The effect of gibberellins soaking duration on germination frequency and growth of true shallot seed in the nursery

A N Wahyuni*, Saidah, Muchtar, A Irmadamayanti, Syafruddin, and I S Padang

Assessment Institute of Agricultural Technology (AIAT) of Central Sulawesi
Jl. Poros Palu-Kulawi Km. 14, Maku, Dolo Sub-District, Sigi Regency, Central Sulawesi
Website: sulteng.litbang.pertanian.go.id

*Email: wahyuninirma@gmail.com

Abstract. Gibberellins are growth regulators that can increase seedling germination of true shallot seed (TSS). This study aims to determine the effect of TSS soaking duration in gibberellins solution on germination and growth of two TSS varieties. The study was conducted from May to June 2020 in Kotarindau Village, Dolo SubDistrict, Sigi Regency. The study used Factorial Randomized Block Design with 2 factors, each repeated 5 times. The first factor is Variety, consisting of Trisula and Lokananta. The second factor is the Seed Soaking Duration (T), consisting of 4 levels which are No Gibberellin Soaking, 2 hours Soaking, 4 hours Soaking, and 6 hours Soaking. To determine the effect of treatment, analysis of variance was carried out, continued with Duncan's Multiple Range Test (DMRT) at 5% when the results of variance showed significant differences. The results showed that varieties and soaking duration of TSS in gibberellins solution treatments have significant effect on the growth of TSS. The highest number of plant height and number of leaves was obtained in the treatment of Lokananta varieties with 6 hours soaking duration, but not significantly different from the treatment of the Trisula varieties with 2 hours soaking duration in the number of leaves parameters.

1. Introduction

Horticulture sub-sector is one of the strategic sub-sectors that have an important role and contribute to agricultural development. There are room for improvement because of the high resource potential. Shallot is one of the strategic commodities in horticulture sub-sector. Shallots are high-value commodities that have an important role in the Indonesian economy. Fluctuations in the amount of shallot availability and price of shallot can affect inflation [1]. Therefore, the government is trying to increase the quantity and quality of shallot production through production acceleration programs, including the development of shallots from True Shallot Seed (TSS).

One of the obstacles encountered in the cultivation of shallots from seed is low germination rate [2]. It resulted in inefficiency of TSS usage, because farmers need to use more seed than the recommended amount. Shallot seed treatment is needed to increase shallot seeds germination, which is related with increased shallot production. Treatment on seed coat, seed embryo, or a combination of seed coat and embryo aims to reactivate dormant seed cells in order to increase seed germination. Furthermore, seed treatment can be done by reducing the thickness of the skin, immersion in water, or immersion in chemicals solution [3].

Another technique to increase germination ability in TSS is the use of growth regulators. Growth regulators are hormones that play a role in promoting plant metabolism, controlling and promoting seed
Germination [4]. Gibberellic acid (GA$_3$) is one of the growth regulators that is helping to increase the growth potential of shallot seeds [5]. Gibberellin hormone plays a role in cell growth and division, breakdown dormancy, and mobilize endosperm in the early growth of seeds [6]. Soaking of shallot seeds in 100 ppm gibberellins solution for 30 minutes can increase plant height and the number of leaves [7]. Meanwhile, the immersion treatment of shallot seeds (Tuktu variety) using gibberellin solution for 4 hours could increase the percentage of germination by 85.33% [8]. Based on this, the application of gibberellins in seed treatment has a significant effect, but further research is needed on the duration of an effective soaking to increase the germination of shallot seeds.

Soaking seeds serve to soften the seed coat, so water can easily penetrate the seeds. Soaking treatment is needed on several types of seeds to facilitate the absorption of water by the seeds. Thus, a hard seed coat that prevents absorption of water becomes lyrical and lax. Furthermore, seed immersion also cleanses the seeds from pathogens that can inhibit seed germination [9]. This study aims to determine the effect of soaking duration of TSS in gibberellins solution on the growth of two TSS varieties (Lokananta and Trisula Variety) that commonly use in Indonesia.

2. Materials and Methods

2.1 Study Area

The study was conducted from May to June 2020. The study location was conducted in Kotarindau Village, Dolo Sub District, Sigi Regency. Materials that used include the seeds of two varieties of shallot, Trisula variety (from Indonesian Vegetable Research Institute) and Lokananta, variety (from PT. East West Seed Indonesia), Gibberellins, organic fertilizer, and rice husks. The tools used are hoe, measuring devices, and other supporting tools.

2.2 Methodology

Factorial Randomized Block Design with 2 factors was used. The first factor is the Variety, consisting of Trisula and Lokananta varieties. The second factor is the Soaking Duration of seeds, consisting of 4 levels: No Gibberellin Soaking, 2 Hours Soaking Duration, 4 Hours Soaking Duration, and 6 Hours Soaking Duration. Total of 100 samples were used in germination percentage parameter for each applied treatment, whilst 10 samples were used in growth component of each treatment. Each treatment was replicated 5 times.

2.3 Research Procedure

The research activities included planting preparation (including planting media preparation, application of organic fertilizer, and rice husk), seed treatment using gibberellins at 100 ppm, seed planting, application of fertilizers, maintenance, data collection and analysis.

2.4 Data Collection and Analysis

Observations were made on the percentage of seedling germination (at 7 days after planting) and the growth components including the plant height and the number of leaves (3 and 6 weeks after planting). In the percentage of seedling germination parameter, observations were made every day after treatment applied and ended after no more seeds germinated. Plant height measurements are carried out from the surface of the growing media or the base of the plant to the shoots. Meanwhile, calculation of the number of leaves done by counting the number of leaves on each plant. To determine the effect of treatment, analysis of variance was carried out with the SAS program, then continued with Duncan's Multiple Range Test (DMRT) with a level of 5% if the results of variance showed significant differences.

3. Results and Discussion

The results showed that growth of two varieties of TSS after the soaking with gibberellin’s solution at several different time durations, gave different percentage of germination. The percentage of germination obtained after treatment is shown in Table 1.
Table 1. Percentage of seedling germination of two varieties of True Shallot Seed (TSS) on different soaking duration in gibberellin’s solution at 7 days after planting

| Soaking Duration (h) | Percentage of Seedling Germination (%) |
|----------------------|----------------------------------------|
| Trisula              |                                        |
| 0                    | 58.89                                  |
| 2                    | 67.78                                  |
| 4                    | 68.89                                  |
| 6                    | 80                                     |
| Lokananta            |                                        |
| 0                    | 66.67                                  |
| 2                    | 70                                     |
| 4                    | 72.22                                  |
| 6                    | 78.89                                  |

Table 1 shows that the highest percentage of germination of shallot seeds was shown after 6 hours of gibberellin soaking on two varieties tested i.e., Trisula and Lokananta. The lowest percentage of germination is found in the treatment without soaking of gibberellin's solution. This is influenced by the concentration of gibberellins that stimulate the growth of shallot seeds. Gibberelin helps to increase the germination ability of shallot seeds. The concentration of gibberellin solution used was 100 ppm, based on the research [10] that stated the use of gibberelin at the concentration of 100 ppm gave the highest result among other treatment applied, which are 50 ppm and 200 ppm. Gibberellins is able to break seed dormancy, so the seeds can germinate and grow normally by accelerating the process of cell division. Gibberellins have two functions in the germination process, which have a role in increasing the growth potential of the embryo and as a promoter of germination and play a role in overcoming mechanical obstacles by the seed cover layer due to the presence of tissue around the radicles [11]. So, the treatment that is applied to the seeds can increase the growth power of shallot seed. Preliminary treatment aims to increase the speed and uniformity of seed germination [12].

Based on the DMRT test result on the shallots growth component showed that gibberellins soaking treatment on two varieties of TSS gave a significant effect on plant height and number of leaves. Average of growth component (plant height and number of leaves) of two varieties of TSS on different soaking duration in gibberellin’s solution shown in Table 2.

Table 2 shows that there was a significant effect on the gibberellins soaking treatment on two varieties of TSS that tested. The highest growth component of the plant height parameter was found in the treatment of the Lokananta variety at 6 hours soaking duration at each time of observation and significantly different from other treatments. In the number of leaves parameter, based on the results of the analysis shown in Table 2, showed that treatment of varieties and gibberellins soaking duration provides real interaction. The highest number of leaves was shown in the treatment of Lokananta and Trisula varieties at 6 hours soaking, but not significantly different from the treatment of the Lokananta variety at 4 hours soaking and Trisula variety at 2 hours soaking duration. Independently, the soaking duration treatment of shallot seeds in a 100 ppm gibberellin solution had a significant effect on the number of leaves. The highest average in the number of leaves parameters was found in the treatment of 6 hours soaking time. This is influenced by the gibberellins soaking duration treatment applied. Gibberellins have a role in accelerating seed germination, shoot growth, stem elongation, leaf growth, and root differentiation, thereby affecting plant growth in shallot [2]. Gibberellins also spurs the growth of plant’s number of leaves by stimulating cell division in shoots and increasing cell wall plasticity [6]. On this research, gibberellin can affect the growth component of shallot, both in Trisula and Lokananta variety. Thus, the gibberellin is needed by plants to stimulate the plant growth.
Table 2. Average of growth component of two varieties of True Shallot Seed (TSS) on different soaking duration in gibberellin’s solution

| Treatment                          | Plant Height | Number of Leaves |
|-----------------------------------|--------------|-----------------|
|                                   | 3 WAP*       | 6 WAP           | 3 WAP   | 6 WAP   |
| Variety                           |              |                 |         |         |
| Trisula                           | 15,89 b      | 32,03 b         | 2,08 a  | 4,15 a  |
| Lokananta                         | 19,15 a      | 40,05 a         | 2,15 a  | 4,28 a  |
| Soaking Duration (Hour)           |              |                 |         |         |
| 0                                 | 17,39 ab     | 32,10 b         | 2,10 a  | 3,95 b  |
| 2                                 | 16,2 b       | 36,10 ab        | 2,15 a  | 4,15 ab |
| 4                                 | 17,57 ab     | 36,00 ab        | 2,00 a  | 4,15 ab |
| 6                                 | 18,92 a      | 39,95 a         | 2,20 a  | 4,60 a  |
| Interaction                       |              |                 |         |         |
| Trisula-No soaking                | 14,58 c      | 27,20 e         | 2,00 b  | 3,70 b  |
| Trisula-2 Hours Soaking           | 16,05 c      | 32,80 d         | 2,30 ab | 4,50 a  |
| Trisula-4 Hours Soaking           | 16,5 c       | 32,60 d         | 2,00 b  | 3,80 b  |
| Trisula-6 Hours Soaking           | 16,43 c      | 35,50 cd        | 2,00 b  | 4,60 a  |
| Lokananta-2 Hours Soaking         | 20,2 ab      | 37,00 bc        | 2,20 ab | 4,20 ab |
| Lokananta-4 Hours Soaking         | 16,35 c      | 39,40 b         | 2,00 b  | 3,80 b  |
| Lokananta-6 Hours Soaking         | 18,65 b      | 39,40 b         | 2,00 b  | 4,50 a  |
| Lokananta-8 Hours Soaking         | 21,4 a       | 44,40 a         | 2,40 a  | 4,60 a  |

The number followed by the same letter in the same column is not significantly different according to DMRT test at 5%. *WAP = Weeks After Planting

Based on the study, treatments with gibberellin gave the highest result on the plant height and number of leaves. This result is in accordance with the result of the research which stated that the treatment of gibberellin acid (GA3) capable of increasing the growth component by influencing of the chlorophyll degradation [13]. Exogenous addition of hormones such as gibberellin will increase the number of cells and cell size. Gibberellin could improve fragmentation and development of cell [14]. Thus, the results of photosynthate will also increase at the beginning of plant growth which affects the acceleration of the vegetative growth process of plants and will indirectly overcome plant stunting [15]. With the addition of these hormones, the cells which were initially inactive will begin to show reactions that will cause physiological development in plants. Gibberellin helps to promote the growth phase by increasing cell division and elongation [16]. Thus, cell development is more optimal in the shallots which were given gibberellin solution treatment compared to those without gibberellin treatment. Optimization of the cell development affects shallot morphology. Thus, the physical appearance shown is higher than other treatments.

It is known that, generally, plants can produce gibberellins in every part of their growth. Gibberellins produced by plants and fungi [17]. About 80 different types of gibberellins are naturally produced by plants, however, the total amount of gibberellins produced in each plant species is relatively low [18]. So, the number of gibberellins produced is not enough to stimulate germination, especially for hard-skinned seeds. The application of soaking treatment on hard-skinned seeds such as shallot seeds is an effort needed to accelerate the germination process.

The hard seed coat will be difficult to penetrate by water and oxygen which are very important in the germination process [19]. Application of seed soaking treatment in gibberellin’s solution can soften the seed coat, making it more permeable to water and oxygen. It will also make it easier for seeds to absorb the gibberellins. Thus, the absorption of the gibberellins hormone into the seeds will stimulate the
formation of enzymes so that the process of metabolism will be more optimal. Based on the study result, the highest number on the growth component was obtained in the 6 hours soaking duration treatment (Table 2). This is influenced by a longer soaking duration will increase growth regulators absorbed by the seeds, so that it can accelerate the germination and increase the percentage of germination, which will ultimately increase plant growth. Saut [20] stated that tomato seeds of Ratna varieties soaked in gibberellin and shimarock solutions have a significant effect on germination, dry weight of normal sprouts, growth speed, maximum growth potential, and plant height. Concentration and duration of soaking in gibberellin solution also influence the percentage of Calopogonium caeruleum germination. The treatment of 500 ppm of gibberellin with 24-hours soaking duration resulted in germination percentage of 57.33% [21].

Plant growth involves gibberellins in stimulating the growth process. It can be seen in the obtained research result. The results showed that the growth components of TSS treated with gibberellin soaking produced the highest number of plant height and number of leaves compared to those without gibberellin treatment. Gibberellin helps in cell enlargement of the plant. Cell enlargement which is the effect of GA3 application is able to reach 15 times higher compared to plant growth without the presence of GA3 [22]. This cell enlargement is influenced by a decrease in the potential energy of water which causes water from outside the cell easily diffuses into the cell, so that the cell enlargement occurs. Gibberellins have a role in stimulating division, growth, and enlargement of plant cells.

Gibberellins can stimulate the formation of the amylase enzyme, where the enzyme will hydrolyze starch so the sugar content in cells will increase and causes a lot of water to diffuse into the cell, so the cells will elongate and increase the respiration rate of the seed [23].

Variety treatment gives a significant effect on plant height parameters, where the highest average of plant height was found in Trisula variety at each age of observation. This is influenced by the genetic factors of the variety. The difference in growth performance between varieties is determined by genetic factors [24]. Different plant varieties will show different growth, even if planted under the same environmental conditions. Differences in plant height between varieties can be used as a feature of a variety [25]. Each seed has the ability to grow by maximizing the use of nutrients, light, and the gibberellin hormone.

4. Conclusion
Gibberellin increased the germination rate of Trisula and Lokananta shallot seed. There was a significant effect on the treatment of varieties and soaking duration of TSS in gibberellins solution on the growth of TSS.

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