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Application of local seaweed extracts to increase the growth and yield eggplant (*Solanum melongena* L.)

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Abstract. Eggplant (*Solanum melongena* L.) is one of the horticultural vegetables that is widely distributed in Indonesia. It is just like other vegetables, and eggplant offers a variety of health benefits. Seaweed is one of a group of marine plants that containing many important minerals. Seaweed also contains a growth-promoting hormone. This research aims to study the effect of application of various types of local seaweed extracts on growth and yield of eggplant. The study was conducted using Randomized Block Design (RBD) which consist of 6 treatments: P₀ = without fertilizer (control), P₁ = fertilizer NPK, P₂ = Seaweed *Caulerpa* sp, P₃ = Seaweed *Sargassum* sp, P₄ = Seaweed *Kappaphycus alvarezii*, P₅ = Seaweed *Ulva* sp. Each treatment is repeated 4 times to obtain 24 units of the experiment. The results of this research showed that the application of seaweed extracts significantly affected on growth and yield of eggplant plants (plant height, number of leaves, leaf area, fresh weight of plant, dry weight of plant, fruit fresh weight, fruit dry weight and chlorophyll content but did not show significant on first flowering appear, roots fresh weight and root dry weight. All seaweeds show a potential to replace the use of NPK in improving the growth and yield of eggplant.

1. Introduction

Eggplant (*Solanum melongena* L.) is one of the most important herbs among vegetable crops belongs to *Solanaceae* family. It is often served in a variety of dishes to fresh vegetables. The fruit has a variety of colors, namely purple, green and white, among the various varieties of eggplant [1]. Eggplant offers a variety of health benefits. Eggplants are very rich in minerals, which are very beneficial for the immune system. Eggplants contain low calorie and high nutrient [2]. It can also be utilized as a medicine to reduce cholesterol in blood, and it is suitable as a diet to regulate hypertension. Presuming that the demand for this crop will increase, therefore, the production should be increased [3]. This crop is one of the important Asian Vegetables grown in Indonesia. As such promising potentials, therefore, effort to improve its productivity should be emphasized. One of the improvement possibilities is the nutritional requirements, which play a major role [4]. Nitrogen, Phosphorus, and Potassium are major essential elements required for physiological mechanisms of crop growth and development.



Organic farming is a production system that ignores or does not use synthetic fertilizers, pesticides. Indonesia is one of the largest seaweed producers in the world. However, the use of seaweed in the country is still limited to food products, semi-finished products, and some cosmetics products, while the use of seaweed for agriculture and horticulture is still a few works [5]. In other countries in the world, the application of seaweed for agricultural crops has long been carried out [6]. Seaweed has long been used directly as a soil conditioner and fertilizer in various coastal areas in the world [7,8]. Unlike chemical fertilizers, extracts made from seaweed can be degraded naturally, non-toxic, non-contaminating, and safe for humans and animals. The use of seaweed as fertilizer or fertilizer additives is expected to be an alternative solution to environmental problems because it is safe for soil microbes and plants and also increases the economic value of seaweed in Indonesia [9,10].

This seaweed is one of a group of marine plants that containing many important minerals from the sea needed by plants [8], seaweed also contains a growth-promoting hormone which has been proven to be able to increase plant growth and yield [11,12]. Seaweed extracts hormones, such as auxin, cytokinin, and gibberellin [8,13]. This hormone is intended to stimulate growth in plants so that plants can grow, bear fruit or flower faster, bigger [14]. The aims of this study was to determine the effect of extract from various local seaweeds on the growth and the yield of eggplant.

2. Material and method

The study was conducted using hand tractors, Spades, hoes, buckets, gauges, cutters, analytical eggplant seeds, soil, some types of seaweeds, NPK fertilizer. This study was conducted using a randomized block design (RBD). The treatments are: P0 = Control (no treatment), P1 = NPK, P2 = (*Caulerpa sp*), P3 = (*Sargassum sp*), P4 = (*Eucheuma canttoni*), and P5 = (*Ulva sp*).

This study uses a randomized block design (RBD) with treatments consisting of:

P0 = No treatment (control)

P1 = NPK fertilizer

P2 = *Caulerpa sp*.

P3 = *Sargassum sp*.

P4 = *Kappaphycus alvarezii*

P5 = *Ulva sp*

2.1. Preparation of the experiment

The treatment was repeated 4 times so that 24 units of the experiment were obtained. Field trial were prepared by removing weeds or other materials that can interfere with the process of plant growth. a bed of 200 cm × 200 cm² as prepared, the bed height is 40 cm, the distance between beds is 50 cm

2.2. Seaweed extract

The method of making seaweed extracts was first of all that must be prepared in advance is the tools and materials, namely: digital scales, filters, heaters, scissors, spoons, blenders, 1500 ml aqua bottles and pots. The seaweeds species are (*Caulerpa sp*), (*Sargassum sp*), (*Kappaphycus alvarezii*), and (*Ulva sp*). After the above tools and materials are available, then to cut those seaweeds in small pieces using scissors. After the seaweed is cut into small pieces, then put the seaweed pieces into a blender. After the seaweed is finely blended, then weigh as much as 100 g. After that, put the seaweed that has been weighed 100 g into a container and add 2 liters of distilled water, then heat using hot plat with a temperature of 70°C and stir with a spoon for one and half hours, then filter using a filter and cool it down [15–17].

2.3. Statistical analysis

An analysis of variance was carried out to determine the effect of treatments n the observe parameters. If it was significant, then 5% Honestly Significance Difference (HSD) test was used to separate the significantly different means [18].

3. Results

3.1. Plant height

Table 1. Average Height of Plants (cm) at ages 3 - 12 WAP

Ages (WAP)	Treatments						HSD 5%
	P0	P1	P2	P3	P4	P5	
3	13,06 ^{ab}	14,34 ^b	12,83 ^{ab}	12,30 ^a	13,31 ^{ab}	13,54 ^{ab}	1,61
4	15,61 ^a	22,77 ^{ab}	22,00 ^{ab}	23,59 ^{ab}	25,94 ^{ab}	29,44 ^b	11,34
5	17,85 ^a	26,95 ^{ab}	25,20 ^{ab}	27,55 ^{ab}	28,93 ^{ab}	33,94 ^b	11,44
6	20,03 ^a	28,67 ^{ab}	27,32 ^{ab}	30,46 ^{ab}	31,40 ^{ab}	33,94 ^b	11,81
7	23,38 ^a	31,90 ^{ab}	30,76 ^{ab}	33,00 ^{ab}	36,62 ^{ab}	38,15 ^b	13,28
8	30,03 ^a	37,19 ^{ab}	35,60 ^{ab}	37,19 ^{ab}	41,49 ^{ab}	43,89 ^b	12,11
9	32,58 ^a	42,61 ^{ab}	38,16 ^{ab}	40,32 ^{ab}	46,06 ^b	48,90 ^b	12,09
10	35,69 ^a	47,15 ^{abc}	40,44 ^{ab}	44,35 ^{abc}	50,61 ^{bc}	54,59 ^c	12,01
11	39,11 ^a	52,20 ^{bcd}	43,10 ^{ab}	47,92 ^{abc}	55,86 ^{cd}	59,91 ^d	11,92
12	42,68 ^a	56,71 ^{bcd}	45,82 ^{ab}	51,30 ^{abc}	59,75 ^{cd}	63,87 ^d	11,67

Note: The average followed by the same letter in the same line is not significantly different in the HST test level of 5%

3.2. Number of leaves

Table 2. Average Number of Leaves of Eggplant Plants aged 3-12 WAP

Ages (WAP)	Treatments						HST 5%
	P0	P1	P2	P3	P4	P5	
3	5,81 ^b	5,63 ^{ab}	4,88 ^a	5,81 ^{ab}	5,69 ^{ab}	5,81 ^b	0,78
4	6,31 ^a	7,50 ^b	7,00 ^{ab}	7,13 ^{ab}	7,56 ^b	7,44 ^b	0,95
5	7,38 ^a	8,00 ^{ab}	8,19 ^{ab}	8,38 ^{ab}	8,94 ^{ab}	9,56 ^{ab}	1,92
6	9,75 ^a	10,38 ^a	10,56 ^a	14,44 ^{ab}	21,75 ^b	13,13 ^{ab}	10,64
7	11,44 ^a	13,81 ^{ab}	13,88 ^{ab}	20,94 ^{ab}	26,38 ^b	16,38 ^{ab}	14,04
8	12,13 ^a	15,19 ^{ab}	15,13 ^{ab}	25,50 ^{ab}	28,56 ^b	21,63 ^{ab}	16,01
9	13,44 ^a	16,38 ^{ab}	16,19 ^{ab}	26,69 ^{ab}	30,50 ^b	23,38 ^{ab}	16,87
10	14,44 ^a	17,44 ^{ab}	17,25 ^{ab}	27,63 ^{ab}	32,38 ^b	25,38 ^{ab}	16,33
11	15,38 ^a	18,81 ^{ab}	18,69 ^{ab}	28,81 ^{ab}	35,19 ^b	28,63 ^{ab}	16,58
12	16,38 ^a	19,94 ^{ab}	22,94 ^{ab}	30,25 ^{ab}	36,38 ^b	30,19 ^{ab}	16,89

Note: The average followed by the same letter in the same line is not significantly different in the HST test level of 5%

3.3. Chlorophyll content

Table 3. Average chlorophyll content of Eggplant Plants aged 12 WAP.

Treatments	Chlorophyll content
P0	41,37 ^{ab}
P1	43,66 ^b
P2	45,53 ^b
P3	33,59 ^a
P4	39,44 ^{ab}
P5	43,11 ^{ab}
HST 5%	9,74

Note: The average followed by the same letter in the same line is not significantly different in the HST test level of 5%

3.4. Fruit fresh weight

Table 4. Average Fruit fresh weight of Eggplant Plants at aged 12 WAP.

Treatments	Fruit fresh weight
P0	50,00 ^a
P1	65,69 ^{ab}
P2	71,79 ^{abc}
P3	79,66 ^{abc}
P4	106,12 ^{bc}
P5	116,70 ^c
HST 5%	50,94

Note: The average followed by the same letter in the same line is not significantly different in the HST test level of 5%

3.5. Leaves fresh weight

Table 5. Average Leaves fresh weight of Eggplant Plants at aged 12 WAP.

Treatments	Leaves fresh weight (g)
P0	20,91 ^a
P1	25,16 ^{ab}
P2	25,40 ^{ab}
P3	28,54 ^{ab}
P4	34,61 ^b
P5	38,15 ^b
HST 5%	13,03

Note: The average followed by the same letter in the same line is not significantly different in the HST test level of 5%

3.6. Leaves dry weight

Table 6. Average Leaves dry weight of Egg Plants at aged 12 WAP.

Treatments	Leaves dry weight (g)
P0	4,84 ^a
P1	8,89 ^{ab}
P2	7,44 ^{ab}
P3	9,75 ^{ab}
P4	10,20 ^{ab}
P5	11,93 ^b
HST 5%	6,24

Note: The average followed by the same letter in the same line is not significantly different in the HST test level of 5%

The study showed that the treatment of various types of seaweed extract significantly affected the parameters including plant height, the number of leaves, leaf chlorophyll content, fresh fruit weight, leaves fresh weight, and leaves dry weight. This is because using seaweed extract given to eggplants have sufficient. In other words, insufficient nutrients can disrupt the metabolic process, and that affect plant growth and development [7]. Seaweed also can improve soil properties such as physical, chemical, and biological properties [19]. As a result, nutrient content in seaweed extract cause vegetative growth in eggplant plants better than control treatment [12].

Seaweed contains macro mineral components, such as calcium, manganese and potassium, and micro minerals, such as zinc, iron, cobalt, molybdate, boron, and contain phytohormones as growth regulators such as auxin, gibberellin, cytokinin[20]. Each of the growth regulators has different functions[21], auxin, for example, play a role in plant physiological processes, such as growth, cell division and differentiation, and protein synthesis; gibberellins are known to affect cambium growth, effectively increase fruit set, whereas cytokinins play an important role in cell division resulting in plant responses to plant growth, fruit growth [16,22].

The seaweed fertilizer that have been used as additional nutrients and as biostimulants or organic fertilizers (biofertilizers) to increase plant growth and yield [23], because they contain plant growth regulators. Growth regulators contained in seaweed play a role in the physiology of plants, such as growth, division, and cell differentials, and protein synthesis. Plants can absorb nutrients, including growth regulators from all surfaces of plant cells [24]. The absorption of nutrients that take place on almost all plant surfaces causes the competence of cells or tissues to grow and develop to form new organs so that the plants can form more shoots and leaves. Plant growth regulators were increased the content of organic and inorganic substances in cells. Subsequently, these substances are converted into proteins, nucleic acids, polysaccharides, and other complex molecules, which in turn form organs and tissues, so that the fresh weight and dry weight of plants increases [25,26].

Plants Growth and development are influenced by the application of fertilizers and the availability of nutrients in the soil [27]. Optimal growth can be achieved if all nutrients are at a balanced level, meaning that there is no one nutrient that is a limiting factor. Using seaweed extract as fertilizer could be a solution to improve the growth and yield of many crops [28], including eggplant.

4. Conclusion

Based on the description of the results of the study above, it can be concluded that the use of various types of seaweed extract significantly affected eggplant growth and yield compared to control treatment. Seaweed *Ulva* sp shows affect eggplant growth and yield better in replacing NPK.

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