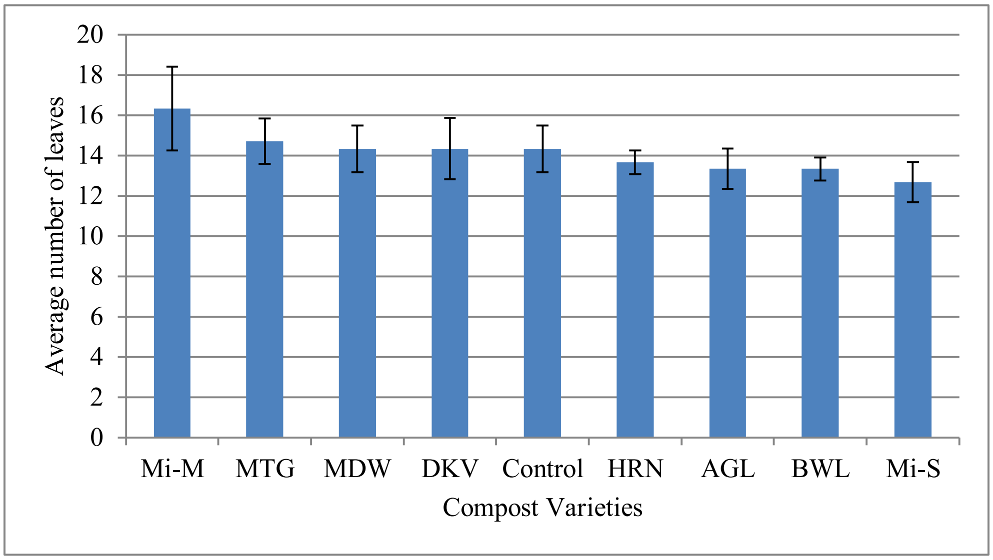

Figure 4: Mean number of leaves measured at 8 WAP for different compost types

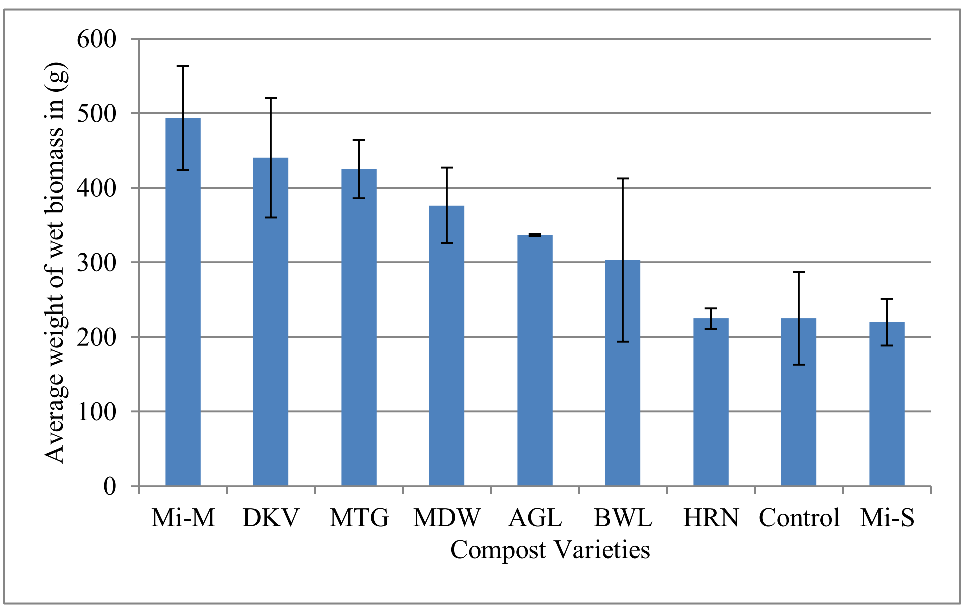

Figure 5: Average weight of wet bio-mass after panicle initiation of maize plants in relation to different compost treatments.

Highest wet bio mass was shown by Mihisaru mixed (460.83 g) compost treatment and followed by Dikovita (438.33g). The least growth was shown by Mihisaru segregated (216.33 g) next to control (235.33g) (Fig.5).

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The wet biomass was measured after panicle initiation approximately after 60 days (8 WAP) after planting. Mihisaru mixed may be either the best nutrient supplier for the development of high biomass or may be the most stable amendment that can keep its nutrients up to 8 weeks without any change of its profile. Even though, wet biomass is not a good parameter to give any decision on the growth of a plant, it gives some indication on the performance of the amendment (compost) as a growth measurement. The highest performance by Mi-M could be due to the improved soil structure and thus nutrient accessibility as reported by Pinamonti [23]. The growth increase is most likely due to the increased nutrient supply from the compost. It can be concluded that compost can be an alternative source of nutrients for sustainable crop yard management. Further, Municipal Solid Waste compost increased the aggregate stability of soil through the formation of cationic bridges thereby, improving the soil structure [24].

Various experiments have indicated that applications of compost improve plant health, yield and nutritional quality [25]. Research conducted by Lima *et al.,* [5] proved the beneficial action of compost on the physico–chemical properties of the soil and on the plant development. Ramadass and Palaniyandi [6] concluded that the amount of nitrate nitrogen and ammonium nitrogen content were found significantly maximum in enriched compost applied soil. In addition, soil available phosphorous, potassium and micronutrients content were found to be higher under the enriched compost applied soil. Pant *et al.,* [7] demonstrated that compost quality impacted on nutrient extraction efficiency, microbial activity, phytohormones and, total nutrient content of the soil solution.

When MANOVA (Multivariate analysis of variance) was performed for 8 WAP, all Wilk's Lambda value statistics indicated that all P values are less than 0.0001 giving some evidence for possible significant difference between highest performed compost treatments and the control (only soil) against all the parameters measured at 8 WAP.

CONCLUSION

When we take all findings of the present study together, it is clear that there is a significant increase in growth parameters such as plant height, stem girth, number of leaves and wet biomass at 8WAP with the addition of compost revealing the beneficial effects of compost in maize plant growth. Except for number of leaves, all other measured growth parameters are performing better than the control. Out of available compost types tested, Mihisaru mixed showed significantly high performance except for plant height at 8 WAP. However effectiveness of compost depends primarily on source and type of organic material, method of composting and compost maturity. Therefore, further studies on the compositions, properties, type of sources and the method of composting are extremely required to explain the observed performances by the *Zea Mays* plants.

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