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Utilization of Sago Waste as Bokashi to Improve The Growth and Yield of Three Varieties of Shallots (*Allium ascalonicum* L) on Peat Land

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ABSTRACT

The shallot plant is a strategic vegetable product horticultural commodity with high economic value. The research aims to determine the effect of sago waste bokashi on three shallot varieties on peatlands. This research was conducted in Alah Air Village, Tebing Tinggi District, Meranti Islands Regency, Riau Province, for four months, from September to December 2023. The study used a completely randomized design with two factors, namely bokashi sago waste (dolomite, dolomite + stem bark, dolomite + fronds, dolomite + sago pulp, dolomite + mixture of the three sago wastes) and shallot varieties (bima brebes, Trisula, and ss Sakato). Parameters observed were plant height, number of leaves, percentage of bulbs formed at 35 hst, number of leaves, number of bulbs per clump, weight of wet bulbs per plot, weight of dry bulbs per plot, and percentage of bulb shrinkage. The results showed that the parameters of the percentage of bulbs appearing 35 hst and the number of bulbs had a significant effect. In contrast, the parameters of plant height, number of bulbs per clump, wet weight per plot, and dry weight per plot were not significantly affected.

Keywords: Bokashi, Peat, Sago Waste, Shallot, Varieties

1. INTRODUCTION

Red onion plants (*Allium ascalonicum* L) are a strategic horticultural commodity of high economic value due to their daily need in various types of seasoning, industries, and health purposes (Pratiwi et al., 2019). The consumption of red onions from 2020 to 2024, considering population growth, is estimated to increase by an average of 3.47% per year, with an estimated average consumption of 1,021.30 thousand tons per year. However, the demand for red onions is not aligned with the production of red onions in Indonesia in 2020, 2021, and 2022, with production figures of 611,165 tons, 564,255 tons, and 556,510 tons, respectively (Badan Pusat Statistik, 2023)

In the effort to develop shallots on peat soil, there are several challenges, such as low soil pH, nutrient availability, low base saturation, high content of organic acids, toxicity of organic acids, and deficiency of both macro and micronutrients. Furthermore, the availability of phosphate nutrients in peat soil is also low due to the absorption of P by Aluminum and Iron in acidic soils (Masganti et al., 2017).

Mulyati et al. (2022) stated that the decline in soil chemical and biological properties is generally associated with decreased soil organic matter content. Therefore, applying organic materials as resilience is one of the efforts in natural land improvement, one of which is using ameliorants. Amelioration plays a role in improving the fertility of peat soil by increasing pH and nutrient availability, as well as reducing levels of organic acids and toxic ions (Lestari & Maftu'Ah, 2021). Various ameliorants can be used, including soil amendments derived from agricultural waste, such as sago waste, including sago stem bark, sago leaf sheaths, and sago pulp. The high productivity of sago can lead to pollution issues in water or land if not properly managed. One type of ameliorant that can be utilized to improve soil texture and structure is bokashi—bokashi results from fermenting organic materials with EM4 (Effective Microorganism-4) technology. When applying bokashi to peat soil, dosage should be carefully considered to ensure it meets the needs of the cultivated plants (R Afiat et al., 2017).

Cultivating shallots in peat soil requires the appropriate use of bokashi to enhance soil fertility and attention to the varieties used, as not all shallot varieties can adapt to peat soil. Varieties play a crucial role in determining the success of plant cultivation, with suitable high-quality varieties for the desired environment reducing the risk of failure. Research results indicate that the maturity level test of compost (1, 3, 5 weeks) on the production of three shallot varieties (Kampar, Medan, Bima Brebes) in peat soil in Pekanbaru City, Riau Province, showed that the Bima Brebes variety could increase the weight of fresh and dry bulbs per plot significantly after just one week of compost maturity. Additionally, a study on the adaptability test of several shallot varieties in peat soil during the rainy season in Central Kalimantan identified Bima Brebes, Sembrani, Maja Cipanas, Trisula, Katumi, Mentes, and Minjung as adaptable varieties, with Sembrani demonstrating the highest adaptability.

This study combines previous research to be tested on peatlands that have never been cultivated for seasonal vegetables using abundant sago waste in the Kepulauan Meranti Regency.

2. MATERIAL AND METHODS

This research was conducted in Alah Air Village, Tebing Tinggi District, Meranti Islands Regency, Riau Province, Indonesia. Coordinate point: Lat $0^0 59' 41.9187^0$N, Long $102^0 40' 52.8257^0$E, starting from September to December 2023.

The materials used in this research were red onion bulbs of the Bima Brebes, Trisula, SS Sakato varieties, bokashi sago bark, bokashi

sago leaf midrib and bokashi sago dregs, dolomite, NPK Mutiara 16:16:16 fertilizer, and Dithane M- 45. Meanwhile, the tools used in the research were hand trackers, meters, hoes, knives, analytical scales, pH meters, sprinklers, plastic buckets, cameras, and writing tools.

The research used a factorial, completely randomized design (CRD). The first factor is sago waste bokashi with 5 levels of treatment, namely dolomite, dolomite + sago bark bokashi, dolomite + sago leaf midrib, dolomite + sago dregs bokashi, dolomite + bokashi mixture of bark, fronds, sago dregs. The second factor is shallot varieties with 3 levels of treatment, namely bima brebes, Trisula, and SS sakato. The number of plants per plot was 25, the sample was 10, and the total was 1,125.

The research implementation included checking the pH of the peat before the research, obtained 3.9, processing and loosening the land, application of dolomite at a dose of 420 g per plot (4.2 tons ha-1) given three weeks before planting, bokashi from sago waste at a dose of 600 g per plot (6 tons ha-1) given one week before planting. Shallot seeds are cut off 1/3 of the tip of the bulb 3 hours before planting, then mixed with Dithane M45 to prevent the appearance of fungus on the bulbs at a dose of 20 g per kg of shallots. Seedlings are planted with a spacing of 25 cm x 25 cm. NPK 16:16:16 fertilization dose of 25 g per plot (250 kg ha-1) is given at planting. Maintenance includes watering, weeding, and controlling pests and plant diseases), then harvest simultaneously 60 days after planting.

The observation parameters carried out were as follows: plant height (cm), percentage of forming tubers aged 35 days after planting (%), number of tubers per cluster (fruit), wet tuber weight per plot (g), dry tuber weight per plot (g) and tuber weight loss percentage (%). Data from observations for each treatment were analyzed statistically. If the calculated F is greater than the F table, proceed with a further Honest Significant Difference (BNJ) test at the 5% level.

The research stages can be seen from the following flow diagram:

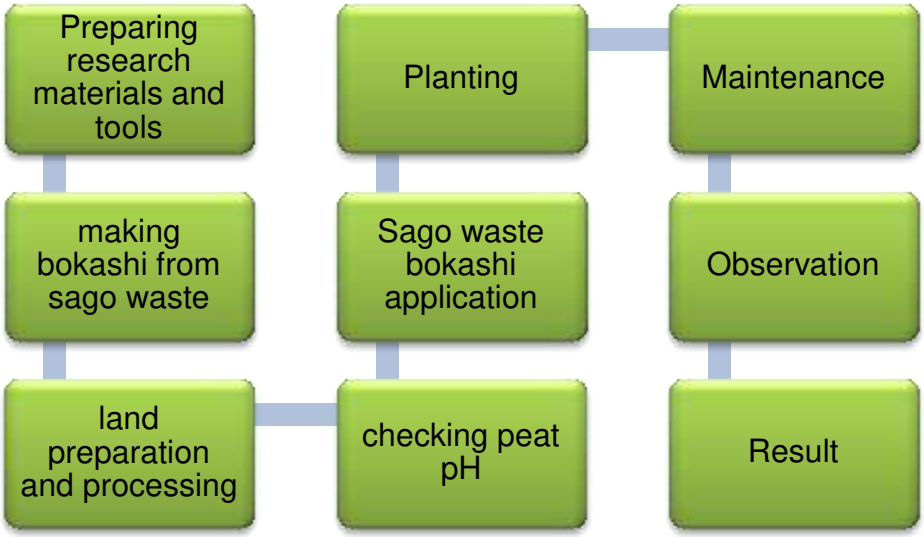

Figure 1. Research flow diagram

3. RESULT AND DISCUSSION

3.1 Plant Height (cm)

The results of the variance analysis showed that the interaction and primary treatment of sago waste bokashi and varieties had no significant effect on shallot plant height. The average results of observations of shallot plant height after carrying out the BNJ test at the 5% level can be seen in Table 1.

Table 1. The average height of plants aged 35 DAP with the bokashi treatment of sago waste and varieties

Sago Waste Bokashi (A)	Variety (V)			Average
	Bima Brebes (V1)	Trisula (V2)	SS Sakato (V3)	
Dolomite (Control)	28,00±7,95	25,78±6,42	22,84±5,35	25,54
Dolomite + Bokashi sago bark	26,50±2,62	25,80±8,48	30,25±9,32	27,52
Dolomite + Bokashi sago leaf midrib	30,83±2,92	14,72±3,22	25,11±5,80	23,55
Dolomite + Bokashi sago dregs	30,56±10,30	19,28±9,81	23,19±8,85	24,34
Dolomite + Bokashi bark + midrib + dregs	24,53±6,77	22,56±9,03	20,59±5,92	22,56
Average	28,08	21,63	24,40	
KK= 29,46%				

Note: The figures presented represent the mean ± standard error. Similar letters adjacent to the mean value indicate differences that are not statistically significant based on the Honestly Significant Difference test at the 5% level.

The data in Table 1 shows that the bokashi treatment of sago waste and varieties did not significantly affect shallot plant height. The average plant height at 35 days after planting is 14.72 – 30.83 cm. Compared with the description of Bima Brebes, Trisula, and SS Sakato, the plant height reaches 25-40 cm.

The low yield of cultivated shallot plants is thought to be due to the low level of fertility in peat, the provision of dolomite and bokashi, which has not been maximized in increasing pH, and when the research process is carried out in the rainy season (off-season), causing the growth and development of shallots to be inhibited. Plant height indicates plant growth that is not correlated with yield.

According to (Firmansyah et al., 2014), acidity stress in peat indicates that the growth and development of roots, leaves, and tuber production is far from its production potential. The application of sago waste bokashi has not consistently increased the growth and yield of shallot plants. Many factors cause this to happen, one of which is thought to be because sago waste bokashi is still in the process of decomposition, so organic acids are formed, which slow down the increase in soil pH, so plant growth is also inhibited.

The research results (Tandi et al., 2021) on the agronomic characteristics and production of shallots in three varieties (trisula, lansuna, and bima brebes) in the city of Tomohon, North Sulawesi Province show that the plant height at 30 days after planting in the trisula variety is 34.30 cm, brebes is 26.84 cm, and Lansuna is 26.40 cm. Environmental factors can influence the appearance of a variety. Several genetic and environmental factors have a close relationship that cannot be separated. If the environmental factors are suitable for plant growth, then plants with optimal appearance will be produced.

3.2 Percentage of Emerging Tubers at 35 DAP (%)

The analysis of variance showed that in terms of interaction and primary, the ameliorant treatment had no significant effect. However, the shallot variety had a significant effect on the percentage of shallot bulbs appearing at 35 days of age. The average observation results of the percentage of tubers appearing after the BNJ test was carried out at the 5% level can be seen in Table 2.

Based on the data in Table 2, shows that the variety of treatments had a real effect, where the best results were in treatments V1 (bima brebes) and V3 (ss sakato) compared to V2 (trisula). The high percentage of tubers appearing in treatments V1 and V3 is because they

have high adaptability; even though they grow in unsuitable conditions, they are still able to develop and quickly emerge tubers, furthermore, the nutrients needed by the plants are sufficient and are suspected that not all the nutrients are washed away by rainwater so they still some can be absorbed by plants for their growth and development.

The results obtained are still low when compared to the results of research (Nur & Sutriana, 2018), where bulbs are formed at the age of 17-21 hst; (Sutriana & Ulpah, 2019), where bulbs are formed at the age of 22-28 hst. This means that at 35 hst, 100% of shallot bulbs have appeared or formed. Several things cause the length of time the bulbs are formed, including allegedly during the onion harvesting process carried out simultaneously, even though maybe not all shallot plants are suitable for harvesting, if, for consumption, it may not be too much of a problem, but if the bulbs are used for the next seed, it may need to be considered again.

Table 2. The average percentage of shallot bulbs appearing with bokashi treatment of sago waste and varieties 35 days after planting

Sago Waste Bokashi (A)	Variety (V)			Average
	Bima Brebes (V1)	Trisula (V2)	SS Sakato (V3)	
Dolomite (Control)	65,33±25,72	60,00±18,33	85,33±8,33	70,22
Dolomite + Bokashi sago bark	72,00±10,58	50,67±26,63	77,33±12,86	66,67
Dolomite + Bokashi sago leaf midrib	62,67±14,05	46,67±26,63	78,67±16,65	62,67
Dolomite + Bokashi sago dregs	66,67±18,04	40,00±14,42	86,67±4,62	64,44
Dolomite + Bokashi bark + midrib + dregs	73,33±12,86	56,00±13,86	78,67±12,86	69,33
Average	68,00 a	50,67 b	81,33 a	
KK= 25,44% BNJ V= 15,28				

Note: The figures presented represent the mean ± standard error. Similar letters adjacent to the mean value indicate differences that are not statistically significant based on the Honestly Significant Difference test at the 5% level.

3.3 Number of Tubers Per Clump

The results of the variance analysis showed that the interaction and main treatment of ameliorant had no significant effect, but the variety significantly affected the number of bulbs per cluster of shallots. The average results of observing the number of shallot bulbs after carrying out the BNJ test at the 5% level can be seen in Table 3.

Table 3. Average number of bulbs in three shallot varieties treated with sago waste bokashi

Sago Waste Bokashi (A)	Variety (V)			Average
	Bima Brebes (V1)	Trisula (V2)	SS Sakato (V3)	
Dolomite (Control)	6,25±0,66	9,83±3,05	5,50±0,75	7,19
Dolomite + Bokashi sago bark	6,00±0,75	9,25±1,75	5,33±0,88	6,86
Dolomite + Bokashi sago leaf midrib	6,83±0,38	7,67±0,63	5,67±0,52	6,72
Dolomite + Bokashi sago dregs	7,42±0,38	8,00±2,05	7,17±1,63	7,53
Dolomite + Bokashi bark + midrib + dregs	6,16±1,01	8,25±0,90	5,58±1,46	6,67
Average	6,53 b	8,60 a	5,85 b	
KK= 18,32% BNJ V= 1,15				

Note: The figures presented represent the mean ± standard error. Similar letters adjacent to the mean value indicate differences that are not statistically significant based on the Honestly Significant Difference test at the 5% level.

Based on the data in Table 3 shows that the variety treatment had a significant effect on the number of tubers per hill, where the best results were found in V2 (trisula) compared to V1 (bima Brebes) and V3 (ss sakato). There are differences in the number of tubers in each variety because genetic and environmental factors influence them. The number of bulbs is also related to the number of leaves produced by the shallot plant. The more leaves there are, the more tubers will be produced.

The results obtained can be said to be almost the same as the research (Sutriana & Baharuddin, 2019)(Heksusetya et al., 2023), namely 5 - 7 tubers, and the research results of Heksusetya et al. (2023), namely the number of seedlings or tubers that obtained without manure, 7 tubers, with manure treatment 8 tubers.

According to (Ma'ruf et al., 2019), the number of bulbs produced by shallots is also influenced by the number of lateral shoots that grow and can form new bulbs. Furthermore, (Azmi et al., 2011) stated that the characteristic number of bulbs in shallots is primarily influenced by genetic factors and to a lesser extent, by the environment, in line with that (Sumarni et al., 2012); (Arman et al., 2016) state that the number of bulbs or offspring is more determined by genetic factors (the seed used), and the number of offspring per clump than by fertilization factors, but environmental factors and soil fertility level also greatly influence the number of bulbs produced.

3.4 Wet Tuber Weight Per Plot

The results of the variance analysis showed that the interaction and primary treatment of bokashi sago waste and varieties had no significant effect on the weight of wet tubers per plot. The average results of observations of wet tuber weight after carrying out the BNJ test at the 5% level can be seen in Table 4.

Table 4. Average wet bulb weight per plot for three shallot varieties treated with sago waste bokashi

Sago Waste Bokashi (A)	Variety (V)			Average
	Bima Brebes (V1)	Trisula (V2)	SS Sakato (V3)	
Dolomite (Control)	25,25 (674,85) ±402,61	21,83 (516,02) ±338,87	17,52 (313,35) ±115,17	21,53 (501,41)
Dolomite + Bokashi sago bark	19,65 (390,67) ±99,27	23,06 (558,71) ±316,34	26,43 (752,89) ±447,79	23,05 (567,42)
Dolomite + Bokashi sago leaf midrib	21,51 (464,35) ±71,53	15,84 (251,50) ±29,39	20,19 (411,17) ±91,31	19,18 (375,67)
Dolomite + Bokashi sago dregs	24,31 (629,08) ±335,41	18,57 (377,50) ±287,14	21,44 (471,29) ±181,17	21,44 (492,62)
Dolomite + Bokashi bark + midrib + dregs	21,11 (453,06) ±141,04	20,30 (432,79) ±234,73	17,02 (309,33) ±201,05	19,48 (398,39)
Average	22,37 (522,40)	19,92 (427,30)	20,52 (451,61)	
KK= 26,34% (54,11%)				

Note: The figures presented represent the mean ± standard error. Similar letters adjacent to the mean value indicate differences that are not statistically significant based on the Honestly Significant Difference test at the 5% level.

The data in Table 4 shows that the weight of fresh tubers per plot does not have a significant effect, but from the data, it is clear that the highest weight of tubers is found in V1 (bima brebes) compared to the varieties ss sakato and trisula. The high fresh weight yield in the bima brebes variety is due to its adaptation to lowlands peatlands during the rainy season and resistance to pests and diseases. The results obtained are higher compared to the study by Azman

et al., 2017, which ranged from 91.67 g - 301.67 g, cultivated in the Rimbo Panjang Village, Kampar Regency, and lower compared to the study by Albani & Baharuddin, 2023, ranging from 400 - 1,491.75 g.

The high or low wet weight of shallot plant bulbs is related to whether or not the plant has sufficient nutrients to be absorbed. If you have enough food, the process of photosynthesis and the formation of plant carbohydrates until they form tubers runs better, and then they also absorb more water. On the other hand, photosynthetic activity will not run smoothly if insufficient, and the increase in plant wet fallow will be reduced.

3.5 Dry Tuber Weight Per Plot

The analysis of variance showed that the interaction and primary treatment of sago waste bokashi and varieties had no significant effect on dry tuber weight per plot. The average results of dry tuber weight observations after carrying out the BNJ test at the 5% level can be seen in Table 5.

Table 5. Average dry tuber weight of three shallot varieties treated with sago waste bokashi

Sago Waste Bokashi (A)	Variety (V)			Average
	Bima Brebes (V1)	Trisula (V2)	SS Sakato (V3)	
Dolomite (Control)	23,60 (591,79) ±364,12	20,50 (459,54) ±318,55	16,16 (267,96) ±107,88	20,08 (439,76)
Dolomite + Bokashi sago bark	18,31 (338,96) ±82,75	21,72 (498,60) ±298,98	25,10 (685,58) ±424,05	21,71 (507,71)
Dolomite + Bokashi sago leaf midrib	20,35 (416,39) ±77,19	14,02 (197,56) ±34,60	19,01 (364,46) ±81,07	17,79 (326,14)
Dolomite + Bokashi sago dregs	23,13 (570,92) ±307,93	17,05 (324,00) ±269,13	20,14 (418,46) ±176,29	20,11 (437,79)
Dolomite + Bokashi bark + midrib + dregs	19,67 (394,58) ±132,61	18,92 (377,46) ±209,71	15,66 (263,02) ±175,13	18,08 (345,02)
Average	21,01 (462,53)	18,44 (371,43)	19,21 (399,90)	
KK= 27,96% (57,06%)				

Note: * Data transformed $\sqrt{x}$) Numbers in brackets indicate original data; numbers in rows and columns are not significantly different based on the F test. The figures presented represent the mean ± standard error. Similar letters adjacent to the mean value indicate differences that are not statistically significant based on the Honestly Significant Difference test at the 5% level.

The data in Table 5 shows that the weight of dry tubers per plot has no significant effect. However, from the data, it is clear that the highest tuber weight was found in the Bima Brebes variety with dolomite + bokashi sago dregs treatment, namely 570.92 g. The parameters of the number of bulbs and the weight of the bulbs greatly influence the amount of productivity produced by shallots. Even though the number of bulbs is small, the weight of the bulbs is higher; conversely, the number of bulbs is large, but the weight of the bulbs is small or lighter. Furthermore, the nutrients absorbed by the plant roots can affect the bulbs' dry weight, so if the nutrients absorbed by the plant are sufficient, the yield of shallot bulbs will be better.

The production of shallots between varieties shows a difference; it is thought that each variety has different growth and adaptability on peatlands. (Sartono, 2010), states that genetic factors affect differences in vegetative growth to shallot production.

The results obtained are still low compared to the results of the research (Albani & Baharuddin, 2023), which is 288 g - 1,208.5 g. This is due to the lack of availability of K absorbed by plant roots, and the element K contributes

greatly to the increase in fresh and dry weight of shallot bulbs.

3.6 Tuber Loss Percentage (%)

The results of the variance analysis showed that the interaction and main treatment of bokashi, sago waste, and varieties did not significantly affect the percentage of shallot bulb shrinkage. The average results of observing the percentage of tuber shrinkage after the BNJ test was carried out at the 5% level can be seen in Table 6.

Table 6. Average percentage of tuber loss in three shallot varieties treated with sago waste bokashi

Sago Waste Bokashi (A)	Variety (V)			Average
	Bima Brebes (V1)	Trisula (V2)	SS Sakato (V3)	
Dolomite (Control)	12,95±1,64	12,78±4,24	15,13±6,15	13,62
Dolomite + Bokashi sago bark	13,10±1,82	11,77±2,68	10,94±5,90	11,93
Dolomite + Bokashi sago leaf midrib	10,62±3,52	21,77±5,93	11,32±1,61	14,57
Dolomite + Bokashi sago dregs	9,73±2,22	16,99±5,99	12,21±5,24	12,97
Dolomite + Bokashi bark + midrib + dregs	13,40±2,51	13,43±3,18	15,55±5,09	14,12
Average	11,96	15,35	13,03	
KK= 31,27%				

Note: The figures presented represent the mean ± standard error. Similar letters adjacent to the mean value indicate differences that are not statistically significant based on the Honestly Significant Difference test at the 5% level.

Based on the data in Table 6, it is evident that the bokashi treatment of sago waste has no significant effect on the three varieties of shallots. The average percentage of bulb loss is 13.45%, which is considered low compared to each description of these shallots. During the daytime, high temperatures occur, supporting plant photosynthesis and resulting in photosynthate accumulation as soluble solids in the bulbs.

4. CONCLUSION

The interaction of bokashi cassava waste and shallot varieties was found to have no significant impact on all the observed parameters. The shallot variety treatment significantly affected the emergence percentage of bulbs at 35 days after planting in the ss Sakato and bima brebes varieties, which were 81.33% and 68%, respectively, as well as the number of bulbs in the trisula variety, which was 8.60 bulbs per clump.

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