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Substituting *Sargassum* sp. Compost for Inorganic Fertilizer Improves the Growth and Yield of Shallot (*Allium cepa* L. Aggregatum Group)

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ABSTRACT

Fertilizers derived from natural materials, such as *Sargassum* sp. (seaweed), are a promising technique to overcome the negative impact of overuse of inorganic fertilizers. Groundwater contamination, soil degradation, and changes in the soil microorganism community are problems related to overdosing on inorganic fertilizer during crop production. The use of *Sargassum* compost (SC) as a substitute inorganic fertilizer was tested by evaluating the growth and yield of shallot grown on sandy soil. The research was arranged in a randomized complete block design consisting of four treatments and three blocks of replications. The treatments involved substituting SC for inorganic fertilizer, which were 100% inorganic, 25% SC + 75% inorganic, 50% SC + 50% inorganic, and 75% SC + 25% inorganic, respectively. The compositions of nitrogen (N), phosphorus (P), potassium (K), sodium (Na), sulfur (S), auxin, gibberellin, cytokinin, and kinetin in SC, as well as the growth and yield of shallot, were analyzed by analysis of variance followed by the least significant difference test. The results showed that the SC contained high organic matter (45.78%), nitrogen (4.1%), phosphate (0.5%), potassium (0.8%), sodium (7.2%), sulfur (0.2%), and plant growth hormones, such as auxin (8.14 mg.g^{-1}), gibberellin (15.97 mg.g^{-1}), cytokinin (7.70 mg.g^{-1}), and kinetin (2.78 mg.g^{-1}). Interestingly, all substitution levels of the SC for inorganic fertilizer improved nutrient absorption in

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the leaves, roots, and bulbs. Moreover, the growth and yield of shallot were not significantly different among the treatments. Therefore, to provide sufficient nutrients and growth hormones, SC could be substituted for up to 75% of organic fertilizers for shallot plants.

Keywords: Growth hormones, nitrogen, phosphorus, potassium, sandy soil

INTRODUCTION

Indonesia has a biodiversity of seaweeds and *Sargassum* sp. is one of the most abundant seaweeds living in the Indonesian seas (Widyartini et al., 2017). This seaweed is a brown alga with a land plant-like morphology in threads or sheets that lives in clear water or choppy and rocky areas and thrives at a depth of 0.5−10 m (Muslimin & Sari, 2017). *Sargassum* sp. contains many organic ingredients, hormones, and amino acids (Silva et al., 2019). Isnansetyo et al. (2017) extracted *Sargassum* brown seaweed to produce fucoidan as an anti-cancer ingredient. The extraction process produced 40% of seaweed waste from the dry material used (Flórez-Fernández et al., 2021). Silva et al. (2019) reported that *Sargassum* contained N 17.4%, P 4.5%, and K 7.2%. Sembera et al. (2018) reported that *Sargassum* as compost contained organic matter of 36.3%, a ratio of carbon to nitrogen (C/N ratio) of 13.5, and a pH of 8.4. Therefore, the *Sargassum* waste could contain high organic matter, potentially as organic fertilizer. We make *Sargassum* compost (SC) from *Sargassum* waste with *Bacillus* sp. decomposition. The SC was analyzed and found that it contained organic matter of 45.78%, a C/N ratio of 11.17, and a pH of 7 (Table 1).

Organic fertilizer is a sustainable choice for nutrient and organic matter input (Chatterjee et al., 2017; Renuka et al., 2016). Other advantages of organic fertilizers are that they increase soil fertility, increase organic matter, improve soil structure, increase moisture content, increase cation exchange capacity, increase nutrient availability, and release nutrients more slowly and more consistently (Roba, 2018). In addition, organic matter will increase soil microorganisms' activity, affecting the availability of nutrients (Amujoyegbe et al., 2007). Elumalai and Rengasamy (2012) reported decomposition of *Sargassum* with *Bacillus* in contained 0.06 mg/g nitrogen dioxide (NO_2), 14 mg/g nitrate (NO_3), 1.71 mg/g phosphate (PO_4), and 8 mg/g potassium (K).

Sargassum waste as an organic fertilizer for shallot (*Allium cepa* L. Aggregatum group) has not been reported in Indonesia. Shallot is an important crop in tropical countries, including Indonesia, as it is useful as a food seasoning and traditional medicine and has high commercial value (Sulistyaningsih et al., 2020). The popularity of shallot has increased yearly consumption (Ministry of Agriculture [MOA], 2019). Consequently, the shallot is cultivated intensively with harvests two or three times per year and extensively in many areas, including sandy coastal areas.

The intensive cultivation of shallot with inorganic fertilizers has the potential to pollute the environment. Shallot cultivation

Table 1
Properties (mineral type, unit and value) contained in the Sargassum *compost, method and equipment used for analysis*

Mineral type	Unit	Value	Method	Equipment
N	%	4.1	Wet destruction	UDK 139 Semi-Automatic Kjeldahl Distillation Unit (Velp Scientifica, Italy)
P	%	0.5	Wet destruction	GENESYS™ 10 UV-Vis Spectrophotometer (Thermo Fisher Scientific, USA)
K	%	0.8	Wet destruction	Flame photometer PFP7C (Rose Scientific. Ltd., Canada)
Na	%	7.2	Wet destruction	Flame photometer PFP7C (Rose Scientific. Ltd., Canada)
S	%	0.2	Wet destruction	GENESYS™ 10 UV-Vis Spectrophotometer (Thermo Fisher Scientific, USA)
Auxin	$mg.g^{-1}$	8.14	Linskens and Jackson (1987)	High-performance liquid chromatography (HPLC) (Thermo Fisher Scientific, USA)
Gibberellin	$mg.g^{-1}$	15.97	Linskens and Jackson (1987)	High-performance liquid chromatography (HPLC) (Thermo Fisher Scientific, USA)
Cytokinin	$mg.g^{-1}$	7.70	Linskens and Jackson (1987)	High-performance liquid chromatography (HPLC) (Thermo Fisher Scientific, USA)
Kinetin	$mg.g^{-1}$	2.78	Linskens and Jackson (1987)	High-performance liquid chromatography (HPLC) (Thermo Fisher Scientific, USA)
Water content	%	2.26	Gravimetric	Oven (Memmert, Germany)
C-organic	%	45.78	Dried combustion	Muffle furnace (MXBAOHENG, China)
C/N ratio		11.17	Dried combustion	Muffle furnace (MXBAOHENG, China)
pH		7	Potentiometrically	pH Meter (Hanna Instruments, Indonesia)
Bacillus sp.	$CFU.ml^{-1}$	10^8	Plate count	GENESYS™ 10 UV-Vis Spectrophotometer (Thermo Fisher Scientific, USA)

requires inorganic fertilizer, such as 102.6 $kg.ha^{-1}$ N, 89.8 $kg.ha^{-1}$ P, and 121 $kg.ha^{-1}$ K, as recommended by Minhal et al. (2019). The continuous overuse of inorganic fertilizers pollutes groundwater, increases air pollution, increases the weed population, and degrades the soil and microorganisms (Rahman & Zhang, 2018). Innovation is needed to provide nutrients for shallot plants to maintain soil health and environmental sustainability. The use of organic fertilizer from *Sargassum* seaweed could be a promising method for maintaining a healthy environment. Adding seaweed as an organic fertilizer supplies macro and micronutrients improves soil structure, increases water availability and soil cation exchange capacity, and increases plant resistance to biotic and abiotic stressors (de Siqueira Castro et al., 2017; Dineshkumar, 2020; Divya et al., 2015).

Therefore, this study was designed to investigate the potency of *Sargassum* waste compost as a substitute for inorganic fertilizer on the growth and yield of shallot planted in coastal sandy soil. Coastal sandy soil was used as the planting medium because it has high filtration capacity, low organic matter, and lacks nutrients (Šimanský et al., 2019).

MATERIALS AND METHODS

Plants and Material Preparation

The research was conducted from June 2021 to August 2021 at the Universitas Gadjah Mada (UGM) experimental station, Banguntapan, Bantul, Special Region of Yogyakarta Province, Indonesia (07°48’ 17”S and 110°24’ 45”E) at an altitude of 107 m above sea level. The mean temperature during the experiment was 29.5 °C, the humidity was 63.5%, and the sunlight intensity was 44,333 lux. The planting medium was coastal sandy soil with contents of N 0.01%, P 0.0016%, K 0.000032%, pH 6.55, moisture level 0.59%, organic matter 9.16%, cation exchange capacity (CEC) 5.43 mg·eq·kg^{-1}, and electrical conductivity (EC) 1.02 dS·m^{-1}. The shallot variety was Bima Brebes. The seaweed material was *Sargassum* sp. waste from the fucoidan extraction process (Isnansetyo et al., 2017).

Sargassum Compost Analysis

The *Sargassum* sp. waste was composted by fermentation for seven days after adding 3% molasses, 20% water, and 0.001% isolated *Bacillus* sp. The SC was analyzed N, P, S, K, Na, auxin, gibberellin, cytokinin, and kinetin contents. The N levels were analyzed using the wet destruction method and the UDK 139 semi-automatic Kjeldahl distillation unit (Velp Scientifica, Italy). Tissue P and S levels were determined using the wet destruction method with a GENESYS™ 10 UV-Vis spectrophotometer (Thermo Fisher Scientific, USA). The K and Na levels were measured using the wet destruction method with a flame photometer PFP7C (Rose Scientific. Ltd., Canada) (Balittanah 2009). Auxin, gibberellin, cytokinin, and kinetin contents were determined using the method of Linskens and Jackson (1987) and high-performance liquid chromatography equipment. The data are listed in Table 1.

Experimental Design

This experiment was set as a single factor randomized complete block design with three blocks as replications. There were four treatments with combinations of the inorganic fertilizer and the SC (Table 2). The 12 bulbs were planted in planting boxes (45 × 33 × 16 cm) with a 10 × 10 cm planting distance. The fertilizer was applied in three stages, such as at the time of bulb planting and at 28 and 42 days after planting.

Table 2
The combinations of fertilization treatments

Treatment	Type of fertilizer (kg.ha^{-1})			
	Sargassum sp. compost	Inorganic		
		N	P	K
0% SC + 100% Inorganic	0	102.6	89.8	121
25% SC + 75% Inorganic	600.5	76.9	67.3	90.7
50% SC + 50% Inorganic	1,201.0	51.3	44.9	60.5
75% SC + 25% Inorganic	1,801.5	25.6	22.4	30.2

Planting Medium Content Analysis

The planting media data consisted of soil organic matter content, bulk density ($g \cdot m^{-3}$), moisture content (%), EC ($dS \cdot m^{-1}$), and pH (Balittanah, 2009). The organic matter content was measured by ashing the sample in a muffle furnace at 550–600°C for 4 hours. The organic matter became carbon dioxide (CO_2), and the metal became a metal oxide. The weight of the missing material was the organic matter, which was converted to C-organic content after multiplying by a factor of 0.58. The bulk density ($g \cdot cm^{-3}$) was calculated by the weight of dry soil (M_{solids}) divided by the total soil volume (V_{soil}). The total soil volume was the combined volume of the solids and the pores, containing air (V_{air}), water (V_{water}), or both. The moisture content (%) was determined by calculating the weight of the field capacity soil divided by the weight of oven-dried soil at 105 °C for 4 hours multiplied by 100%. The EC and pH were measured by weighing 10 g of planting medium into a shaker bottle, adding 50 ml of distilled water, beating the mixture with a whisk for 30 min, and using an EC meter with sodium chloride (NaCl) calibration for the EC value. The pH was determined with a pH meter (Hanna Instruments, Indonesia).

Shallot Tissue Analysis

The shallot tissue included N, P, S, K, and Na. The methods of tissue analysis were as follow in SC analysis.

Growth and Yield of Shallot

Growth and yield were measured by plant height (cm), the number of leaves, leaf area (cm^2), total fresh weight (g), total dry weight (g), and fresh bulb weight (g). The leaf area was calculated with the WinDIAS 3 leaf area meter (United Kingdom). The total dry weight was calculated from total biomass dried in an oven at 80 °C for 48 hours.

Statistical Analysis

All data obtained were analyzed for analysis of variance with a significance level of 0.95, followed by the least significant difference (LSD) test. This analysis was performed using *R* statistical software (v. 3.2.2) (The R Foundation for Statistical Computing, Austria).

RESULTS AND DISCUSSION

Sargassum Compost Content

The SC was analyzed before being applied as a planting medium. The SC was processed through fermentation for seven days after adding 3% molasses, 20% water, and 0.001% of a *Bacillus* sp. isolate. The properties of the SC and the analytical method are shown in Table 1. The proportion of C-organic and the C/N ratio of the SC were 45% and 11.17, respectively. According to the Ministry of Agriculture (MOA), Indonesia (2011), those values were standard characteristics of SC. The standard requirement for C-organic is >15, and the C/N ratio should range between 10 and 20. The C/N ratio indicates the decomposition process in which a lower ratio value indicates the higher availability of nutrients (Setiawati et al., 2018). The pH value (7.0) and water content (2.26%) showed that the SC was available to be used as organic fertilizer. The contents of essential nutrients were 4.1% N, 0.5% P, 0.8% K, 7.2% Na, and 0.2% S, respectively. It also contains hormones to regulate plant growth. The hormones in the SC were 15.97 $mg \cdot g^{-1}$ gibberellin, 8.14 $mg \cdot g^{-1}$ auxin, 7.70 $mg \cdot g^{-1}$ cytokinin, and 2.78 $mg \cdot g^{-1}$ kinetin.

Planting Medium Characters

The sandy soil containing the combined SC and inorganic fertilizer treatments 65 days after planting showed that the organic matter and moisture contents increased (Table 3). The 75% SC + 25% inorganic fertilizer treatment had a significantly increased amount of organic matter (9.77%) and moisture content (9.86) compared to those in the 100% inorganic fertilizer treatment. The increase in organic matter content by SC improved the soil moisture content. *Sargassum* contains alginate, which absorbs and stores water. The results confirm that applying seaweed as an organic fertilizer could make soil store more water (Sinulingga & Darmanti, 2007). Other studies have reported that seaweed applications increase organic matter and absorption of water and minerals in the topsoil (Abdel-Raouf et al., 2012; Raghunandan et al., 2019). Soil moisture content can be used as a basis for measuring the availability of water in the planting medium. Water is a vital component of plant metabolism (Osakabe et al., 2014). Therefore, the quality of the sandy soil as a planting medium would improve based on the SC's organic matter and moisture contents.

Tissue Analysis

The highest N content among the treatments was in the leaves, followed by root and bulb. The highest N content value (3%) was found in the leaves with a combined treatment of 50% SC + 50% inorganic (Figure 1). SC substitution up to 50% did not affect the

Table 3
Organic matter, bulk density, moisture content, and pH of the sandy soil after treatment with the Sargassum *compost 65 days after planting*

Treatment	Organic matter (%)	Bulk density ($g.cm^{-3}$)	Moisture content (%)	EC ($dS.m^{-1}$)	pH
0% SC + 100% Inorganic	9.64 ± 0.09b	1.55 ± 0.01a	9.41 ± 0.36b	1.03 ± 0.01 b	6.54 ± 0.03a
25% SC + 75% Inorganic	9.67 ± 0.04b	1.56 ± 0.01a	9.52 ± 0.14ab	1.07 ± 0.00 ab	6.54 ± 0.02a
50% SC + 50% Inorganic	9.70 ± 0.01ab	1.57 ± 0.01a	9.64 ± 0.15ab	1.80 ± 0.00 a	6.56 ± 0.01a
75% SC + 25% Inorganic	9.77 ± 0.01a	1.57 ± 0.03a	9.86 ± 0.09a	1.90 ± 0.05 a	6.56 ± 0.01a
CV (%)	7.46	8.09	9.20	9.87	7.10

Note. Means followed by the same letters in the same column are not significantly different according to the LSD test; α = 5%

accumulation of leaf N levels but decreased at 75% SC substitution. The accumulation of nitrogen in the leaves shows that N plays a role in many photosynthetic processes. Plants require nitrogen for metabolism and protein syntheses, such as chlorophyll and cell division (Agirman & Cetin, 2015; Iqbal et al., 2020). After leaves, N content accumulates in the root. Substitution of 25% SC showed the highest N content in root and decreased at 50% to 75% SC. The N element that accumulates in the roots is useful in the root elongation process to make the roots more flexible in nutrient absorption. Applying seaweed also increases the activities of enzymes involved in the N cycle, such as ureases and dehydrogenases (Wang et al., 2018). The last application, 0% to 75% SC substitution, showed that N content in the bulb tended to be stable.

Figure 2 shows that the highest average P content was detected in the bulbs, except in the 25% SC + 75% inorganic treatment. By increasing the SC percentage for inorganic fertilizer, the P content in the bulb tended to increase, and the highest P content (0.44%) was found in the combined 75% SC + 25% inorganic treatment. Elemental P plays a role in assimilating transport, affecting the size and weight of onion bulbs (Anbes et al., 2018). It shows that the shallot wants P, which is always available, unlike the case with the root and leaves of shallot, which prefer P inorganic. It is evident that the smaller the inorganic fertilizer, the lower the P content in the roots and leaves.

K content accumulated the highest in the roots of all treatments (Figure 3). The K content increased as the percentage of SC applied in the planting medium was increased. Elemental K strengthened the cell walls of shallot, which supports the roots to penetrate the media and absorb water (Gunadi, 2009). After the root, K content accumulates in the bulb. K content in bulb showed stable results at 0.63 to 0.80%. However, it is different from the K content in shallot leaves; K content also increased as the percentage of SC applied in the planting medium was increased. Elemental

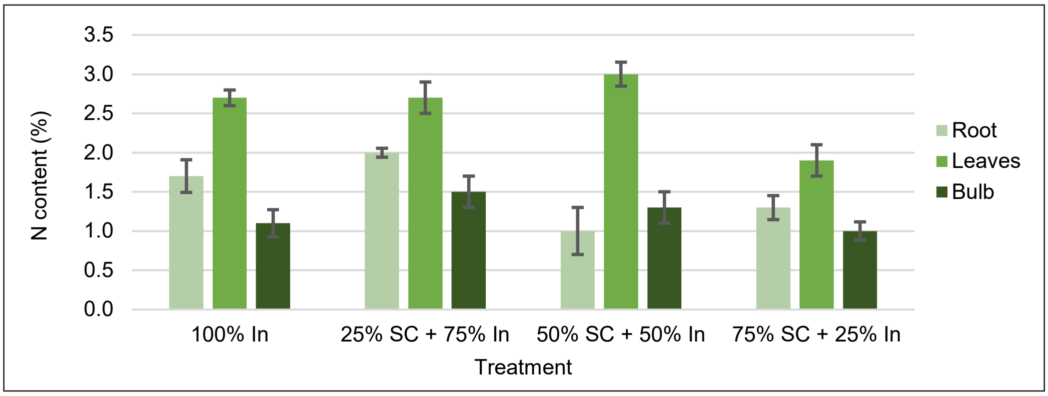

Figure 1. Tissue analysis of N content in roots, leaves, and bulbs with four treatments: 100% In = 100% inorganic fertilizer; 25% SC + 75% In = 25% *Sargassum* compost + 75% Inorganic fertilizer; 50% SC + 50% In = 50% *Sargassum* compost + 50% Inorganic fertilizer; and 75% SC + 25% In = 75% *Sargassum* compost + 25% Inorganic fertilizer, respectively

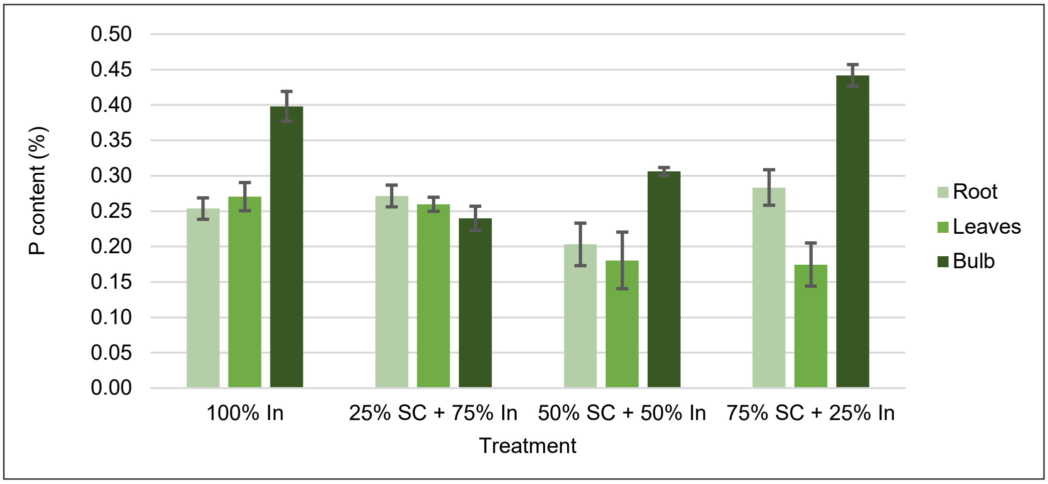

Figure 2. Tissue analysis of P content in roots, leaves, and bulbs with four treatments: 100% In = 100% inorganic fertilizer; 25% SC + 75% In = 25% *Sargassum* compost + 75% Inorganic fertilizer; 50% SC + 50% In = 50% *Sargassum* compost + 50% Inorganic fertilizer; and 75% SC + 25% In = 75% *Sargassum* compost + 25% Inorganic fertilizer, respectively

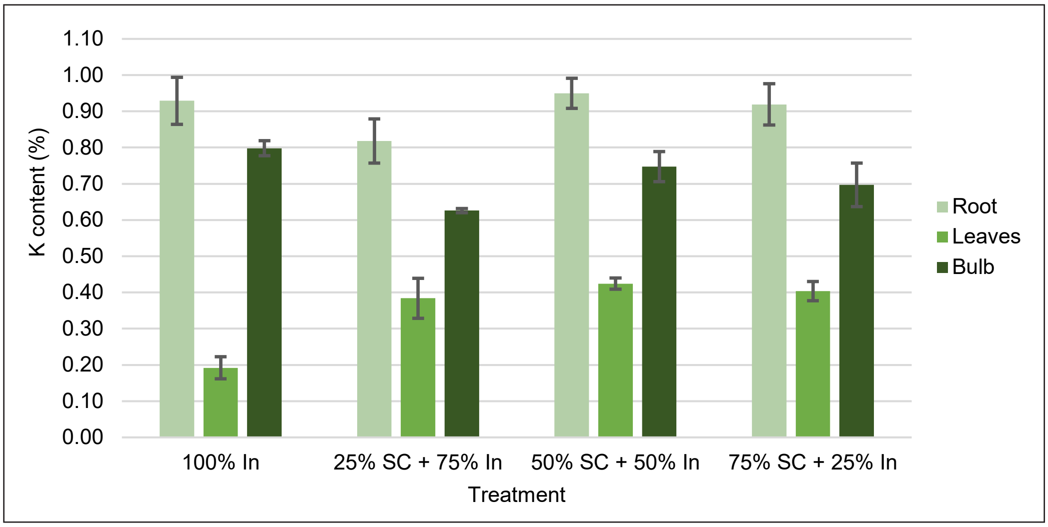

Figure 3. Tissue analysis of K content in roots, leaves, and bulbs with four treatments: 100% In = 100% inorganic fertilizer; 25% SC + 75% In = 25% *Sargassum* compost + 75% Inorganic fertilizer; 50% SC + 50% In = 50% *Sargassum* compost + 50% Inorganic fertilizer; and 75% SC + 25% In = 75% *Sargassum* compost + 25% Inorganic fertilizer, respectively

K in leaves plays a role in guard cells in stomata that regulate gas entry and exit (Hasanuzzaman et al., 2020). In addition, K plays a role in protein transporters and several enzymes involved in respiration and photosynthesis, so it affects plant growth (Ashley et al., 2006).

The highest Na accumulation was detected in the roots of all treatments (Figure 4). Elemental Na was observed because the

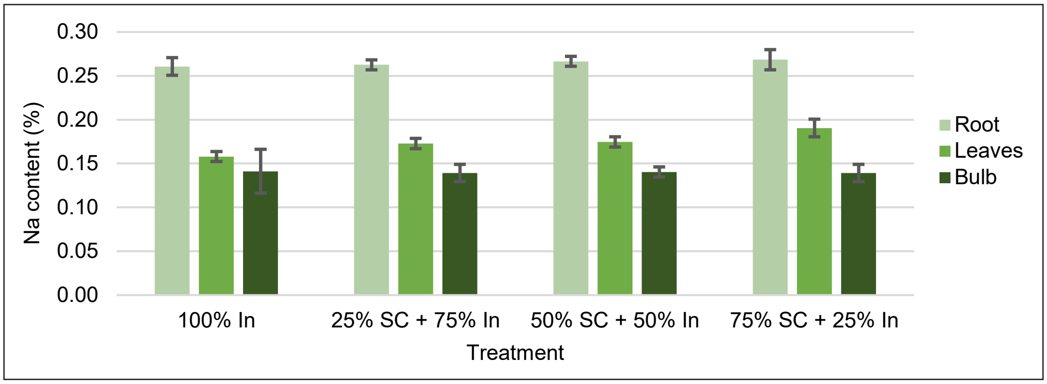

Figure 4. Tissue analysis of Na content in roots, leaves and bulbs with four treatments: 100% In = 100% inorganic fertilizer; 25% SC + 75% In = 25% *Sargassum* compost + 75% Inorganic fertilizer; 50% SC + 50% In = 50% *Sargassum* compost + 50% Inorganic fertilizer; and 75% SC + 25% In = 75% *Sargassum* compost + 25% Inorganic fertilizer, respectively

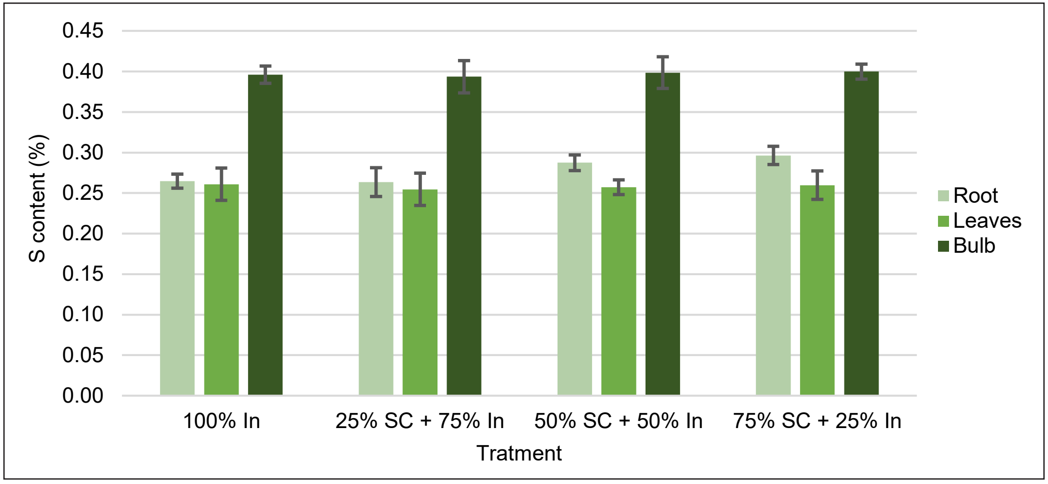

Figure 5. Tissue analysis of S content in roots, leaves, and bulbs with four treatments: 100% In = 100% inorganic fertilizer; 25% SC + 75% In = 25% *Sargassum* compost + 75% Inorganic fertilizer; 50% SC + 50% In = 50% *Sargassum* compost + 50% Inorganic fertilizer; and 75% SC + 25% In = 75% *Sargassum* compost + 25% Inorganic fertilizer, respectively

raw material for SC comes from marine organic material. Accumulation Na content in garlic roots could reach 0.03% (Astaneh et al., 2018). However, *Allium* species can absorb Na content depending on each genetic. The Na content has accumulated from the growing media, which contains Na, evidenced by the EC of the growing media (Table 3). Giving SC did not increase the Na in the growing media to an extreme. However, shallot of Bima Brebes variety accepted can adapt to high Na conditions as evidenced by Na content in root up to 27%. This result can relate to Syamsiyah et al. (2020) reported that the Bima Brebes variety shows better tolerance under salinity conditions or has a higher Na tolerance than other varieties. Furthermore, this result was in accordance with Nabti et al. (2017), who reported that applying a large amount of seaweed fertilizer increases Na levels in plant tissues. Elemental Na is useful for increasing the osmotic potential, absorbing water, maintaining turgor, and stimulating plant growth, particularly under a potassium ion (K^+) deficiency (Pardo & Quintero, 2002; Wu, 2018). In addition, onion was grown under salinity conditions not given to affect the total S content (Aghajanzadeh et al., 2018). The highest S content (0.40%) was found in the bulbs of all treatments (Figure 5). S is a micronutrient that affects the quality of shallot bulbs for pungency related to the quantity of allicin. González-Morales et al. (2017) reported that S affects the sulfoxide in Allium plants which is an organoleptic quality for taste and sharpness.

Growth and Yield

The growth parameters, as indicated by plant height, the number of leaves, and leaf area of shallot 56 days after planting in each treatment, are shown in Table 4. None of the shallot growth parameters was significantly different among the treatments. Because SC was able to substitute nutrients in the treatment of reduced doses of inorganic fertilizer 25% to 75%. SC contained 4.1% N, 0.5% P, 0.8% K, 7.2% Na, and 0.2% S (Table 2). The SC treatment provided the nutrients needed by the shallot plants. Therefore, SC reduced the inorganic fertilizer dose application. Reducing inorganic fertilizer use to 75% with the SC application resulted in the same growth as that of the treatment with 100% inorganic fertilizer. The good performance of shallot was also supported by the availability of hormones in the SC, including auxin, gibberellin, cytokinin, and kinetin (Table 1). These hormones stimulate growth through transcription factors or gene expression activities that affect morphological and physiological processes (Buttò et al., 2020).

The yield parameters, such as total fresh weight, total dry weight, and shallot bulb weight 65 days after planting, were not significantly different among the combined treatments (Table 5). The combination of organic and inorganic fertilizers prevents mineral loss so plants can absorb nutrients sufficiently and increase plant growth and yield (Liu et al., 2021). The combined fertilizer types were ideal for crop cultivation

Table 4
Plant height, number of leaves, and leaf area of shallot 56 days after planting

Treatment	Plant height (cm)	Number of leave	Leaf area (cm^2)
0% SC + 100% Inorganic	39.98 ± 5.74a	23.00 ± 3.50a	362.45 ± 21.68a
25% SC + 75% Inorganic	47.43 ± 3.33a	22.66 ± 8.28a	339.41 ± 43.09a
50% SC + 50% Inorganic	45.61 ± 3.53a	21.16 ± 6.64a	316.46 ± 22.66a
75% SC + 25% Inorganic	42.45 ± 4.66a	17.50 ± 8.26a	309.66 ± 9.36a
CV (%)	11.016	16.784	10.142

Note. Means followed by the same letters in the same column are not significantly different according to the LSD test; α = 5%

because inorganic fertilizers provide nutrients for plants during the early stages of growth, while the SC provided stable nutrients until the end of growth and filled the sinks of the crop organs. Therefore, our results show that shallot can be cultivated by reducing inorganic fertilizer to 75% of the recommended dose and replacing it with 25% SC.

Table 5
Total fresh weight, total dry weight, and shallot bulb weight 65 days after planting

Treatment	Total of fresh weight (g)	Total of dry weight (g)	Bulbs fresh weight (g)
0% SC + 100% Inorganic	44.40 ± 12.08a	4.22 ± 0.93a	16.16 ± 5.33a
25% SC + 75% Inorganic	38.72 ± 8.07a	4.41 ± 0.68a	17.09 ± 4.32a
50% SC + 50% Inorganic	39.50 ± 9.21a	4.23 ± 0.93a	19.24 ± 4.57a
75% SC + 25% Inorganic	35.84 ± 9.51a	3.85 ± 1.41a	16.72 ± 7.37a
CV (%)	13.294	15.005	11.547

Note. Means followed by the same letters in the same column were not significantly different according to the LSD test; α=5%

CONCLUSION

SC contained of 4.1% N, 0.5% P, 0.8% K, 7.2% Na, 0.2% S, 8.14 mg.g^{-1} auxin, 15.97 mg.g^{-1} gibberellin, 7.70 mg.g^{-1} cytokinin, and 2.78 mg.g^{-1} kinetin. Substitution of 75% SC could increase 13% organic matter, 45% moisture content, and 87 dS.m^{-1} EC of soil compared to 100% inorganic fertilizers, which gave the trend of increasing issue P, Na, and S content of shallot bulbs. Application of 25% to 75% SC substitution rate provided the same growth and yield of shallot as 100% inorganic fertilizer. Reducing 75% inorganic fertilizer use in shallot cultivation is possible by replacing 75% SC with organic fertilizer.

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