The effect of seaweed fertilizer and compost combination on the growth of lettuce head

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Abstract. Research on the effect of organic fertilizer combination, seaweed fertilizer and compost, on the growth of head lettuce plants has been conducted. The treatment in the study was head lettuce fertilizing with compost and seaweed fertilizer in ratio 2:0, 1:1, and 0:2. Land used for head lettuce without fertilizing treatment as control. The study was intended to get the best combination of organic fertilizer for head lettuce growth. The results showed that the best fertilizer formula was obtained from a combination of compost and seaweed fertilizer in ratio 2:0. Growth indicators are average leaf length of 26.64 cm, leaf width of 25.48 cm, 40 number of leaves, weight 311.75 g, and moisture content of 93.51%. Compost can stabilize acidity of planting land but the present of seaweed fertilizer can stabilize humidity of planting land and does not indicate the presence of fungi and parasites.

1. Introduction
Head lettuce or iceberg lettuce cultivation is one of the agricultural activities that is increasingly in demand along with the growth of the culinary and tourism industry. Lettuce is one of the most widely consumed vegetables worldwide. This vegetable is low in calories, fat and sodium, a good source of fiber, iron, folate, and vitamin C. Lettuce reported has anti-inflammatory, cholesterol-lowering, and anti-diabetic activities attributed to the bioactive compounds in it. More nutritious lettuces are leaf type lettuce and romaine with folate content comparable to other rich leafy vegetable sources.

The challenge in cultivating head lettuce before harvest is leaf spot disease caused by the fungus Cercospora and Alternaria. Besides that, the caterpillars that attack during the growth period of 1-2 weeks. Farmers generally use pesticides and their residues can endanger consumers. Research on the growth of bacteria supporting plant growth has been carried out and will be applied to the head lettuce cultivation land. the presence of fungi and parasites will be observed qualitatively, while the growth of head lettuce will be observed quantitatively. The study expected to get the best combination of fertilizers with the highest growth indicator of head lettuce and not indicated the presence of fungi and parasites.

2. Material and method
Materials used in the study were seaweed liquid biological fertilizer, seaweed solid biological fertilizer, compost, and head lettuce seedlings.
2.1. Seaweed liquid fertilizer preparation
Biological liquid fertilizer is prepared by homogenizing 93% of solid waste extraction so that in sap liquid cottonii and 7% bacterial consortium. The bacteria used are the same as in making solid fertilizer.

2.2. Biological seaweed solid fertilizer preparation
Biological solid fertilizer is prepared by homogenising 2% fish meal, 1% molasses, 73% Sargassum flour, 2% cottonii processed into pasta, 5% livestock manure, 10% dolomite and 7% bacterial consortium. Bacteria used include Azotobacter sp., Azospirillum sp., Pseudomonas sp., Lactobacillus sp., Bacillus sp., Rhizobium sp., and Streptomyces sp.

2.3. Compost fertilizer preparation
Compost fertilizer is prepared by homogenising the results of fermentation of the leaves waste with animal manure. Aerobic fermentation was carried out for 3 months by arranging layers of 1 part of leaves and 2 part of animal waste sequentially.

2.4. Head lettuce seedlings head
Seed used in this research produced by Bina Sarana Bakti Agatho Organic Farm as a result of the adaptation of the original seed from Switzerland. Poly bag filled with 1 part of sand and 1 part of compost, then added with 4 seeds. Seeding is done in 7 to 10 days or until 4 leaves grow from each seed. After that the seedlings from the seeding are sorted, about 164 seedling need for each plot.

2.5. Preparation of planting land
Planting land measuring in Bina Sarana Bakti Agatho Organic Farm area is 10 m² per plot and each treatment uses 1 plot. Liquid seaweed biofertilizer is applied to all plots after the planting land has been processed, then allowed to stand for 10 days. After that, planting seeds is carried out with a spacing of 25 cm.

2.6. Observation and data analysis
Measurements include head lettuce growth parameters (leaf length, leaf width, number of leaves, plant weight, and plant moisture content), as well as environmental parameters (pH and soil moisture). The experimental design used in this study was completely randomized design with 5 replications. Data obtained were analyzed using MS-excel program.

3. Results and discussion
Characteristics of fertilizer used in the study showed in Tabel 1. The fertilizer contain macro and micro nutrients, also growth hormones. Micro nutrients in solid biological seaweed fertilizer contain ferum (Fe), cuprum (Cu), mangan (Mn), and cobalt (Co) higher than others but it has zink (Zn), plumbum (Pb), cadmium (Cd), and sulphur (S) lower than others. All macronutrients content in compost is higher than others, it indicate that the growth of head lettuce might be better if treat by fertilizer containing compost. For growth hormones parameter, both solid and liquid biological seaweed fertilizer has similar content, except Gibberellin. The liquid fertilizer has higher content of Gibberellin.

Planting land prepared for the study was in Bina Sarana Bakti Agatho Organic Farm area, in rainy season. There was special treatment to control water volume entry in planting land and humidity also such as using plastic mask over the planting land and minimize water. The growth of head lettuce can follow by measuring length and width of the leaf, weight and increasing number of leaf. It might support by using seaweed fertilizer which contain growth hormones such as auxin, cytokinin, and gibberellin.
Table 1. Characteristics of fertilizer used in study.

| Parameter          | Solid biological seaweed fertilizer | Liquid biological seaweed fertilizer | Compost |
|--------------------|-------------------------------------|-------------------------------------|----------|
| Micro nutrients    |                                     |                                     |          |
| Fe (ppm)           | 8105.85                             | 6534.25                             | -        |
| Cu (ppm)           | 43.41                               | 42.1                                | -        |
| Mn (ppm)           | 279.92                              | 275.24                              | -        |
| Zn (ppm)           | 68.56                               | 75.85                               | -        |
| Pb (ppm)           | 31.79                               | 37.28                               | -        |
| Cd (ppm)           | 2.85                                | 3.45                                | -        |
| Co (ppm)           | 11.15                               | 10.37                               | -        |
| S (%)              | 6.63                                | 11.87                               | -        |
| Macronutrients     |                                     |                                     |          |
| N (%)              | 0.13                                | 0.1                                 | 2.0 – 2.5|
| P (%)              | 0.35                                | 0.41                                | 0.01 – 0.14|
| K (%)              | 2.19                                | 2.55                                | 0.39 – 1.35|
| Na (%)             | 0.78                                | 0.76                                | -        |
| Ca (%)             | 13.66                               | 13.3                                | 0.13 – 1.32|
| Mg (%)             | 4.53                                | 3.57                                | 0.04 – 0.21|
| C-org (%)          | 15.99                               | 16.88                               | 19.0 – 40.0|
| pH                 | 7.25                                | 7.52                                | -        |
| Growth hormones    |                                     |                                     |          |
| Sitokinin (%)      | 0.01                                | 0.01                                | -        |
| Giberelin (%)      | 0.01                                | 0.10                                | -        |
| Auksin (%)         | 0.02                                | 0.02                                | -        |
| Kinetin (%)        | 0.02                                | 0.02                                | -        |

Apparently, lettuce head with A3 fertilizer has increased the length of leaves (picture 1) and roots that are longer (picture 1 and 2) after a maintenance period of 14 days, but lower in width (picture 3 and 4). Among all the combination fertilizer, A3 fertilizer has shown a maximum shoot and root length compared to C and others. Growth hormone in seaweed fertilizer both liquid and solid plays a role, including auxin, cytokines (zeatin and kinetin), and gibberellin.

![Figure 1](image1.png) ![Figure 2](image2.png)

**Figure 1.** The growth at 14 days  **Figure 2.** The growth of head lettuce at 28 days

Auxin as one of growth hormones plays a role in cell division, stem and root growth and other developmental change [11]. Auxin can be obtained from fresh and extracted seaweed thallus [3, 4].
The presence of microbes in seaweed fertilizer does not interfere with the presence of auxins [3]. Cytokines (zeatin & kinetin) are also involved in plant cell division, especially during embryogenesis, shoots, young leaves, cambium and leaf aging, and root formation, but also play a role in terms of environmental stress tolerance and nutrient signaling [10, 12, 13, 15]. Higher P content in seaweed fertilizer (Table 1) also played a role in this regard. Phosphorus has functions to stimulate root growth of seeds or young plants, accelerate and strengthen the growth of young plants.

![Figure 3. Length of head lettuce leaf](image3.png)

![Figure 4. Width of head lettuce leaf](image4.png)

After a 28-day maintenance period, the roots no longer elongate and grow more towards the widening of the leaves. Besides that, the leaves appear to move in a circle in one direction. Apparently, the role of the gibberellin hormone can be seen in this condition. Gibberellin plays a role in leaf expansion and trichome development [6, 1, 8, 10, 14]. Leaf widths in plants with A1 fertilizer appeared to increase larger and plants with C fertilizer were slightly lower. Leaves on plants with A3 fertilizer appear to be increasing linearly but still lower than C and A12, while plants with A2 fertilizer appear to no longer widen.

![Figure 5. the growth of head lettuce at 42 days](image5.png)

![Figure 6. Number of head lettuce leaf](image6.png)

![Figure 7. Weight of head lettuce leaf](image7.png)
Plant weight and number of leaves appear maximum after maintenance 42 days. Picture 5, 6, and 7. It has increased significantly. This is in accordance with the increase of leaf strands and leaf widening. The treatment with the lowest number of leaves was obtained in plants with A1 fertilizer, but it was heavier than the other treatments. N content in compost is higher than seaweed fertilizer (Table 1), this macro nutrient element is needed in the formation of vegetative parts of plants, such as leaves, stems and roots, the formation of green leaves as a place of photosynthesis for the formation of proteins, fats and various organic compounds, and improving the quality of leaf-producing plants. The green color of the lettuce head qualitatively seems unchanged, especially in plants that receive rumpt fertilizer (A2 and A3). The intake of Mn from seaweed fertilizer seems to play a role this element serves to maintain the green condition of the leaves on old leaves, as an enzyme activator of the assimilation process.

After 42 days of observation, lettuce head takes 8-10 days to be harvested. This period is a critical period where leaf spot disease often appears. On day 42 appeared brown spots on the lower leaves of the C treatment plants, on the 50th day these patches increased in the lower leaf layers and the same symptoms appeared in the A1 treatment plants. Apparently, the use of a bacterial consortium on seaweed fertilizer works well. Lettuce heads do not experience leaf spot disease on maintenance until the 50th day. The role of mineral K is also predicted to play a role. This element can function to strengthen the body of the plant so it is not easy to fall and higher resistance to disease. As in table 1, K content in seaweed fertilizer is higher than compost, as well as the Ca. K works together with the elements Ca and B in multiplying nodule branches so that it can provide a lot of growth-supporting bacteria so as to prevent parasitic bacteria.

Soil acidity indicates conditions that are not yet in accordance with the needs of lettuce head growth, i.e. pH 5.5 - 7.5. Shown in Figure 8, the acidity of the soil in the planting area is quite low (below 5.5). One of the ways to handle soil with high acidity is by using compost [7]. However, the consistency of watering land also affects. on the 28th day, the acidity of the soil decreased because watering was reduced from 2 times a day to 1 time a day because it was associated with high rainfall. If it is not a reduced watering schedule, the watering volume may be able to maintain the acidity of the soil around pH 5. This is possible because in general between H-42 and H-50 where watering is back to normal, the acidity of the soil can increase again.

Besides seasons or rainfall, watering plants also affects soil moisture. Cultivation of this type of plant requires 75% soil moisture. As with soil acidity, soil moisture seems to decrease significantly due to reduced watering, then return to the expected conditions after watering again as usual, the soil moisture seemed stable maintained at around 75% in the A2 and A3 treatments using seaweed fertilizer.
The results of the study in the form of indicators of plant height, leaf width, number of leaves, and plant weight showed the highest value on head lettuce with A1 treatment (combination of compost and solid biological seaweed fertilizer are 2:0). But qualitatively, the use of seaweed fertilizer can provide a better green color until harvest time, soil moisture is well maintained, and leaf spot disease is not visible. Further research is needed to obtain the right stages and portions in the application of compost and seaweed fertilizer in the cultivation of head lettuce as well as to observe the stability of leaf green and other bioactive compounds i.e. chlorophyll, carotenoids, and tacomachrol [5], phenolic compounds and vitamin [9].

4. Conclusion
The best growth of head lettuces obtained from maintenance using a combination of compost and solid seaweed biofertilizers in the ratio of 2:0. Growth indicator shows that yields of head lettuce fertilized with compost have characteristics of average leaf length of 26.64 cm, leaf width of 25.48 cm, 40 number of leaves, weight 311.75 g, and moisture content of 93.51%. Compost can stabilize acidity of planting land but the combination fertilizer can stabilize humidity of planting land and does not indicate the presence of fungi and parasites.

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