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Research Article

The Effect of Shallot Bulbs Storage Duration and Paclobutrazol Treatments to Disease Attacks on Shallot Plant in Karo Highlands

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Abstract

Background and Objective: A major challenge in the development of shallot seeds is the limited availability of qualified seed due to pathogen infection during the vegetative phase. The study aimed to determine the effect of storage duration and paclobutrazol (PBZ) treatment to the resistance of shallots crop. The study was conducted at the Berastagi Experimental Fields, Vegetable Crops Research Institute from February to May 2017. **Materials and Methods:** The experiment was arranged by randomized block design with two factors. The first factor is the bulbs storage duration, which is without storage and stored for 2 months. The second factor is PBZ treatment with levels ie 0, 0.5. 1, 1.5 and 2 mL/L. The observation parameters are the diseases percentage, diseases intensity, roots number, and roots length. **Results:** The results showed that the shallot bulbs that singly stored had a significant effect on the diseases caused by Peronospora destructor, Alternaria poor, and Fusarium wilt with low percentage category. The PBZ treatment had no significant effect on all observation variables, but the interaction with 2 months storage duration had an effect on root length at 60 days after planting (DAP).

Keywords: Downy mildew, Fusarium wilt, paclobutrazol, Purple blotch, Shallot bulbs, Storage duration.

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Introduction

Shallot (Allium cepa) is one of the popular horticultural crops, with a high economic value and high market demand throughout the year. To meet the demand of shallot, seed quality is needed to be developed during the growing season and beyond the growing season. However, commercially grown shallots have constraints include expensive seeds price, low-quality seed caused by pest and pathogen infections, and low selling cost during harvest season. This condition causes a reduction of the shallots national inventory rapidly at a high price (Mutia et al., 2015 in Eko Priyanto et al., 2016). There are two rare efforts to resolve the supply of shallot seeds continuously known as bulbs selection and bulbs storage.

Storage is one of the important post-harvest handlings, role s to ensure continuity of seed availability with acceptable quality by the market, and eventually, are expected to control the price fluctuations. To protect the shallot bulbs from fungal attack and disease expansion, before being stored the bulbs need to be dried and free from the soil so that good characteristics can be obtained (Yuti and Tian, 2013). Terms of the bulbs storage warehouse are the room temperature range between 25-30 °C with 70-80% humidity, sufficient ventilation, not mixed with any other commodity, and clean storage areas (Jasmi et al, 2013). Storage duration of shallot bulbs is the time required for the storage of bulbs, which can then be referred to a period of seeds dormancy (Karno, 2011). Shallot bulbs which ready for planting, necessary to be stored for 2-4 months depending on the shallot varieties.

To improve the quality and the storability of shallot bulbs, the plant growth regulator (PGR) which acts as retardants can be used. One of retardants substances that play a role in inhibiting the activity of gibberellin and can initiate bulbs formation is paclobutrazol (Tekalign and Hammes, 2005) and coumarin (Lolaei et al, 2015: Sumadi et al 2015). According to Ravindran and Babu (2005), another retardants compounds that commonly used to improve production and quality of bulbs is paclobutrazol (PBZ) and daminozide. Falcon et al. (2006) also report that PBZ treatment in potato plant can increase the bulbs production. In 2008, Fathonah reported that PBZ treatment with a concentration of 20 ppm can increase the production of shallot bulbs.

To find out how to increase the production quality and plant resistance to disease of shallot, we combined bulbs storage to the bulbs and PBZ treatment to the plant. This study was aimed to determine the effect of bulbs storage and PBZ treatments in suppressing the disease and improving the percentage of shallot vegetative growth in the field.

Materials and Methods

Plant Material and Culture Conditions

Local shallot cultivar was used in this study from a local plantation. The experiment was conducted with a randomized block design with 2 treatment factors and 3 replications. The first factor is the duration of shallot bulbs storage ie without storage and stored for 2 months. The second factor is PBZ treatment with several levels ie 0, 0.5. 1, 1.5 and 2 mL/L. The experiment consists of 30 experimental units. The shallot bulbs with equal size were planted in the experimental field with a row spacing of about 20 cm x 20 cm. PBZ was applied to the leaves by spraying the 42 and 56 days after planting (DAP).

Data Analysis

The observation parameters are the percentage of disease, root length, and number of tillers that observed at the age of 15, 30, 45, and 60 DAP. Measurements were made with a destructive way of uprooting the plants and measure it. The number of plants on each experiment is 20 samples. The observation data were analyzed using analysis of variance (F test) with 5% and 1% real error level, and then continued by Duncan Multiple Range Test (DMRT) at 5% error level.

Results

The results showed that the disease percentage of shallot downy mildew (Peronospora destructor), purple blotch (Alternaria porri) and fusarium wilt (Fusariumoxysporum) are not significantly affected by the interaction between the two treatment factors, bulbs storage duration, and extent PBZ treatment. Treatment of shallot bulbs that singly stored has a significant effect on the variable the root length, the number of roots, and the percentage of downy mildew, purple blotch, and fusarium wilt disease. The average observation data is varied in age 15, 30, 45, and 60 DAP, whereas the extent of PBZ treatment has no significant effect on the observation variables. There is an interaction between the bulb duration storage and PBZ treatment levels on root length at the age of 60 DAP.

Disease attack percentage on shallots plant

After 5 days of in the MS medium supplemented with BAP and NAA, the explants from male and female trees of *andaleh* were starting to break the buds (Table 1 and Fig. 1a). But, in the medium with 2.0 mg L^{-1} BAP, there was no bud break until the end of the research.

Figure 1. The highest and the lowest roots length. a. Shallot that bulbs were stored for 2 months, b. Shallot without being stored as a control.

In the treatment of shallot bulbs were stored for 2 months shows the percentage of downy mildew disease (caused by Peronospora destructor), changes at 15 DAP to 60 DAP with the lowest average reached 1:25 % to25.75%, compared to the without storage treatment that had generate percentages ie 2.75% to 37.50% at the age of 15DAP to 60 DAP.

Table 1. The effect of shallot bulbs storage and PBZ treatment to the percentage of downy mildew (Peronospora destructor) attacks at the 15,30, 45, and 60 DAP.

Treatments	Average percentage of downey mildew (*Peronospora destructor*) attacks			
	15 DAP	**30 DAP**	**45 DAP**	**60 DAP**
Storage Duration				
S0 (without storage)	2.75 b	10.50 b	28.25 b	37.50 b
S1 (2 months storage)	1.25 a	6.25 a	17.75 a	25.75 a
Average	2.00	8.37	23.00	31.62
PBZ Treatment Levels				
P0 = without treatment	4.15 ns	9.16 ns	29.25 ns	34.50 ns
P1 = 0.5 mL/L	4.21	7.50 ns	26.15 ns	29.25 ns
P2 = 1 mL/L	3.85 ns	7.25 ns	25.45 ns	27.75 ns
P3 = 1.5 mL/L	3.50 ns	6.75 ns	24.38 ns	27.05 ns
P4 = 2 mL/L	3.75 ns	6.10 ns	22.50 ns	22.48 ns
Average	3.91	7.35	25.54	28.20

Numbers followed by the same lowercase at the same column were not significantly different based DMRT

The average percentage of purple blotch attacks from 15 to 60 DAP that bulbs were stored for 2 months shows the lowest average percentage which is 0.5% to 20.65% compared to the shallot bulbs without being stored with the average percentage about 2.25% up 25.15%

Table 2. The effect of shallot bulbs storage and PBZ treatment to the percentage of purple blotch (Alternaria porri) attacks at the 15, 30, 45, and 60 DAP.

Treatments	Average percentage of purple blotch (*Alternaria porri*) attacks			
	15 DAP	**30 DAP**	**45 DAP**	**60 DAP**
Storage Duration				
S0 (without storage)	2.25 b	9.28 b	25.55 b	25.15 b
S1 (2 months storage)	0.50 a	5.14 a	14.40 a	20.65 a
Average	1.37	5.92	19.97	35.47
PBZ Treatment Levels				
P0 = without treatment	3.15 ns	6.50 ns	8.11 ns	15.40 ns
P1 = 0.5 mL/L	7.40 ns	9.15 ns	14.50 ns	19.15 ns
P2 = 1 mL/L	13.82 ns	15.02 ns	19.25 ns	25.25 ns
P3 = 1.5 mL/L	17.15 ns	28.18 ns	29.55 ns	31.50 ns
P4 = 2 mL/L	22.17 ns	28.05ns	30.50 ns	30.95 ns
Average	12.73	17.38	20.38	24.45

Numbers followed by the same lowercase at the same column were not significantly different based DMRT

The percentage of Fusarium wilt attacks represent in 15 to 60 DAP increase from 10.0% to 43.33 %compared to bulbs without being stored is 16.66% to 56.66%, which included the moderate category. This indicates that the shallot bulbs which stored for 2 months has good viability and vigor; shows from the bulbs grow ability and survive against plant diseases in the biophysical field. Shallot which is stored for 2 months through the drying process aims to eliminate the soil so that the disease does not develop, as well also as stimulate the growth of shoots and roots.

The balance between the growth of shoots and roots directly accelerate the absorbent of macro and micronutrients that available in the soil to initiate the photosynthesis process, the photosynthates will be translocated to all parts of the plant to spur the development of vegetative and generative phase(Hamli et al., 2015 in Burhanuddin and Nurmansyah, 2002). According to Sadjad et al. (1999) in Priyantono et al. (2013), that the seeds which have high vigor cause a rapid enzymatic reactivity process so that growth and metabolism process is not hampered. Optimal growth will produce a strong plant tissue so that effect to the low intensity of the disease.

Table 3. The effect of shallot bulbs storage and PBZ treatment to the percentage of fusarium wilt (Fusarium oxysporum) attacks at the 15, 30, 45, and 60 DAP.

Treatments	**Average percentage of Fusarium Wilt (*Fusarium oxysporum*) attacks**			
	15 DAP	**30 DAP**	**45 DAP**	**60 DAP**
Storage Duration				
S0 (without storage)	16.66 b	43.33 b	53.33 b	56.66 b
S1 (2 months storage)	10.00 a	30.00 a	36.66 a	43.33 a
Average	13.33	36.65	43.49	49.99
PBZ Treatment Levels				
P0 = without treatment	3.33 ns	10.00 ns	23.33 ns	43.33 ns
P1 = 0.5 mL/L	6.66 ns	13.33 ns	33.33 ns	56.66 ns
P2 = 1 mL/L	6.66 ns	10.00 ns	33.33 ns	56.66 ns
P3 = 1.5 mL/L	13.33 ns	16.66 ns	43.33 ns	56.66 ns
P4 = 2 mL/L	16.66 ns	33.33 ns	43.33 ns	66.63 ns
Average	9.32	16.66	35.33	55.92

Numbers followed by the same lowercase at the same column were not significantly different based DMRT

Plants Vegetative Growth

Root length reveals major vegetative organs for growth and development of plants and plant resistance to disease. The roots play a role to absorb nutrients that plant is needed. Based on the analysis of variance results showed that the shallot seeds stored singly had a significant effect on root length at the 15 to 45 DAP, but at 60 DAP two treatments as singly treatment did not significantly affect the root length. There is an interaction between the two treatments on the 60 DAP observation (Table 4 and Table 5).

In the treatment of shallot bulbs were stored for 2 months shows the highest average change of the root length at the 15 to 45 DAP ie 6:40 to 12:57 cm compared shallot bulbs without being stored are 6:40 until 10:43 cm. This indicates that storage duration during 2 months can induce the bulbs to germinate and when it has been planted the root will rapidly grow. ill be rapid. This also indicates that the long roots have a great reserve food forming epicotyl and bigger and stronger radical system. According to Sutopo (2002) in Komalasar (2015), reserve food and bulbs storage are correlated to extend the plants roots.

Table 4. The effect of shallot bulbs storage and PBZ treatment to the percentage of root length at the 15, 30, 45, and 60 DAP.

Treatments	Average percentage of Fusarium Wilt (*Fusarium oxysporum*) attacks			
	15 DAP	**30 DAP**	**45 DAP**	**60 DAP**
Storage Duration				
S0 (without storage)	6.40 a	9.24 a	10.43 a	14.27 ns
S1 (2 months storage)	7.75 b	11.40 b	12.57 b	14.54 ns
Average	7.07	10.32	11.50	14.40
PBZ Treatment Levels				
P0 = without treatment	7.80 ns	9.77 ns	12.30 ns	14.54 ns
P1 = 0.5 mL/L	7.18 ns	10.11 ns	12.16 ns	14.18 ns
P2 = 1 mL/L	8.83 ns	11.08 ns	11.52 ns	14.71 ns
P3 = 1.5 mL/L	8.02 ns	10.71 ns	11.99 ns	14.33 ns
P4 = 2 mL/L	7.41 ns	10.66 ns	10.80 ns	14.26 ns
Average	7.84	10.46	11.75	14.40

Numbers followed by the same lowercase at the same column were not significantly different based DMRT

Table 5. The effect of interaction between shallot bulbs storage and PBZ treatment to the percentage of root length at the 60 DAP.

Bulbs Storage Duration	Root length (cm) in each PBZ treatment				
	P0	**P1**	**P2**	**P3**	**P4**
S0 = without storage	6.75 bc	9.04 b	8.50 b	5.83 bc	6.15 bc
S1 = 2 months stored	12.10 a	10.75 ab	11.45ab	7.07 b	5.0a5 c
CV (%)			15:02		

Numbers followed by the same lowercase at the same column were not significantly different based DMRT

Root length observation data showed an interaction between bulbs storage duration and PBZ treatment level at the 60 DAP (Table 5). This means a combination of bulb storage duration and the PBZ treatment level has a real different influence. On the root length, the highest average was obtained on shallot bulbs were stored for 2 months without being treated with PBZ (S1P0), is 12.10 cm. While the lowest roots length is the treatment of shallot bulbs were stored for 2 months with a level of PBZ 2 mL/L. This indicates that the formation of Rosset thus inhibiting the canopy and root growth but did not inhibit cell division.

The interaction of shallot bulbs that storage for 2 months with 2 mL/L PBZ treatment can decrease the length of the roots. Similar results were obtained in Watsonia culture (Ascough et al 2008) which causes plant canopy to be stunted and roots growth to be short (Figure 1).

Total Root Number

Based on the analysis of variance showed that the number of roots was not influenced by the interaction between storage duration and PBZ treatment level on shallot plant. The shallot seeds stored singly had a significant effect to the number of tillers was observed at 15, 30, 45 and 60 DAP, whereas the PBZ treatment level had no significant effect on the number of roots (Table 6).

In the treatment of shallot bulbs were stored for 2 months showed the highest average change of roots number at the 15 to 60 DAP ie 26.43 to 210.71, compared shallot bulbs without storage ie 17.66 to 120.59. This shows that the stored bulbs are able to increase the vigor, which indicated with active metabolism and secondary roots growth. According to Merhar et al (2003), that the seeds after two weeks of storage, as well as four weeks, can improve seed vigor, metabolism and secondary roots.

Table 6. The effect of shallot bulbs storage and PBZ treatment to the percentage of roots number at the 15, 30, 45, and 60 DAP.

Treatments	Average percentage of Fusarium Wilt (*Fusariumoxysporum*) attacks			
	15 DAP	**30 DAP**	**45 DAP**	**60 DAP**
Storage Duration				
S0 (without storage)	17.68 b	40.76 b	73.35 b	120.59 b
S1 (2 months storage)	26.43 a	26.43 a	103.39 a	210.71 a
Average	22.05	72.24	88.37	165.65
PBZ Treatment Levels				
P0 = without treatment	22.68 ns	49.47 ns	93.12 ns	126.52 ns
P1 = 0.5 mL/L	20.16 ns	49.28 ns	100.20 ns	131.32 ns
P2 = 1 mL/L	23.93 ns	58.47 ns	80.79 ns	136.08 ns
P3 = 1.5 mL/L	23.22 ns	58.47 ns	90.85 ns	234.73 ns
P4 = 2 mL/L	20.29 ns	55.57 ns	765.88 ns	233.94 ns
Average	22.05	54.28	88.36	172.51

Numbers followed by the same lowercase at the same column were not significantly different based DMRT

Conclusions

Treatment of shallot bulbs that singly stored has a significant effect on the percentage of shallot disease (downy mildew, purple blotch, and fusarium wilt), the length of roots, and the number of roots. PBZ treatment did not have a significant effect on the observed variables. The interaction between storage shallot bulbs with PBZ treatment against root length at the 60 DAPS.

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