GERMINATION AND FIELD EMERGENCE OF VEGETABLE SEEDS IN COMPOSTED BIOSLUDGE

Connie Francis

Bachelor of Science With Honours (Plant Resource Science and Management) 2004
GERMINATION AND FIELD EMERGENCE OF VEGETABLE SEEDS IN COMPOSTED BIOSLUDGE

CONNIE FRANCIS

This project is submitted in partial fulfillment of the requirements for the degree of Bachelor of Science with Honors (Plant Resource science and Management)

Faculty of Resource Science and Technology
UNIVERSITY MALAYSIA SARAWAK
March 2004
Germination and Field Emergence of Vegetable Seeds in Composted Biosludge

Connie Francis

Plant Resource Science and Management Program
Faculty of Resource Science and Technology
University Malaysia Sarawak

ABSTRACT

A field study was conducted to determine the influence of composted biosludge on seed germination and seedling emergence of ten types of vegetables. Results revealed apparent improvement on the percentage germination and emergence of vegetable seedlings for both composted-soil (2 compost:1 topsoil (C2S1)) and (1 compost:1 topsoil (C1S1)) compared to non-composted soil (control (C0S1)) for all types of vegetable. Early germination and emergence have also observed for treatments C2S1 and C1S1 for A. blitum, Brassica spp., Ipomoea aquatica, L. esculentum, P. erosus and R. sativus. Germination and emergence of A. blitum, B. rapa, A. esculentus, L. esculentum and R. sativus was highest in C2S1. Both C2S1 and C1S1 did not contribute marked difference on the percentage of germination and emergence of seedlings for I. aquatica, P. vulgaris, P. erosus and R. sativus. The biomass exhibited evidence of high and vigorous seedlings growth occurred for C2S1 followed by C1S1, hence concluded the advantage of dressing topsoil with composted biosludge.

Keywords: vegetable seeds, composted biosludge, germination, emergence, biomass

ABSTRAK

Satu kajian lapangan telah dijalankan bagi menentukan kesan kompos ‘biosludge’ ke atas percambahan biji benih dan pertumbuhan anak benih sepuluh jenis sayuran. Keputusan menunjukkan adanya peningkatan dalam peratusan percambahan biji benih dan pertumbuhan anak benih sayuran pada nisbah kompos-tanah (2 kompos:1 tanah (C2S1)) dan (1 kompos:1 tanah (C1S1)) berbanding dengan tanpa kompos (kontrol (C0S1)) untuk semua jenis sayuran. Didapati juga bahawa percambahan dan pertumbuhan anak benih berlaku lebih cepat di kedua-dua rawatan C2S1 dan C1S1 untuk A. blitum, Brassica spp., Ipomoea aquatica, L. esculentum, P. erosus dan R. sativus. Percambahan biji benih dan pertumbuhan anak benih A. blitum, B. rapa, A. esculentus, L. esculentum dan R. sativus didapati berkesan pada nisbah 2 kompos dan 1 tanah (C2S1). Hasil kajian juga mendapati bahawa perbezaan peratusan percambahan biji benih dan pertumbuhan anak benih adalah tidak ketara untuk L. aquatica, P. vulgaris, P. erosus dan R. sativus. Penentuan biojisim menunjukkan pertumbuhan anak benih yang lebih tinggi pada C2S1 dan diikuti dengan C1S1 dan ini menyimpulkan faedah penggunaan kompos ‘biosludge’.

Katakunci: biji benih sayuran, kompos ‘biosludge’, percambahan, pertumbuhan, biojisim
INTRODUCTION

Vegetables are important as sources of vitamins and minerals and provide fiber, which aids the digestion and cleanses the intestinal canal. However, ample availability and efficient utilization of all nutrients are critical to food production and human being because of the imbalanced of fertilizer used (Dibb and Darst, 1996). The upsurge commodities demand on vegetables resulted in increased appraisals in diverse area of crop production (Egli, 1998; Evans, 1993). Currently, the production of quality seeds and planting material is still insufficient in the country. Local vegetable varieties are of the open pollinated type and in most cases, giving inconsistent and unstable performance (Melor, 2003).

Seeds are important in crop production. Its quality determines success and failure of a crop. Besides planting material is also important input for successful implementation of any agricultural projects. Rapid rate of emergence and ability of seedlings to obtain a stand before the soil crusts are highly desirable (Craddock and Vogel, 1955). Studies have shown that different responses in seedling emergence of many vegetable crops are determined by seed size and conditions (Muhyaddin and Wiebe, 1989; Egli, 1998). Such conditions are through unfavorable temperatures, deficient oxygen supply, too high salt concentration, crusted soil, disease and insects.

Methods designed to improve the seedling appear to have merit are by soaking in growth regulator solutions (Omran, El-Bakry and Gawish, 1980; Miller and Holcomb, 1982),
polyethyleneglycol (PEG) (Heydecker, Higgins and Gulliver, 1973; Muhyaddin and Wiebe, 1989), osmoconditioning (Wolfe and Sims, 1982) fluid drilling (Muhyaddin and Wiebe, 1989; Currah, Gray and Thomas, 1974; Wolfe and Sims, 1982) and priming (Rao, Akers and Ahring, 1987). Improving soil conditions is another important aspect of vegetable cultivation. Applying compost to soil give seeds a helping hand by providing more favorable conditions.

The USDA’s Agricultural Research Service (ARS) in Beltsville, Maryland had conducted researches in composting municipal wastewater biosolids or sewage sludge (Goldstein and Gray, 1999). They defined sludge as the solids removed from wastewater during treatment and concentrated for further treatment and disposal (Cheremisinoff, 1994) or simpler definition is organic sediment deposited during the treatment of sewage. The sludge contains about 70-80% organic matter (Jones, 1993). The utilization of biosludge as fertilizer and soil enhancer is concurrent with the intent to ensure that sewage sludge is used or disposed of in a way that protects both human health and environment (EPA, 1994). Mixing bulk environmental quality sewage sludge with bulking agents, wood chips or substances is commonly done by commercial and municipal appliers for agriculture. Besides, composts can control diseases caused by soil borne plant pathogen by inducing systemic acquired resistance (Goldstein, 1999; Miller, 1999).

Soil organic matter is a major component of biochemical cycles of the major nutrients elements. Thus the quantity and quality of soil organic matter both reflects and controls primary productivity. Organic matter is added into the soil to minimize the nitrogen lost in soil by means of leaching and denitrification and as well as to improve the physical and chemical properties of
the soil. Benefit ascribed to organic matter includes increased soil cation-exchange capacity, increased water-holding capacity, and decreased soil compaction, improved stability of soil aggregates and retention of micronutrients (Agrawal, 1980). In fact, China is the leading country on recycling nutrients from usable organic materials for centuries (Dibb and Darst, 1996). However, crop response to fertilizer can vary with the amount of rainfall or irrigation received during growing season. Adequate moisture content in the root zone is an important factor for efficient use of available nutrients.

The applications of biosludge as composts are negligible or rare in Malaysia. Hence, the purpose of this study was to evaluate the germination and emergence of 10 types of selected vegetables. The effect of different mixtures of compost and topsoil on the germination of seeds and emergence of seedlings of the vegetable were examined. The influence on the germination and emergence was also analyzed using the biomass of seedlings.
MATERIAL AND METHOD

Material

The composted biosludge used was processed at University Putra Malaysia, Bintulu. The vegetable seeds were obtained from local market in Kuching. Three classes of ten vegetables of high quality were evaluated as in Table 1.

Table 1: General classification, scientific nomenclature and vernacular name of the ten vegetables.

<table>
<thead>
<tr>
<th>Classification</th>
<th>Scientific Nomenclature</th>
<th>Vernacular Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leafy</td>
<td><em>Amaranthus blitum</em></td>
<td>Amaranth, Bayam, Spinach</td>
</tr>
<tr>
<td></td>
<td><em>Brassica chinensis</em></td>
<td>Caisin, Chinese Mustard, Sawi Bunga</td>
</tr>
<tr>
<td></td>
<td><em>Brassica oleracea</em></td>
<td>Chinese Kale Kailan,</td>
</tr>
<tr>
<td></td>
<td><em>Brassica rapa</em></td>
<td>Celery Cabbage, Chinese Cabbage, Pak Choi, Sawi Putih</td>
</tr>
<tr>
<td></td>
<td><em>Ipomoea aquatica</em></td>
<td>Kangkong, water spinach</td>
</tr>
<tr>
<td>Fruit</td>
<td><em>Abelmoschus esculentus</em></td>
<td>Kacang Bendi, Kacang Lendir, Lady’s Finger, Okra,</td>
</tr>
<tr>
<td></td>
<td><em>Lycopersicon esculentum</em></td>
<td>Love Apple, Tomate, Tomato</td>
</tr>
<tr>
<td></td>
<td><em>Phaseolus vulgaris</em></td>
<td>French Bean, kacang Buncis</td>
</tr>
<tr>
<td>Root/Tuber</td>
<td><em>Pachyrhizus erosus</em></td>
<td>Sengkuang, Yam Bean</td>
</tr>
<tr>
<td></td>
<td><em>Raphanus sativus</em></td>
<td>Chinese Radish, Daikon Lobak Putih, Oriental Radish, Radish</td>
</tr>
</tbody>
</table>
Method

The field treatments of different ratios of compost mixed with topsoil were 2 compost:1 topsoil (C₂S₁); 1 compost:1 topsoil (C₁S₁) and topsoil as control (C₀S₁), were arranged in a randomized block design. Each bed of 6m x 2m was divided into three equal sections of 2m² surface area (Figure 13-14). One hundred seeds were sown 2cm apart and 1 to 1.5cm deep. Five types of vegetables were planted in five rows in each section on each bed (Figure 14 and 15 in Appendix).

Figure 1: Field plot showing beds for seed germination and seedling emergence of ten types of vegetables.
Figure 2: Beds (a) and (b) showing the compost-soil treatments (C₂S₁, C₁S₁ and C₀S₁) and rows of seedling emergence of vegetables.

The germination and pre emergence of vegetable seeds were counted daily up to 15 days after sowing. Only seeds with its root radicle bulged and develop into seedlings were counted. Five seedlings from each type of vegetables were taken at random from each section for each replicates on the 15th day after sowing to obtain wet and dry weight of each vegetable. To determine the biomass for each seedling, formula below was used:

\[ \text{Biomass} = \text{Seedlings Wet Weight (g)} - \text{Seedlings Dry Weight (g)} \]
RESULT AND DISCUSSION

Three classes of vegetables (leafy, fruit and root) of ten different types were used for assessing the seed germination and field emergence of seedlings in composted biosludge. Data analyses using ANOVA and MINITAB were summarized in Table 2-6 (Appendix). Tukey HSD and Least Significant Difference (LSD) multiple comparisons tests were made to access the location of significant differences between treatment means for each type of vegetables planted in composted and non-composted soil. Percentages of seed germination and seedling emergence for 15 days discussed were mean ± standard error.

Germination and Emergence

Leafy Vegetable

*Amaranthus blitum*

<table>
<thead>
<tr>
<th>Period (day)</th>
<th>C2S1</th>
<th>C1S1</th>
<th>C0S1</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>4</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>5</td>
<td>8</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>6</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>7</td>
<td>12</td>
<td>12</td>
<td>12</td>
</tr>
<tr>
<td>8</td>
<td>10</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>9</td>
<td>8</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>10</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>11</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>12</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>13</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>14</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>15</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>

Figure 3: Seed germination and field emergence of seedlings for *A. blitum*. 

7
In Figure 3, A. blitum seedlings were observed to emerge beginning at 3 days after sowing for C2S1 (2 compost:1 topsoil) and C1S1 (1 compost:1 topsoil) as compared to 4 days for C0S1 (topsoil for control). The percentage of seedling emergence for C2S1 was higher than C1S1 for the first week and both C2S1 and C1S1 were higher than C0S1. However, the percentage of seedling emergence for C2S1 slightly decreased in the second week, mainly due to the damage and death of seedlings from heavy rain. In the second week, a decreased in percentage of seedling emergence was the observed.

Data analysis showed that there was a significant difference (p<0.05) in the percentage of emergence for the seedlings within C2S1, C1S1 and C0S1. The mean percentages of seed germination and seedling emergence for C2S1 and C1S1 were 5.96±0.85% and 5.62±0.89% respectively. While, for C0S1 was 2.24±0.35%. This indicated that the percentage of seedling emergence for A. blitum was higher in the composted biosludge than in the topsoil alone.

The significantly high percentage of seedling emergence occurred in composted biosludge was due to early germination of seeds in the medium. According to Egli (1998), spinach seeds need consistent soil moisture for proper germination. They can grow in a range of soils as long as they are moist and fertile. High in organic matter is recommended for planting spinach.
As shown in Figure 4, it was observed that *B. chinensis* seedlings began to emerge on day 2 for C$_2$S$_1$ and C$_1$S$_1$, while for the control (C$_0$S$_1$), earliest emergence of seedlings was observed to appear at day 3. Seedling emergences were rapid on each of these treatments at different rates for the first four days. The maximum percentages of seedling emergence for both C$_2$S$_1$ (45%) and C$_1$S$_1$ (64%) treatments were higher as compared to the control, C$_0$S$_1$ (26%). The emergence percentages were more uniform for all treatments from day 6 to day 10. After day 10, the percentages of emergence were reduced for all these treatments.

Data analysis indicated that there is a significant difference among the treatments (p<0.05) and the difference was between C$_1$S$_1$ and C$_0$S$_1$. The mean percentage of seed germination and seedling emergence for C$_2$S$_1$ was 30.16±4.08% and C$_1$S$_1$ was 41.47±6.22%. While, for C$_0$S$_1$ was 16.04±3.45%. The seedlings growth produced almost the same percentages of emergence at day
15 for both C2S1 (16%) and C1S1 (19%), where the percentages of emergence of seedlings were lower than that obtained in the first week.

*Brassica oleracea*

The seedling emergence in Figure 5, indicated that the highest percentage of seedling emergence was for C1S1 (58%). The germination and emergence of seedlings occurred as early as day 2 for C2S1 and C1S1, and reached maximum between 6-10 days after planting for all three treatments (C2S1= 44%, C1S1= 58% and C0S1= 38%). The seedlings were observed to emerge at day 2 for C2S1 and C1S1, while for C0S1, seedlings were observed to emerge on the third day. The performance of seedlings for *B. oleracea* was similar to *B. chinensis* where they attained maximum percentages of emergence between day 6 to day 10 of germination.

![Figure 5: Seed germination and field emergence of seedlings for *Brassica oleracea*](image)
Data analysis revealed that there was no significant difference (p>0.05) between percentages of seedlings emergence for all the treatments (C₂S₁, C₁S₁ and C₀S₁). Mean percentages of seed germination and seedling emergence were 30.45±3.86% for C₂S₁, 36.60±5.29% for C₁S₁ and 24.09±3.70% for C₀S₁.

Brassica rapa

![Graph](image)

Figure 6: Seed germination and field emergence of seedlings for Brassica rapa

Maximum percentage of emergence occurred on day 6-10 after planting for C₂S₁ (22%) and day 9 to day 12 for C₁S₁ (19%) indicating that seedlings emergence were faster in C₂S₁. A notable effect of compost-topsoil mixtures on seedling emergence of B. rapa was that emergence was higher for C₂S₁ than C₁S₁ and C₀S₁. Figure 6 showed that seedlings emergence for C₂S₁ and C₁S₁ occurred at day 3, while for C₀S₁ was at day 5. It was observed that B. rapa has a lower percentage of emergence as compared to the other Brassica species.
Data analysis implied that a highly significant difference exist between the means of treatments at p<0.05. This meant that the emergence of seedlings in $C_2S_1$ was higher than the percentage of emergence for $C_1S_1$ and $C_0S_1$. It was also observed that the emergence of seedlings was better in $C_1S_1$ as compared to $C_0S_1$. Hence, mean percentages of seed germination and seedling emergence were 12.18±2.26% for $C_2S_1$, 9.51±1.95% for $C_1S_1$ and 1.67±0.30% for $C_0S_1$.

*Ipomoea aquatica*

An exponential growth in the percentages of emergence were observed in *I. aquatica*. Both $C_2S_1$ and $C_1S_1$ produced early seedlings emergence that were on day 2 compared to $C_0S_1$ on day 3. For $C_2S_1$, maximum percentage (72%), emergence of seedlings occurred at day 8 to 11, on day 12 for $C_1S_1$ (66%) and $C_0S_1$ (62%). The percentages of seed germination and emergence of seedlings were reduced for $C_2S_1$ and $C_0S_1$ started from day 13 onwards.

Figure 7: Seed germination and field emergence of seedlings for *Ipomoea aquatica*
Data analysis did not support the existence of significant difference between means (p>0.05). This implied that the percentages in emergence of seedlings were not enough to suffice the production of seedling growth, which might be due to the damages in seedling emergence in all these three treatments (C2S1, C1S1 and C0S1). The mean percentage of seed germination and seedling emergence for C2S1 was 50.65±6.70% and C1S1 was 45.63±5.90%. While, for C0S1 was 41.11±5.77%.

**Fruit Vegetable**

*Abelmoschus esculentus*

![Graph showing seed germination and field emergence for Abelmoschus esculentus](image)

Figure 8: Seed germination and field emergence of seedlings for *Abelmoschus esculentus*

As shown in Figure 8, emergence of seedlings for *A. esculentus* started at day 3 in C2S1, C1S1 and C0S1. The emergence of seedlings was observed rapid for the three treatments for the first 4 days (day 3 to day 6). The growth in seedlings emergence noted for C1S1 was slow and slightly low,
whilst for $C_0S_1$, there was a slight increase in percentage of seedlings emergence. Maximum percentage of seed germination and seedling emergence was 44% for $C_2S$, 33% for $C_1S$ and 42% for $C_0S$. The percentage of emergence for seedlings on $C_0S$, however, decreased rapidly beginning from day 10. The decrease in the percentage was due to damages and death of seedlings from heavy downpour (raindrops) onto the beds rather than the actual seedling growth.

Data analysis conducted did not show any significant difference between means (p>0.05) for these treatments ($C_2S$, $C_1S$ and $C_0S$). The mean percentage of seed germination and seedling emergence for $C_2S$ was 29.64±4.18%, $C_1S$ was 22.98±3.00% and for $C_0S$ was 22.22±4.20%.

*Lycopersicon esculentum*

![Figure 9: Seed germination and field emergence of seedlings for *Lycopersicon esculentum*](image)

In Figure 9, it was observed that emergence of seedlings was highest for $C_2S$ and reached maximum percentage of germination and emergence of 17% from day 12 to day 15. The $C_2S$
compost-topsoil mixture showed improvement of the media, produce better and faster emergence of seedlings, which appeared at day 4 for C2S1, at day 5 for C1S1 and C0S1. The percentage emergence was rather low and slow for C0S1, and it maintained the lowest percentage of seedling emergence up to day 9, though the percentage (11%) of seedling emergence for C0S1 and C1S1 were at the same value in the second week.

Data analysis suggested that a significant difference existed between the means (p<0.05). The differences were between C2S1 and C0S1. The mean percentage of seed germination and seedling emergence for C2S1 was 10.13±1.80% and C1S1 was 5.73±1.19%. While, for C0S1 was 4.27±1.29%.

*Phaseolus vulgaris*

![Figure 9: Seed germination and field emergence of seedlings for Phaseolus vulgaris](image)

Observations in Figure 9 for field emergence indicated that the seeds of *P. vulgaris* were of high quality. This was because nearly all the seeds germinated and emerged in the field for all the
treatments. The maximum percentage emergence of seedlings was observed at day 8 to day 9 for 
$C_2S_1$ (98%), at day 9 to day 10 for $C_1S_1$ (95%) and at day 9 for $C_0S_1$ (94%). The influence of 
compost-topsoil was not significant. The seedlings emergence was observed beginning at day 2, 
for both composted and non-composted beds. The emergence of seedlings was rapid for the first 
few days up to day 5 for all treatments. On day 12, the percentages slowly decreased. However, 
it was noted that the emergence for $C_2S_1$ and $C_1S_1$ were higher as compared to $C_0S_1$.

This referred the statement postulated by Duke (1983) that good coverage and sufficient 
mobility promotes fast germination and growth of $P. vulgaris$ even though little or no 
fertilization was employed. Seeds of good quality are essential for production of dry beans. $P. 
vulgaris$ grow best in well-drained, sandy loam, silt loam or clay loam soils, rich in organic 
content. Beans do not need much nitrogen since they are able to take nitrogen from the air and 
fix it on their roots. Watering is a must for bean because of the shallow root system (Egli, 1998).

Data analysis gave no evidence to support the existence of significant difference between 
treatment means ($p>0.05$). The mean percentage of seed germination and seedling emergence 
was 72.89±9.01% for $C_2S_1$ and 70.40±8.70% for $C_1S_1$. For $C_0S_1$ mean percentage of seed 
germination and seedling emergence was 68.49±8.54%.
Root (Tuber) Vegetable

Pachyrhizus erosus

As showed in Figure 11, the seedlings emergence for *P. erosus* produced a marked different in percentages of emergence. The seedlings emergence was at maximum percentage (37%) for C₂S₁ and C₁S₁ as compared to 27% for C₀S₁ at day 15. Though, the early emergence was rather low and slow, as observed at day 7 for C₂S₁, day 5 for C₁S₁ and day 6 for C₀S₁, the seedling emergence was rapid after day 10 onwards. There was no noticeable effect of downpour to the germination and emergence of seedlings as those, which were found to cause damages on the other vegetables. The large seed size for *P. erosus* might contribute to the reduce degree of disturbance from heavy raindrops.

Data analysis supported an existence of significant difference between the treatment means (p<0.05). The differences were among C₂S₁, C₁S₁ and C₀S₁. Table 3 (Appendix) shows that the
percentage of seed germination and seedling emergence for C_2S_1 was 39.11±5.27%, C_1S_1 was 35.96±5.19% and C_0S_1 was 19.24±3.44%.

*Raphanus sativus*

Figure 11: Seed germination and field emergence of seedlings for *Raphanus sativus*

There was a rapid emergence of seedlings beginning on day 4 and 5 for all the treatments as shown in Figure 11. The earliest seedling emergence was occurred for C_2S_1 and C_1S_1 on day 4, as compared to day 5 for C_0S_1. It was noted that there were decreased in the percentage of seedling emergence for C_0S_1 at day 6 to day 7 and again on day 13 onwards. Maximum percentage of emergence for C_2S_1 was 57%, 38% for C_1S_1 and 27% for C_0S_1. This thereby revealed that the use of compost-topsoil mixtures improved the germination media and therefore increased the percentage of seedling emergence for *R. sativus*.
However, data analysis did not support any significant difference between the treatment means (p>0.05). Thus, percentage of seed germination and seedling emergence for *R. sativus* in C2S1 and C1S1 were 16.04±4.19%, 16.31±4.21% and 10.71±2.97% for C0S1.

Most seeds germinated on different ratios of compost-topsoil mixtures emerged early and at higher rate as compared to the seedlings for the control (C0S1). Large seed sizes of *P. vulgaris, A. esculentus, P. erosus* and *R. sativus* were observed to germinate and emerge at higher maximum percentages as compared to the small sizes of vegetable seeds. This supported the statement of Egli (1998) that seed size and shape was related to the ability of seeds to expand, how fast it grew and how long this growth continued. However, it was also observed that the percentage emergence for vegetable seedlings decreased in the second week of sowing in most of the varieties of vegetable. This decreased was observed more rapid and obvious in the seedlings of the leafy vegetable, those were *A. blitum* and *Brassica spp.* This result is not surprising since the different environmental factors, especially raindrops destroyed the seedlings that have germinated and emerged.

As an addition, rapid or early seed germination had been observed associated with smaller seeds like *A. Blitum, Brassica spp.* and *I. aquatica*. This is thought to be due to a reduced endosperm thickness (Atherton and Rudich, 1986 cited in Whittington et al., 1965). Besides, early germination depends on endosperm to provide nutrition for the initial growth of the embryo (Atherton and Rudich, 1986).
Biomass of Seedlings

Figure 12: Biomass of seedlings for 10 types of vegetable germinated in composted biosludge up to 15 days.

Determination of the biomass of seedlings for ten types of vegetables exhibited in Figure 13, revealed an apparent effect between means of treatment. The biomass of seedlings of *P. vulgaris* for C2S1 (7.02g) was the highest compared to the biomass of seedlings in other types of vegetable. This was followed by *P. erosus* (3.18g), *I. aquatica* (2.42g), *B. oleracea* (0.28g), *B. chinensis* (0.26g), *B. rapa* (0.10g) and *A. blitum* being the least with only 0.05g. As for C1S1, the biomass of seedlings for *P. vulgaris* was the highest (5.34g) and the lowest biomass of seedlings was found in *A. blitum* and *B. rapa* that were both 0.06g. The second highest biomass of seedlings was observed in *P. erosus* (2.96g), followed by *R. sativus* (1.38g), *I. aquatica* (1.26g), *A. esculentus* (1.16g), *B. oleracea* (0.23g), *L. esculentum* (0.15g) and *B. chinensis* (0.14g).
The biomass of seedlings for C₀S₁ gave the lowest values compared to C₂S₁ and C₁S₁ for all types of vegetable in this study, except for biomass of seedlings in B. rapa. The biomass of seedlings for A. blitum was the same value (0.06g) for C₂S₁ and C₀S₁ compared to 0.05g for C₁S₁. The biomass of seedlings for B. rapa on the other hand had its highest value in C₂S₁ (0.10g), compared to 0.06g for C₁S₁ and 0.08g for C₀S₁.

The biomass of seedlings for all types of vegetables planted in C₂S₁ was 1.69±0.69g and in C₁S₁ was 1.27±0.54g. While for C₀S₁, the seedling biomass was 0.76±0.38g. There was significant different between biomass of seedlings for all types of vegetables planted in composted and non-composted soil since data analysis shows that p>0.05 (Table 5-6 in Appendix).