Nano Rice Husk Ash as Bulb Coating in Increasing Storability of Shallot Seed (*Allium cepa* var. *aggregatum* group)

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Abstract. Shallot seed generally used form bulb that stored for short period, and it led to decrease the seed quality. Application of nano rice husk ash that contain high silica could utilize as seed coating to minimize the decrease in seed quality. The experiment was carried out for evaluating the usage of nano rice husk ash as bulb coating in increasing storability of shallot seed. Concentration of nano rice husk ash with concentration of 0%, 0.1%, 0.2%, 0.3% and 0.4% were test in this research. Application of rice husk ash as shallot seed coating could preserve the quality of seed. Moreover, the concentration of 0.3 and 0.4 could maintain water content, weight loss, firmness, bulb diameter, number of bulb loss, vigor index and germination rate in optimum value.

1. Introduction

Shallot (*Allium cepa* L. var. *Aggregatum group*) is one of the main horticulture products with high economic value that influence Indonesian agriculture. Shallots contain a lot of useful ingredients for human life, especially as flavor to dishes by Indonesian [1,2]. Therefore, the need for shallots was increasing as increasing population [3,4], so the consumption of shallots is relatively high. Furthermore, shallot ranks third amongst all vegetable crops in Indonesia in terms of cultivated area [5]. One of the main problems in shallot production is the provision of seeds. The shallot seeds commonly used from bulb of previous crops which is cannot be stored for long periods of time [6]. Generally, bulb loss in storage varied between 1-30% [7], sometimes it can increase to 75% due to presence of Fusarium basal rot [8].

Silica has the potential to be used to prevent bulb from losing water during storage [9]. Silica acts as a layer that prevents water from escaping, thus controlling hydration and transpiration from the bulb [10]. In addition, the silica layer can also prevent penetration or infection from insect and diseases [9,10]. One of Bio-Silica source that can be used derived from rice husk ash. Rice Husk as contain about 87-92% of Silica [11,12]. Bio- silica derived from RH has several advantages compared to silica mineral, it has a fine particle, more reactive, can be obtained easily with low cost,
abundantly available and from renewable raw materials [13]. Increasing the efficiency of utilizing silica can be done by changing the particle size to the nano size. As a result, lesser amounts of nanosized particles cover a large surface area [9] and higher effect can be achieved [14–16].

The process regarding the ability of plants to utilize silica in adapt from biotic and abiotic stress system is still mystery. Moreover, research related to the use of silica, especially from rice husk ash as seed coating and its effect in storage has never been found before. However, the research regarding the ability of silica to enhance germination rate have been research on tomato [17]. Therefore, this research focused on the use of nano rice husk ash as a seed coating for shallot bulb and its effect in storage.

2. Materials and Methods

This research was carried out in the Greenhouse of Agrotechnology, Universitas Muhammadiyah Yogyakarta, Indonesia. This research activity was carried out from August to November 2019. This research was carried out using Completely Randomized Design (CRD) with five treatment of nano rice husk ash with concentration of 0%, 0.1%, 0.2%, 0.3% and 0.4%, each treatment was replied three times. the Biru Lancer cultivar was used on this research.

2.1. Preparation of nano rice husk ash

Rice husks transform to rice husk as by burn using direct combustion at 350°C. white ash separate form black ash using 80 mesh sieves prior to nanofication. Process of nanofication was done by placing white ash (25%) in ball mill with the addition of small iron ball (62.5%) and water (12.5%) for five hours. The water was removed using an oven at 300°C. Based on Scanning Electron Microscopy (SEM) the average size of particle was 62.326 nm and 87% of particle size below 100 nm. Based on Energy Dispersive X-ray Spectroscopy (EDX) the particle contains of 40.36% Silica, 46.86% Oxygen, 11.93% Carbon and 0.85% photassium.

2.2. Bulb Selection and application of nano rice husk ash

The bulb at the age of 65 DAP were harvested and cleaned from soil. Bulb with size between 1.5-1.8 cm and weight between 5-10 gram and without sign of damaged was selected. Two kg of selected bulb for each unit were applied using nano rice hu sk ash based on treatment. Bulb was dipping for five minutes in solution of nano rice husk with addition of nonylphenol ethylene oxide 95 g/l and polyvinyl alcohol 19 g/l as adhesive agent. Afterwards, the bulb was curing under direct sunlight for 5 day. Then, bulb was put on polynet to prevent bulb loss from falling, and store in a dark, cool, dry, and well ventilated for 1.5 month. The data observed on weight loss (%), firmness of bulbs using hand penetrometer (N m-2), bulb diameter (mm), water content (%) using oven method, and percentage of bulb loss before planting. The data were analyzed using the F test with 5% level and continued LSD test.

2.3. Replanting

Bulb of shallot after treated and stored for 1.5 month was planted in greenhouse to measure the quality of seedling. Twenty-five of random bulb from each unit was planted in fiber box (33 x 30 x 12 cm) which filled using sand and without fertilizer. Observations were made for two weeks on the germination rate, index vigour, plant height, and number of leaves. The data were analyzed using the F test with 5% level and continued LSD test.

3. Results and Discussion

The water content of bulb after applied with various concentration of nano rice husk ash could be seen in Table 1. It shown that long with the length of storage, the water content in the bulbs will decrease. The bulb applied nano rice husk 0% ash sown highest decreasing compare to bulb that applied with nano rice husk ash. The reduction of water content in bulb during storage due to transpiration and respiration in bulb [18]. Application of nano rice husk ash can preserve water in
bulb because nano rice husk ash contain silica and it could make a layer in outer shell [19]. This layer will act as controller for respiration and transpiration lead to minimum usage of water in bulb.

Table 1. Water content (%) of shallot bulb after applied with nano rice husk ash.

| Treatment    | Water content (%) during storage |
|--------------|---------------------------------|
|              | Day 10 | Day 20 | Day 30 | Day 45 |
| NRH solution 0% | 91.56 b | 79.10 b | 64.91 b | 39.65 b |
| NRH solution 0.1% | 92.63 b | 81.31 ab | 75.79 ab | 49.46 ab |
| NRH solution 0.2% | 96.76 a | 85.69 ab | 77.33 a | 45.63 ab |
| NRH solution 0.3% | 95.59 a | 85.39 ab | 82.77 a | 49.76 ab |
| NRH solution 0.4% | 95.43 a | 86.12 a | 81.14 a | 55.04 a |
| CV (%)       | 0.91   | 4.41   | 8.58   | 14.31  |

Mean values within a column followed by the same letters indicated non significantly different as determined by LSD at α = 5%.

Weight loss was a quality parameter to represent the bulb’s freshness. Shallot bulbs lost the weight due to decay, vaporization, and damage during storage [20]. Most causal of weight loss is mostly influenced by respiration and transpiration [18]. As shown on Table 2, the application of nano rice husk ash as shallot seed coating shown lower weight loss compare with 0%. The silica layer form application of nano rice husk ash could help water content decrease slowly and weight loss became less [19].

The silica layer in outer shell could enhanced firmness of bulb after store for 1.5 month. The concentration 0.3% of nano rice husk ash shown better firmness compared to concentration 0% dan 0.1%. bulb firmness affected by concentration of soluble solids and water potential [21]. Adding silica material as coating could add soluble solid in bulb lead to increasing firmness of shallot bulb.

Table 2. Weight loss (%), firmness (N m⁻²) and bulb diameter (mm) of shallot bulb after applied with nano rice husk ash and store for 1.5 months.

| Treatment    | Weight loss (%) | Firmness (N m⁻²) | Bulb diameter (mm) |
|--------------|-----------------|------------------|--------------------|
| NRH solution 0% | 11.50 a         | 14.62 c          | 41.50 b            |
| NRH solution 0.1% | 7.33 b          | 15.72 bc         | 46.11 a            |
| NRH solution 0.2% | 7.67 b          | 17.60 ab         | 46.37 a            |
| NRH solution 0.3% | 10.33 ab        | 17.94 a          | 47.90 a            |
| NRH solution 0.4% | 8.50 ab         | 16.22 abc        | 46.33 a            |
| CV (%)       | 18.78           | 6.69             | 2.72               |

Mean values within a column followed by the same letters indicated non significantly different as determined by LSD at α = 5%.

Bulb diameter of shallot with 0% concentration of nano rice husk ash have lower bulb diameter compare with other concentration. Shrinkage from bulb tissue due to cell evaporation, so that shrinkage a cell volume. Depreciation area also occur in the shallot endodermis [20] lead to shrinkage of bulb diameter. A layer of silica in shallot bulb under application of nano rice husk ash control evaporation in cell lead to minimum shrinkage in bulb diameter.

Based on the variance analysis, the effect of nano rice husk ash as shallot bulb coating gives significant effect to the number of damaged bulbs (Fig. 1). This indicated that during the storage, all treatments experienced disease attack that caused bulbs damage. The application on nano rice husk ash with concentration of 0% as coating have higher number of damaged bulbs compare to the other
application, while the application with concentration 0.4% have a smaller number of damaged bulbs.

![Figure 1. Effect of various concentration of nano rice husk (NRH) ash applied towards the number of damage bulb of during storage for 1.5 months.](image)

Seed germination plays important role as foundation for plant growth, development and yield [17]. One of high vigor indicators is shown by the ability of the plant to grow more than 60% for horticulture commodity. The high number of vigor index indicated the bulb ability to germinate simultaneously. As presented on Table 3, show the various concentration of nano rice husk ash is used in shallot bulbs did significantly affect the vigor index. Bulb that applied with nano rice husk with concentration 0.4% as coating shown highest vigor index and germination rate. This result in line with [17] which tomato applied with nano silica with concentration of 8 g L⁻¹ could increase seed germination, germination mean time, and seedling vigor index. Sabaghnia [22] found that Lentil applied with nano silica could enhance germination and seedling in early growth under salinity stress.

Table 3. Vigor index and germination rate (%) of shallot bulb after applied with nano rice husk ash and store for 1.5 months.

| Treatment      | Vigor Index | Germination Rate (%) |
|----------------|-------------|----------------------|
| NRH solution 0%| 10.59 b     | 65.00 bc             |
| NRH solution 0.1%| 10.20 b     | 60.00 bc             |
| NRH solution 0.2%| 9.92 b      | 53.33 c              |
| NRH solution 0.3%| 12.17 ab    | 75.00 ab             |
| NRH solution 0.4%| 14.91 a     | 86.67 a              |
| CV (%)         | 17.44       | 16.66                |
| F-Test         | *           | *                    |

Mean values within a column followed by the same letters indicated non significantly different as determined by LSD at α = 5%.

4. Conclusion
Application of rice husk ash as shallot seed coating could preserve the quality of seed. Moreover, the concentration of 0.3 and 0.4 could maintain water content, weight loss, firmness, bulb diameter, number of bulb loss, vigor index and germination rate in optimum value.
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