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Survival Rate, Disease Incidence, and Yield of Shallots by Seed Priming and Application of Tithonia Compost Enriched with *Gliocladium virens*

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ABSTRACT: This study aimed to evaluate the effects of seed priming with Moringa leaf extract (MLE) and the application of Tithonia compost enriched with *Gliocladium virens* on survival rate, disease incidence, and yield components of shallot. This research was carried out from September to December 2022 at the Teaching Farm, Faculty of Agriculture, Hasanuddin University. The study was conducted with a factorial design of two factors with three replications. The first factor was seed priming, consisting of unprimed hydropriming, 12.5% MLE, 25% MLE, and 37.5% MLE. The second factor is the dose of compost, composed of 0 t/ha, 5 t/ha, 10 t/ha, and 15 t/ha. All data were evaluated using analysis of variance (ANOVA) and Tukey's multiple means comparison to determine statistical differences between treatments at the 95% confidence level. The results showed that seed priming with MLE and Tithonia compost enriched with *Gliocladium virens* affected the percentage of surviving seedlings after transplanting. Alone, seed priming with MLE at a concentration of 37.5% and application of Tithonia compost at a dose of 15 t/ha had the best effect on the number of bulbs per plant, bulb weight, bulb diameter and bulb production. Furthermore, adding Tithonia compost enriched with *Gliocladium virens* reduced the incidence of Fusarium wilt. As a result, the use of MLE as a priming agent and the addition of Tithonia compost enriched with *Gliocladium virens* is recommended.

KEYWORDS: moringa, seed priming, shallot, tithonia diversifolia

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INTRODUCTION

Shallots are a type of plant that is widely grown in Southeast Asia and several African countries. Every household consumes shallot daily, making it a vital horticultural commodity. For example, in Indonesia, shallot consumption per capita is 15.87 g per week (Central Bureau of Statistics, 2022). Domestic demand for shallots continues to rise in tandem with population growth and the availability of various processed forms, resulting in shortages at times. Shallots are included in the seven critical commodities because they significantly impact inflation when supplies in the community are scarce (Kustiari, 2017).

Bulb scarcity occurs due to purchasing competition between farmers and household consumers. As a result, using shallot botanical seeds is a viable solution to this issue. However, cultivating shallots through seeds encounters several challenges, including unsynchronized seed growth and poor seedling quality, which impacts the percentage of seedlings that survive in the field after transplanting. To improve the growth quality of shallot seedlings, seed priming can be done using plant extracts. Plant extracts are complex compounds that refer to compounds that contain active ingredients from plants (Jardin, 2015). Moringa leaf extract (MLE) is a priming agent that has been widely used. MLE is a natural biostimulant that can boost plant growth, production, and quality (Mashamaite *et al.*, 2022).

Furthermore, the influence of soil fertility is a frequently encountered issue. Excessive use of synthetic fertilizers on shallot cultivation land reduces soil quality physically, chemically, and biologically. Adding organic matter in the form of compost is one way to reduce the use of inorganic fertilizers. Compost can be produced using existing natural resources, specifically plant biomass. The Tithonia (*Tithonia diversifolia*) plant has created one type of compost. Ristanti *et al.* (2022) and Syofiani (2019) discovered that applying tithonia compost increased the production of shallots and soybeans.

Beneficial fungi, such as *Gliocladium virens*, can make compost from plant biomass. These fungi can degrade plant biomass into usable forms. A study by Dewi and Ahmad (2021) demonstrated that the fungus *Gliocladium virens* could be used as a decomposer agent, with the compost produced having organic N, P, K, and C content of 0.11%, 0.49%, 0.07%, and 37.89%, respectively. *Gliocladium virens* is also an antagonistic fungus against *Fusarium oxysporum*, the pathogen that causes shallot wilt disease. Fusarium wilt is a severe shallot disease that can stunt growth. Ramadhina *et al.* (2013) discovered that the fungus *Gliocladium* sp. is antagonistic to *Fusarium oxysporum.*

Given some of the abovementioned issues, it is necessary to research the effect of seed priming with moringa leaf extract (MLE) and the addition of tithonia compost enriched with *Gliocladium virens* on shallot survival rate and production, also incidence of Fusarium wilt.

MATERIALS AND METHODS

Location and Experimental Design

The field experiment was carried out at the Teaching Farm, Faculty of Agriculture, Hasanuddin University, Makassar. The field is located at coordinates 5° 7' 40.07"S, 119° 28' 48.94"E, at an altitude of 9 m above sea level. The observation from September to December 2022. The average daily temperature was 29.51 ± 0.55° C. The study was arranged in a two-factor factorial design in a randomized block design (RBD) with three replications. The first factor is priming, which consists of 4 levels, namely control or without priming (s0), priming with water (s1), 12.5% MLE (s2), 25% MLE (s3), and 37.5% MLE (s4). The second factor was the dosage of Tithonia compost (K), consisting of 4 levels: without compost (K0), 5 t/ha (k1), 10 t/ha (k2), and 15 t/ha (k3).

Compost Preparation

Tithonia plant biomass (*Tithonia diversifolia*) was obtained from the Teaching Farm, Faculty of Agriculture, Hasanuddin University. All parts of the plant are harvested, then chopped using a grinder to become smaller parts. The chopped biomass was allowed to wilt and dry for three days, then 100 grams of *Gliocladium virens* suspension (density 1.64×10^{11} cfu/g) was sprinkled, which was dissolved in water (100 g with 5 liters of water). One hundred grams of the fungus was applied to biomass weighing 50 kg. After being sprinkled, the biomass is mixed evenly, put in a compost bag, and left for 30 days. The chemical characteristics of Tithonia compost are described in Table 1.

Table 1. Chemical Properties of Tithonia Compost

Parameters	
pH	6,95
Carbon	12,31%
Nitrogen	0,95%
C/N Ratio	13
Phosphorus	0,14%
Potassium	0,32%
CEC	41,62 cmol/kg

Preparation of Moringa Leaf Extract (MLE)

The preparation of moringa leaf extract refers to Yaseen *et al.* (2020). The first stage is to take clean and healthy Moringa leaves. The first step is to collect clean, healthy Moringa leaves. Following that, Moringa leaves are taken, separated from the stem, and thoroughly washed with running water. After that, it was crushed in a blender with distilled water in a 1:1 (v/w) ratio. The results of the blender are then squeezed through a fine cloth and filtered through filter paper. After that, the extract is refrigerated in a sterile bottle.

Priming Process

The seed used is the Sanren F1 variety. The seeds were placed in varying concentrations of moringa leaf extract. The seed to solution volume ratio is 1:5 (W/V). Following the placement of the seeds and solution in a plastic jar, a hose connected to the aerator is inserted. The seeds were then soaked for 20 hours based on the previous lag phase determination results. The seeds are removed and dried once the priming time has ended. The seeds are sown after they have returned to their original weight.

Planting and Cultivation Process

The research area will be cleaned of any existing garbage and dirt. The pre-planting herbicide is then sprayed with the active ingredient oxyfluorfen 240 g/L. After that, make beds measuring 100 cm x 150 cm. Following that, plastic mulch was laid down and planting holes were dug. Shallot seedlings were transplanted to previously prepared beds 40 days after sowing, with one plant in each hole. Fertilization was performed by applying half of the fertilizer dose recommended by Hermanto et al. (2017). Pre-plant fertilizer used was elemental phosphate, P_2O_5, at a dose of 62.5 kg/ha, and the application was made seven days before transplanting. After transplanting, 60 kg/ha of K_2O and 90 kg/ha of N are done at 15, 30, and 45 days. Harvesting occurs when the plants enter the harvest period and meet the harvesting criteria.

Parameters and Data Analysis

The experimental parameters included the percentage of surviving seedlings, number of bulbs per plant, bulb weight, bulb diameter, bulb production, bulb moisture, soluble solids, as well as the incidence of fusarium disease. The number of bulbs per plant, bulb weight, bulb diameter and bulb production were observed at harvest. The incidence of fusarium wilt was observed from transplanting to harvest, using a formula (1) refers to Aprilia *et al.* (2020), as follows:

$$x = \frac{a}{n} \times 100\% \qquad (1)$$

Remarks:
a = number of diseased plants and
n = total plant population

The collected data is then analyzed using variance (ANOVA) with an alpha of 0.05; if there is a significant effect, a Tukey test is performed. RStudio 4.2.1 is used for data analysis

RESULTS AND DISCUSSION

The survival of the seedling parameter shows how many seeds have successfully grown after the transplanting process. In general, seeds primed with MLE survived after transplanting (Figure 1). The average survival of seedlings in seed priming treatments with MLE at concentrations of 37.5%, 25%, and 12.5% combined with Tithonia compost was respectively 15 t/ha, 10 t/ha, and 5 t/ha, and water priming with Tithonia compost at 15 t/ha had the highest survival percentage of seedlings, namely 100%. Meanwhile, combining treatments without priming and without Tithonia compost application resulted in the lowest seedling survival percentage, 93.50%. As a priming agent, MLE acts as a biostimulant that contains many nutrients and growth regulators that can improve the quality of the seedlings. Balliu *et al.* (2017) stated that the application of biostimulants can be a solution that can improve the quality of seedlings and their resilience in adapting when transplanting is carried out. The transplanting process can cause mechanical damage, resulting in broken primary roots and root hairs due to the process of transferring seedlings from the nursery to the field. In addition, the transplanting process causes a brief shock or stress that causes slowed growth (Qui and Leskovar, 2020). The success of the seedlings in surviving after transplanting was also influenced by the addition of Tithonia compost. Adding organic matter in the form of compost improves soil characteristics. Adugna (2016) discovered that adding compost to soil can reduce soil density, increase organic matter levels, and improve soil moisture. The addition of compost can help reduce the stress that seedlings undergo after transplantation due to changes in microclimate and physical damage.

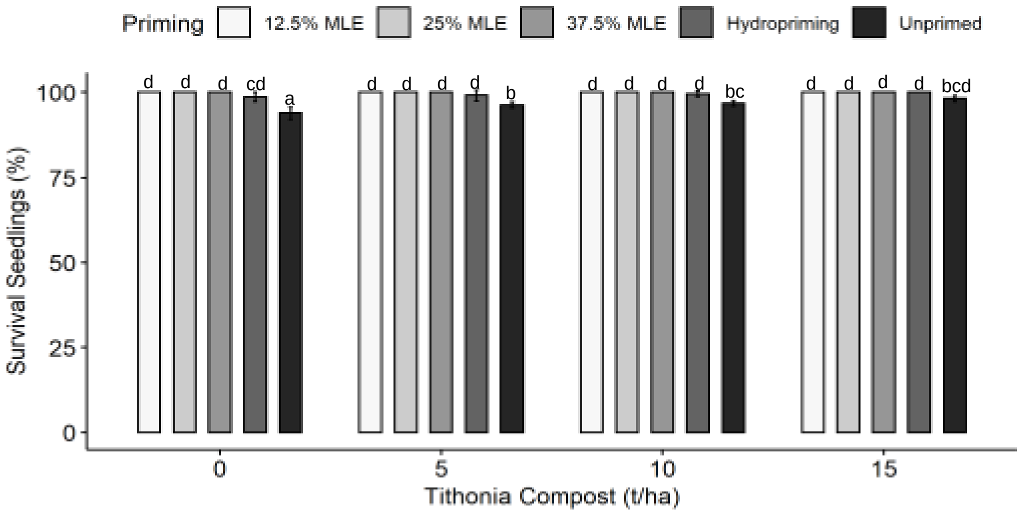

Figure 1. Percentage of survival seedlings with priming and Tithonia compost aplication

The use of MLE as a priming agent positively impacts the production of shallot plants. The higher the concentration of MLE, the better the effect on plants. The concentration of 37.5% MLE was proven to increased number of bulbs per plant (43,90%), bulb diameter (8,66%), bulb wight (55,25%) and bulb production (55,25%) compared to unprimed (Table 2). The treatment was statistically different from plants that were not primed, even with the hydropriming treatment. The increase in growth in height and number of leaves is more rapid, influenced by the nutrient content and phytohormones contained in MLE. According to Yuniati *et al.* (2020), Moringa leaf extract contains at least several nutrients and plant growth regulators: N, P, K, auxins, cytokinins, and gibberellins. As we know, some of these nutrients and phytohormones can help in the process of plant growth. Research conducted by Afzal *et al.* (2022) and Bakhtacar *et al.* (2015) found a positive impact of MLE on the growth of sunflower and maize plants at various planting times. Furthermore, Abdalla (2013) stated that MLE accelerates nutrient uptake by improving root membrane permeability and increasing the mobility of nutrients.

Table 2. Effect ff Seed Priming with Moringa Leaf Extract on Shallot Production

Treatment	Parameters			
	Number of Bulb per Plant	Bulb Diameter (mm)	Bulb Weight (g)	Bulb Production (t/ha)
Unprimed	1.64^{a}	31.96^{a}	18.26^{a}	9.47^{a}
Hydropriming	1.73^{a}	32.49^{ab}	19.73^{a}	10.23^{a}
12.5% MLE	1.98^{ab}	33.76^{abc}	24.05^{b}	12.47^{b}
25% MLE	2.14^{ab}	34.07^{bc}	24.62^{b}	12.76^{b}
37.5% MLE	2.36^{b}	34.73^{c}	28.35^{c}	14.70^{c}
Tukey	0.57	1.94	3.71	1.92

Means followed by the same letter are not significantly different for $p \leq 0.05$ according to Tukey multiple comparison test

Application of Tithonia compost enriched with *Gliocladium virens* at a dose of 15 t/ha had a significant effect on shallot production, increased number of bulbs per plant (28,73%), bulb diameter (5,56%), bulb weight (23,47%) and bulb production (27,77%) compared to unprimed (Table 3). Tithonia compost not only promotes growth and production, but it can also reduce the incidence of Fusarium disease in plantations. It was discovered that there was no Fusarium wilt incident in the 10 and 15 t/ha treatments. Due to the higher dosage, plant growth tends to be better than other Tithonia compost dosages. Tithonia compost has at least essential nutrients that can support plant growth and development. The more Tithonia compost is added, the more plant nutrients are available. The laboratory analysis showed that Tithonia compost contains at least 0.95% N, 0.14% P, and 0.32% K. The high nitrogen content can support plant growth through photosynthesis, according to Fathi (2022) stated that sufficient nitrogen for plants can maintain the balance of photosynthesis because it can increase the formation of chlorophyll. Plants deficient in nitrogen will experience a reduced capacity to form a assimilate.

The plant leaves' rapid growth is also in harmony with the rapid formation of bulbs. Regarding the number of bulbs, bulb weight, and bulb diameter, the 15 t/ha Tithonia compost gave the best results. The excellent allocation of assimilates directly influenced better bulb formation. The potassium and phosphorus content in Tithonia compost certainly has a role in forming plant bulbs. Research conducted by Junior *et al.* (2016) found that phosphorus significantly affected onion bulb formation. Moreover, Turmundi *et al.* (2019) and Pelu *et al.* (2019) also found that adding Tithonia compost can increase the growth and production of peanuts and pakchoi compared to the control.

Fusarium wilt incidence is also strongly influenced by Tithonia compost. In the treatment that was not given to Tithonia compost, some plants were found to be infected, although the number was not that large. Gliocladium virens in the compost heavily influence the low incidence of Fusarium wilt. This fungus is classified as an antagonist against the pathogen *Fusarium oxysporum*, which causes wilt in shallot plants. Research conducted by Suryaminasih *et al.* (2020) and Rahayu *et al.* (2020) found that the fungus *Gliocladium virens* has an antagonistic ability to inhibit the growth of the fungus *Fusarium oxysporum*.

Table 3. Effect of Tithonia Compost enriched with *Gliocladium virens* on Shallot Production and Disease Incidence

Dose per Hectare	Parameters				
	Number of Bulb per Plant	Bulb Diameter (mm)	Bulb Weight (g)	Bulb Production (t/ha)	Disease Incidence (%)
0 t	1.74^{a}	32.69^{a}	20.70^{a}	10.37^{a}	1.33^{a}
5 t	1.93^{ab}	33.18^{ab}	22.83^{a}	11.84^{a}	0.09^{b}
10 t	1.96^{ab}	33.58^{ab}	22.92^{a}	11.88^{a}	0.00^{b}
15 t	2.24^{b}	34.51^{b}	25.56^{b}	13.25^{b}	0.00^{b}
Tukey	0.57	1.23	2.34	1.22	1.27

Means followed by the same letter are not significantly different for $p \leq 0.05$ according to Tukey multiple comparison test.

CONCLUSİONS

Considering the findings, it is possible to conclude that seed priming with MLE and Tithonia compost enriched with *Gliocladium virens* affects the percentage of seedlings that survive after transplanting. Seed priming with 37.5% MLE and application of Tithonia compost at a dose of 15 t/ha had the most significant effect on the number of bulbs per plant, bulb weight, bulb diameter, and bulb production per hectare when used alone. At last, adding Tithonia compost enriched with *Gliocladium virens* reduced Fusarium wilt incidence.

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