Effect of Glycerine Spiked Compost-Soil Mixture on the Growth of Wheat Grass

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ABSTRACT

The purpose of this study was to investigate the effect of glycerine spiked compost-soil mixture to the growth of wheat grass. Five composts that were originally spiked with 0%, 10%, 20%, 30%, and 40% of glycerine, were obtained and mixed with top soil at the ratio of 1:2. Six different treatments (i.e. top soil only with no compost, soil with compost that was originally spiked with 0%, 10%, 20%, 30%, and 40% of glycerine) were set up for comparison. The growth of wheat grass in terms of shoot height was monitored over a period of eight days. The final biomass of shoots and roots of the wheat grass were harvested and measured on Day 8. Overall, the result was encouraging as the growth of wheat grass in soil mixture containing glycerine spiked compost was better than that containing top soil only. The growth of wheat grass was most robust and healthy in soil-compost mixture that was not spiked with any glycerine as well as soil-compost mixture that was originally spiked with 10% of glycerine. On the other hand, compost that was originally spiked with 40% of glycerine could have inhibitory effect to the growth of wheat grass.

INTRODUCTION

Glycerine or glycerol is the by-product of transesterification during the production of biodiesel. Pure glycerine has been widely used in various industries as lubricant, humectant, emulsifier, thickener or surfactant [1]. However, the glycerine by-product generated from biodiesel is in crude form which needs to be further purified and refined before using as industrial feedstock. With the increasing demand of biodiesel, the production of glycerine has increased drastically and changed the supply structure of glycerine market. In long term view, the price of glycerine could trend downwards and create burden of costs on biodiesel [2]. This stimulates research interests on finding new and innovative applications for the oversupplied glycerine. A few initiatives to value-add to the glut of glycerol are such as the conversion of glycerine to propylene glycol [3], acrolein [4, 5], and epichlorohydrin [6]. Wolfson et al. (2007) had also demonstrated glycerol as high conversion and selective green solvent for a variety of organic reactions [7]. Since glycerine is non-toxic and biodegradable, it has high potential to be used as additive in composting. This had led us to explore the possibility of such option by looking into the effect of glycerine spiked compost to the growth of plant.

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In this study, the effect of glycerine spiked compost-soil mixture on the growth of wheat grass was investigated over a period of eight days. Plant height and final weight of shoots harvested were used as investigating parameters to evaluate the growth of wheat grass on glycerine added compost-soil mixture.

MATERIALS AND METHODS

J. Arthur Bower's Top Soil was first screened using mesh of size 2.80 mm. After which, the soil was pre-mixed with *J. Arthur Bower's* vermiculite at the ratio of 3:1. Addition of vermiculite is to prevent the soil mixture from hardening. Vermiculite also helps to retain nutrients and maintain the moisture content of the soil. Five different composts that were spiked originally with 0%, 10%, 20%, 30%, and 40% of glycerine, were sun-dried and grinded using a blender. Every 120 g of the soil was then mixed with 60 g of the compost.

In this study, wheat grass was selected due to its fast growth rate. Furthermore, wheat grass seeds are readily available for purchase because they can be grown in tropical area like Singapore as food crop. Wheat grass seeds obtained from Kin Yan Agrotech was first soaked for approximately 8 hours under room temperature. The seeds were then drained, and allowed to germinate in an upside down position at area of good ventilation and drainage. The seeds were rinsed twice a day to ensure that they were adequately moist during the germination stage. The process took place for 2 days until little white shoots appeared on the seeds. Following that, the germinated wheat grass was further sprouted on cotton wool until small green shoots of less than 1 cm were noticed.

Wheat grass seeds that were germinated successfully were then transplanted into the respective plastic tray (16.2 cm X 9.6 cm X 3.5 cm) containing soil and glycerine spiked compost. Six different treatments namely, soil with no compost, soil with compost that was originally spiked with 0%, 10%, 20%, 30%, and 40% of glycerine, were experimented in triplicates. Each tray was planted with 20 wheat grass seeds. It should be noted that the 0%, 10%, 20%, 30%, and 40% of glycerine here represent the initial concentration of the glycerine being spiked into the compost. The final concentration of glycerine remained in the compost at the time they were used for this experiment was not measured.

The wheat grass was grown for 8 days in Daikin plant growth chamber. The temperature at the plant growth chamber was set to be 28°C, 70% humidity, 75% light intensity and 12 hours daylight cycle. The positions of the trays were randomized and rotated daily to eliminate treatment bias. Furthermore, the wheat grass was watered with the same amount of water (approximately 1 ml) three times a day. Moisture content of the glycerine spiked compost-soil mixture was maintained at 40%.

The height of the wheat grass was measured daily from Day 2 after most of the shoots had grown above 1cm. On Day 8, the wheat grass was harvested and being separated into shoots and roots portions. The fresh biomass of the shoots and roots were measured. The shoots portion was then dried in the oven at 65 degree C until constant weight was

achieved. The final dry weight of the shoots portion was thus obtained. The wheat grass was harvested on Day 8 because tip of some wheat grass shoots started to turn yellowish. Besides, the growth rate in terms of plant height measured started to slow down in general. Common practice in wheat grass farm is to harvest the wheat grass after they have grown up to seven or eight inches so as to ensure the quality of wheat grass produced. This will normally take about seven to eight days.

RESULTS AND DISCUSSION

Interpretation of Legend in Figures:
'Soil only' represents treatment consisted of top soil only; 'Soil + 0% compost' represents treatment that consisted of soil and compost free of glycerine; 'Soil + 10% (20%, 30% or 40%) compost represent treatment that consisted of soil and compost that was originally spiked with 10% (20%, 30% or 40%) of glycerine.

Percentage of successful growth

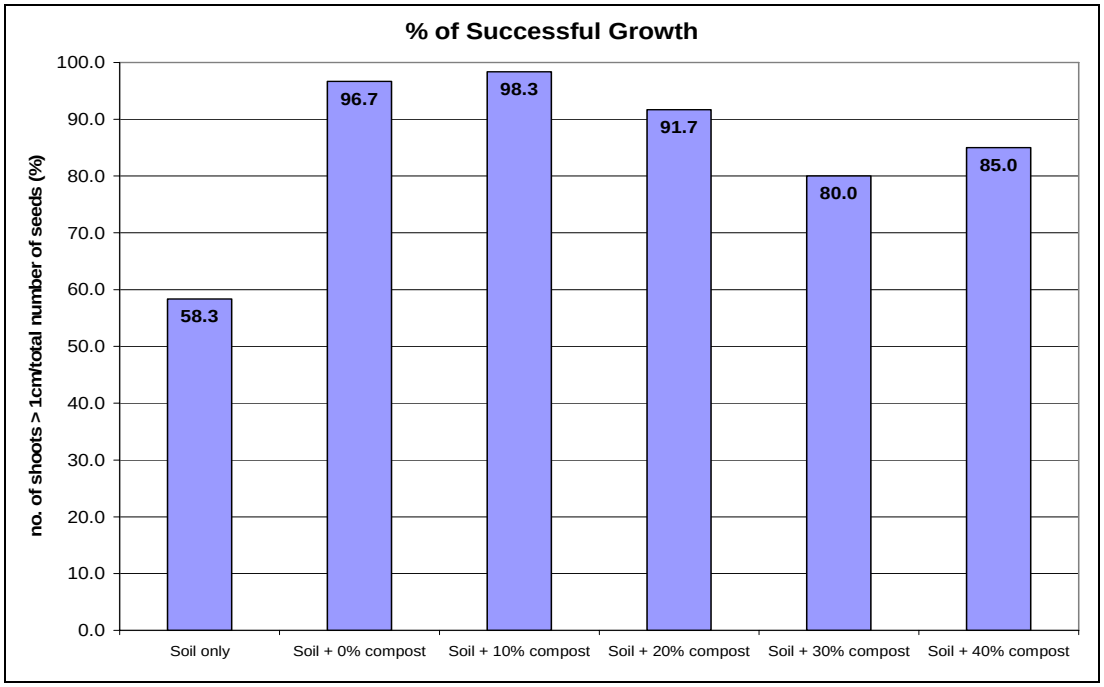


Figure 1: Percentage successful growth of wheat grass

A total of 60 seeds were planted for each treatment. At the end of the growth period of eight days, the total number of seeds that had successfully grown taller than 1cm was accounted for each treatment. Only 58% of the seeds planted on top soil survived and grew to more than 1cm. On the other hand, at least 80% of the seeds planted on glycerine spiked compost-soil mixture survived and grew (refer to Figure 1). This indicated that wheat grass were able to grow in soil with compost that were spiked with different concentrations of glycerine.

Growth of wheat grass

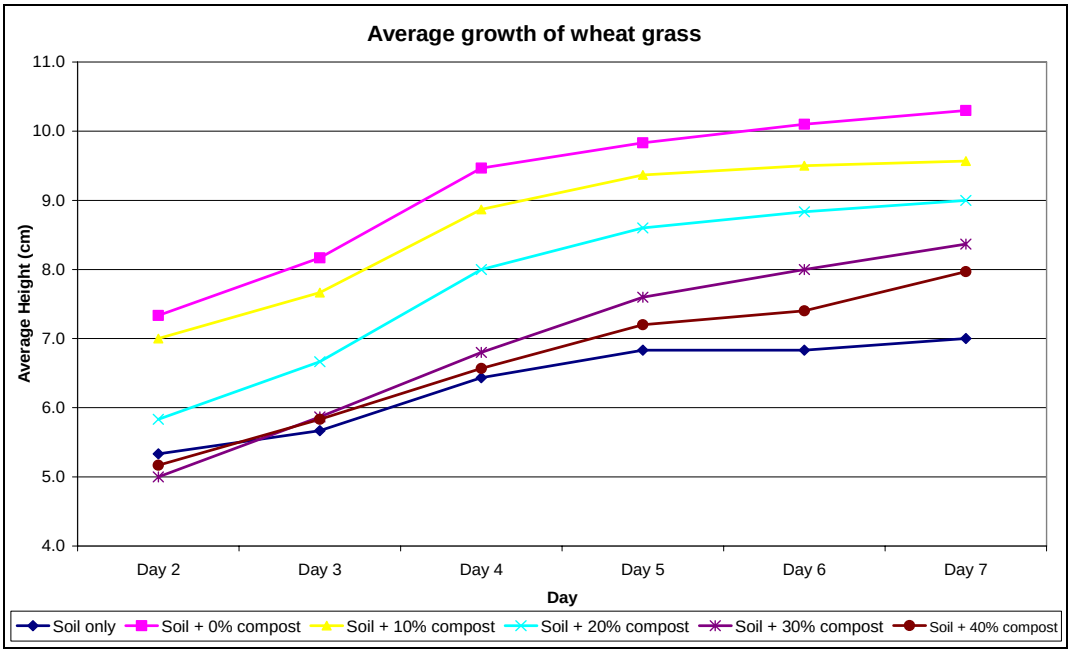


Figure 2: Growth curve of wheat grass

As shown in Figure 2, the wheat grass took about three days to adjust and adapt to the new soil condition after transplanting. The growth of wheat grass started to accelerate after Day 3. From Day 3 onwards, it was also observed that the growth of all wheat grass in soil containing compost out-performed that of which only consisted of top soil only. Besides, the growth of wheat grass in soil containing compost followed a trend in which the lower the original percentage of glycerine spiked in the compost, the better was the growth of the wheat grass. As such, the growth of wheat grass was the best in soil mixture that contained compost free of glycerine, followed by soil mixture that contained compost originally spiked with 10%, 20%, 30%, and 40% of glycerine respectively.

Judging from the gradients of the curves in Figure 2, it is interesting to note that the growth of wheat grass in soil-compost mixture that was originally spiked with 10% and 20% of glycerine seemed to have slowed down from Day 5. This could be because the wheat grass was approaching maturity. Whereas, those of which in the 30% and 40% glycerine spiked compost seemed to show trend of speeded up growth. This is especially true for the case of 40% glycerine spiked compost-soil mixture (brown line in Figure 2). This could probably because the wheat grass needed to take longer period of time to adapt to such growing condition.

Photo 1: A comparison of the best and worst growth on Day 4. Wheat grass grew the best in soil-compost mixture that was free of glycerine (right). The left indicates the worst growth in top soil only. It can be seen that the wheat grass shoots in soil only condition was significantly thinner.

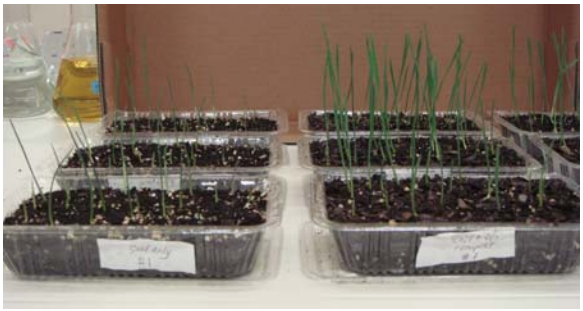


Photo 2: Overview of the growth of wheat grass in different treatment on Day 5. The left most treatment being soil only, followed by compost-soil mixture with original 0%, 10%, 20%, 30% and 40% of glycerine (from left to right). The shoots in glycerine free compost-soil mixture (second from left) and 10% glycerine spiked compost-soil mixture (third from left) were denser, taller and sturdier. The growth of wheat grass become less robust as the amount of glycerine that were originally spiked into the compost increased from 20% (4th treatment from left) to 40% (right most treatment).

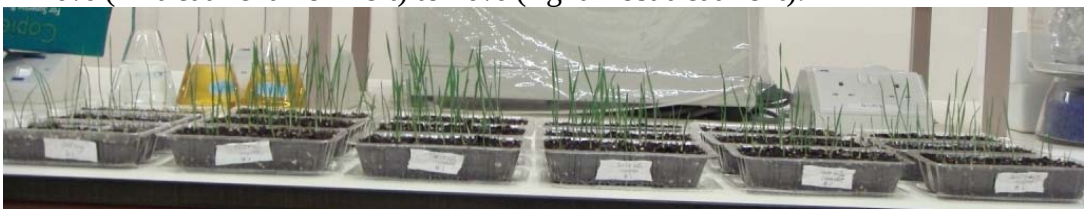


Photo 3: The growth of wheat grass in soil-compost mixture that was originally spiked with 10% of glycerine showed robust growth (right) as in the case of soil-compost mixture that was free of glycerine (left). This photo was taken on Day 5.

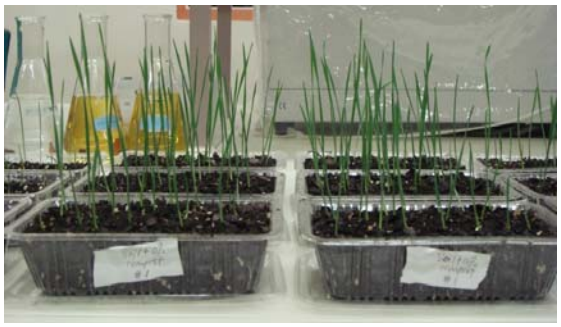
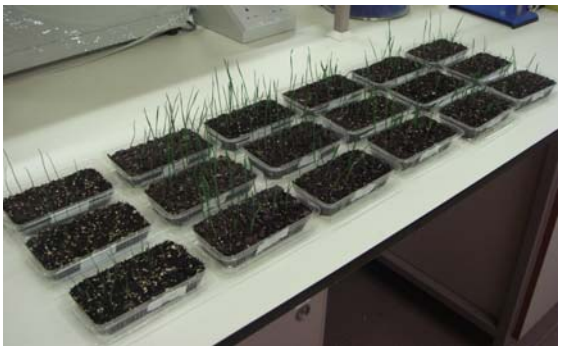


Photo 4: Overview of wheat grass on Day 8. All wheat grass shoots were characterised by dark green colour. The best growth occurred in soil-compost mixture that was originally spiked with 0% (second from left) and 10% (third from left) of glycerine.



Final shoot height

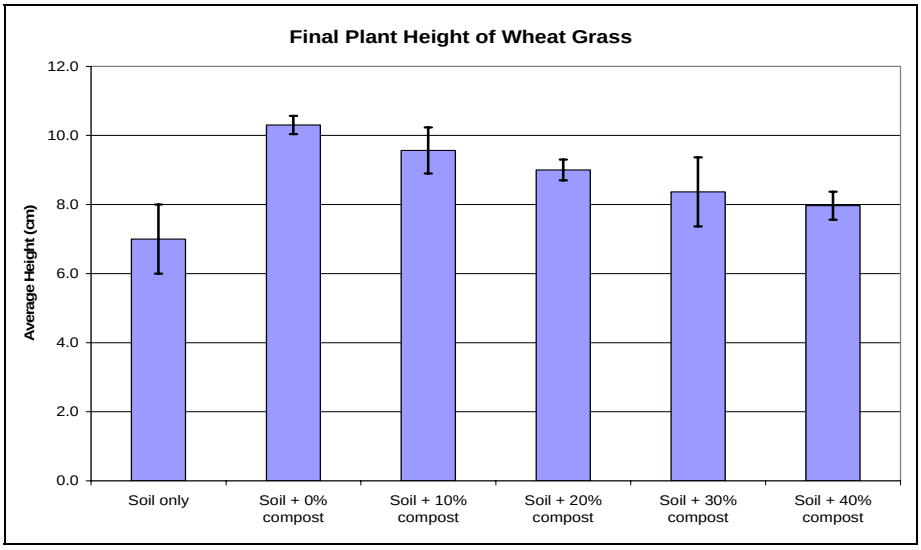


Figure 3: Final average height of wheat grass after growing for 8 days in glycerine spiked compost-soil mixture.

As shown in Figure 3, wheat grass grew the best in soil-compost mixture that did not spike with any glycerine. The wheat grass had also shown prominent growth in soil-compost mixture that was originally spiked with 10% of glycerine. Overall, the result was encouraging as the growth of wheat grass in soil mixture containing glycerine spiked compost was better than that containing top soil only. Commercially, compost has been used to promote the growth of wheat grass. As in the case of the wheat grass farm at Kin Yan Agrotech, chicken compost is mixed into the soil media for growing of wheat grass.

Shoot mass

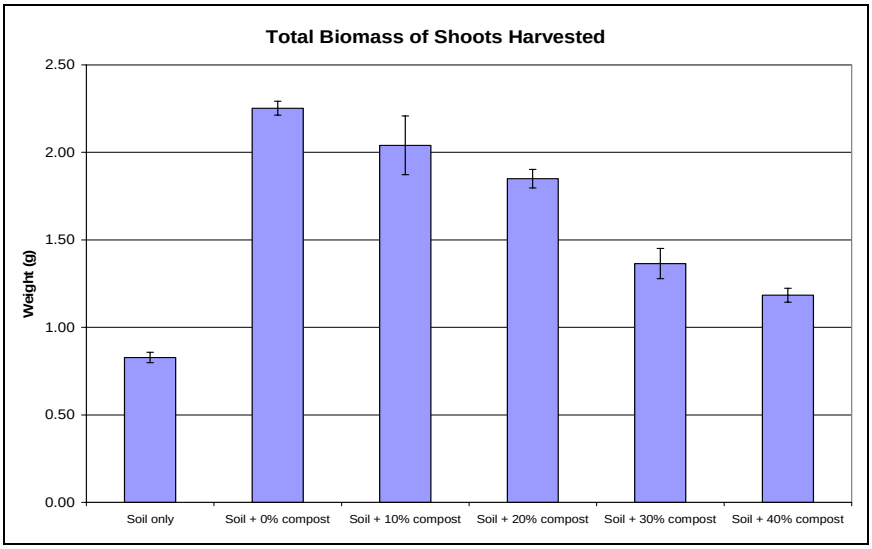


Figure 4: Total weight of fresh shoots harvested on Day 8.

The total fresh weight of wheat grass shoots harvested after growing for eight days are shown in Figure 4. Compost-soil mixture that was free of glycerine produced the highest total biomass of shoots. The total biomass of shoots harvested decreases as the percentage of glycerine that was originally spiked into the compost increases. On the whole, total biomass of shoots harvested from soil-compost mixture is more than that harvested from soil only. As shown in Figure 5, the total dry weight of wheat grass shoots harvested in the six different treatments follows the same trend as in Figure 4.

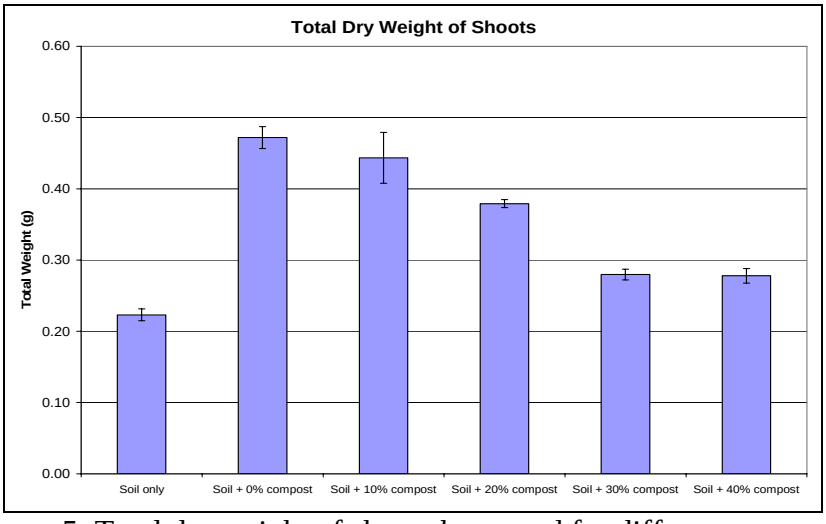


Figure 5: Total dry weight of shoots harvested for different treatment

Based on the results obtained, it can be seen that compost promotes the growth of wheat grass in general. In contrast, the effect could be balanced out by the inhibitory effect of compost spiked originally with high percentage of glycerine.

The nutrient content such as nitrogen and carbon in the soil-compost mixture could significantly influence plant growth. One of the possible reasons of the trend observed in this study could be due to the effect of remaining glycerine in the compost. Given the same composting period, compost that was originally spiked with highest percentage (40%) of glycerine could have the highest concentration of glycerine remained in the compost. As such, the wheat grass might need to take more time to adjust to such growing condition. Study conducted by Brouquisse et al. 2007 pointed out that plant cells do not utilize glycerine efficiently as carbon substrate and their metabolism will be affected by glycerine [8].

On the other hand, it was previously determined that the higher the concentration of glycerine added in the compost, the higher the DHA (dehydrogenase activity) reading, indicating glycerine can be broken down during the composting process. Therefore, another possibility is that the microbial degradation of glycerine in compost spiked with the highest percentage (40%) of glycerine could be the highest. As a result, the nutrient content in the compost might be the lowest which caused the poor growth of wheat grass in compost-soil mixture that was originally spiked with 40% of glycerine. Alternatively, there could be undesirable biodegradation by-product such as sulphides being formed in compost spiked with higher percentage of glycerine which might inhibit the growth of wheat grass.

Root mass

Even though root is not the edible portion of wheat grass, it might worth documenting the response of the wheat grass roots since they were in contact directly with soil and glycerine added compost mixture.

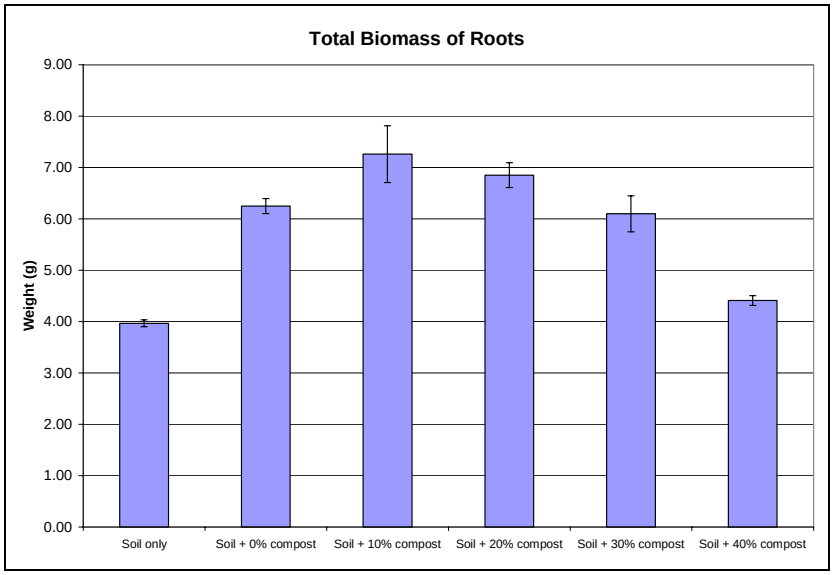


Figure 6: Final biomass of roots of wheat grass.

Figure 6 reports the final biomass of roots of the wheat grass in different treatments. The biomass of roots was the highest in soil mixture containing compost that was originally spiked with 10% of glycerine. Soil-compost mixture that was spiked originally

with 40% of glycerine also resulted in relatively low biomass of roots. However, final biomass of roots in treatment containing top soil only was the lowest. Experiments carried out by Brouquisse et al. 2007 confirmed that glycerine is not toxic to maize root tips. On the other hand, the data suggested that glycerine could not sustain the growth and protein synthesis of maize root tips [8].

Measurement of total root mass was subject to technical limitation as it was difficult to remove all the soil particles and organic debris trapped on roots. Excessive washing may damage and cause loss of root tissue; whereas incomplete washing may leave large quantity of residual soil embedded among the roots. Care was taken during the washing and drying process to minimize these sources of error.

CONCLUSION

In conclusion, the result was encouraging as the growth of wheat grass in soil mixture containing glycerine spiked compost was better than that containing top soil only. The growth of wheat grass was most prominent in compost that was not spiked with any glycerine as well as compost that was originally spiked with 10% of glycerine. On the other hand, compost that was originally spiked with 40% of glycerine could probably have inhibitory effect to the growth of wheat grass.

FUTURE WORK

It should be useful to examine the composition characteristics of the glycerine compost to determine how much glycerine is left and what are the by-products produced at the end of the composting period. The effect of glycerine compost on the growth of other plant species could be studied. Furthermore, crude glycerine can be spiked directly into soil to examine its effect to plant growth instead of using the end product of glycerine compost.

ACKNOWLEDGEMENTS

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