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Application of *Trichoderma harzianum* in Breaking Dormancy and Growing Porang (*Amorphophallus muelleri* Blume.) Bulbil Buds

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Abstract
Propagation of porang through bulbil is considered effective, but it has the drawback of relatively long dormancy period. *Trichoderma harzianum* can stimulate IAA production through the tryptophan biosynthesis pathway. This study aims to describe the effect of *Trichoderma harzianum* in breaking dormancy and promoting the growth of porang bulbil shoots. The method used was a factorial Randomized Block Design with three repetitions. The first factor was the concentration of *Trichoderma harzianum* (0%, 25%, 50%, and 100%), accompanied by an auxin control. The second factor was soaking duration (1 hour, 3 hours, and 6 hours). Parameters for breaking dormancy included the vigor index and sprouting time. The parameters for bud growth consisted of the number of buds, the length of the buds, and the length of the root buds. The results show that the concentration of *Trichoderma harzianum* and the duration of soaking significantly affect all parameters. The interaction between the two factors did not substantially affect the vigor index, sprouting time, and number of sprouts. However, it significantly affected the length and root length of the sprouts. The combination of 100% *Trichoderma harzianum* and 6 hour soaking duration was the optimal treatment for all parameters.

dKeywords: porang bulbil; dormancy; soaking duration; sprout growth; *Trichoderma harzianum*; agriculture
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INTRODUCTION

Porang (*Amorphophallus muelleri* Blume.) is a tuberous plant belonging to the Araceae family. It thrives in mountainous regions with loose soil and gently sloping terrain, especially where there is about 50% canopy cover. Additionally, porang can grow under the shade of teak, mahogany, sonneratia, and durian trees as long as it still receives some sunlight (Hamdhan, 2021). In open fields, porang grows at an altitude of more than 400 meters above sea level with a maximum slope of 30%, characterized by light to medium-textured, loose, fertile soil, with temperatures of 22-35°C, pH 6-7, and rainfall of 1,200 to 2,800 mm/year (Sasmita *et al*., 2021).

The content of mannan (glucomannan) in porang increases its value because glucomannan can be utilized in the health and food industries (Widari and Rasmito, 2018). In addition, the starch, fiber, protein, and fat content in porang tubers can be used as alternative food ingredients (Fatoni *et al*., 2018). Cultivating porang plants can be one of the efforts for food diversification to achieve food security in Indonesia. The highest production of porang in East Java is in Madiun Regency, with a potential yield reaching 31,557 tons in 2020. The export of porang in Indonesia in 2019 amounted to 14,545.50 tons to various export destinations ranging from Asia to Australia and Pakistan (Naomy *et al*., 2023). Based on its high export potential, the availability of porang needs to be increased to achieve a balance between production and market demand.

Bulbil is one of the vegetative organs in porang, characterized by a dark-colored protrusion that grows in the middle of the leaf branch or at the tip of the leaf branch (Harijati and Ying, 2021). Propagation of porang through bulbil is more effective than through tubers because it can be done in large quantities. At the age of 1 year, the produced tubers are still small and require another 1-2 years to produce large tubers, whereas the bulbils start falling to the ground and can be used for further propagation (Naomy *et al*., 2023). Porang is a polyembryonic plant, meaning that each seed, bulbil, or tuber can produce multiple sprout (Pusat Penelitian dan Pengembangan Porang Indonesia, 2013). There are many tubercles on the skin of the bulbil that serve as places for buds to grow (Afifi *et al*., 2019).

Although the propagation of porang through bulbil is considered effective, there is a dormancy period in the bulbil influenced by the seasons. Porang bulbil require about 4-5 months to be ready for planting (Saefudin *et al*., 2021).

Breaking the dormancy of porang bulbil outside its season needs to be done by applying Plant Growth Regulators (PGR). PGR are non-nutrient compounds from outside the plant whose quantities affect physiological processes in the plant (Abidin, 1982; Heddy, 1990). The increase in the growth of a plant is influenced by the presence of auxin in red onion extract, which plays a role in stimulating cell growth (Pratomo *et al*., 2018). Research by Hidayat *et al*. (2023) using auxin showed the best results at a concentration of 200 mg/l and a soaking duration of 180 minutes, which resulted in a sprouting time of 15.2 days. A concentration of 200 mg/l and a soaking time of 240 minutes yielded the highest vigor index value, which was 100%. A soaking duration of 240 minutes at a concentration of 200 mg/l yields the best bulbil shoot diameter of 2.96 mm.

Trichoderma harzianum is an antagonistic fungus that is often used as a biological agent to control soil pathogens, a decomposer, and a PGR stimulant. *Trichoderma harzianum* produces Indole Acetic Acid (IAA), which are plant growth and development hormones (Bader *et al*., 2020). Research by Trovicana *et al*. (2024) shows that adding Trichoderma harzianum increases chili plant production. *Trichoderma harzianum* enhances plant growth and production by stimulating plant cell development as a PGR such as IAA. *Trichoderma* strains inoculated 5 days with 1 x 10^7 conidia/ml in three repetitions showed IAA production ranging from 11.10 µg/ml-1 to 21.14 µg/ml-1. The IAA produced by *Trichoderma harzianum* control without the addition of tryptophan in its culture medium is 11.10 µg/ml-1 (Bader *et al*., 2020). Research conducted by Dalame *et al.* (2019) reported that a dose of *Trichoderma koningii* 200 g increased the vigor index by 32.964% in soursop germination despite no soaking. The results of the study by Nuari *et al*. (2023) showed that soaking Mekongga and Inpari 37 rice varieties in *Trichoderma harzianum* 30x10^6 cfu/gram yielded better results than soaking in aquades and coconut water. There was an increase in the germination percentage, averaging 92% for the Mekongga variety, while the Inpari 37 averaged 90.33% or above 80%. It is because *Trichoderma harzianum* 30x10^6 cfu/gram can produce growth hormones such as auxins and gibberellins, as well as various types of enzymes like amylase, protease, cellulase, and chitinase.

The application of *Trichoderma harzianum* in breaking dormancy and the growth of porang bulbil shoots still has limitations, so this study aims to describe the effect of *Trichoderma harzianum* as a PGR stimulant and the soaking duration in breaking dormancy and the growth of porang bulbil shoots. This research will contribute to the efforts to achieve the Sustainable Development Goals (SDGs), specifically to end hunger by increasing the cultivation of porang as a diversification of food sources..

MATERIALS AND METHODS

The research was conducted from October to December 2024, at the Biology Greenhouse, Faculty of Mathematics and Natural Sciences, State University of Surabaya. The design used in this study was a factorial Randomized Block Design (RBD). The first factor was the concentration of *Trichoderma harzianum*, which consisted of four levels (0%, 25%, 50%, and 100%) along with a positive control. The second factor was the duration of immersion, which consisted of 1 hour, 3 hours, and 6 hours. The research was repeated three times, resulting in 45 experimental units.

The first step was the preparation of the planting medium by sifting and drying the soil (topsoil). Then, the soil was mixed with burned rice husks in a 2:1 ratio (Prayoga *et al*., 2022). The porang bulbils were obtained from local farmers in Sumberbendo Village, Saradan District, Madiun Regency. The bulbils that had fallen to the ground were collected and weighed, and only those weighing 9 to 12 grams were selected (Prayoga *et al*., 2022).

The preparation of *Trichoderma harzianum* concentration referred to the usage standards found on the packaging, which was 200 ml per 14 L of water or 14 ml per liter of water. The IAA content in *Trichoderma harzianum* was 11.10 µg/ml^{-1} (Bader *et al*., 2020). Thus the following formula was obtained:

a. Concentration 100% *Trichoderma harzianum* (equivalent to IAA 100 mg/L):

$$Comparison\ ratio = \frac{100\ mg/L\ (synthetic\ IAA)}{11{,}1\ mg/L\ (IAA\ Trichoderma\ harzianum)} = 9{,}009$$

Concentration 100% = standard usage × comparison ratio
= 14 ml/L × 9,009 = 126,13 ml/L

b. Concentration 50% *Trichoderma harzianum*

Concentration 50% = $\frac{50}{100} \times 126{,}13\ ml/L = 63{,}07\ ml/L$

c. Concentration 25% *Trichoderma harzianum*
Concentration 25% = $\frac{25}{100} \times 126{,}13\ ml/L = 31{,}53\ ml/L$
d. Concentration 0% *Trichoderma harzianum*
Without *Trichoderma harzianum* = 0 ml/L

The application was carried out by soaking the bulbils in several concentrations of *Trichoderma harzianum*: 25% (31.53 ml/L water), 50% (63.07 ml/L water), 100% (125.13 ml/L water), and in water solution only as a control. For the auxin control, a 100 mg/L IAA solution was used with NaOH dilution, without the addition of *Trichoderma harzianum* (Juliarti *et al*., 2023). The bulbils that had been soaked with various treatments were then drained for 30 minutes and planted in polybags (Prayoga *et al*., 2022).

Bulbils were planted in groups of 5 in each polybag. The planting distance was 2 x 2 cm with the buds facing upwards (Juliarti *et al*., 2023). Bulbils were planted at a depth of 5 cm (Marlina *et al*., 2021), then covered with a thin layer of burned rice husk. The maintenance included watering every morning and weeding.

Dormancy breaking was observed with vigor index (%) over 9 days and sprouting time (Days After Planting/DAP), which was the day the first sprout grew, and the number of sprouts (sprouts). The growth of shoots was observed by the number of shoots (shoots) and the length of shoots (cm) observed on days 1-8 DAP, as well as the root length (cm) at the end of the observation when the plants were uprooted. Data were analyzed using the Two-Way ANOVA test with post-hoc Duncan test at a significance level of 5%.

RESULTS

Observation parameters for dormancy breaking include vigor index (%) and sprouting time (DAP). Then, the observation parameters for bud growth consist the number of buds (buds), bud length (cm), and root length of the buds (cm). Based on Table 1, the treatment with a concentration of *Trichoderma harzianum* 0% (water) is significantly different from the treatments with concentrations of 25% to 100% and also significantly different from the treatment with 0% concentration. The treatment with a concentration of 25% *Trichoderma harzianum* is significantly different from the treatments with concentrations of 50%, 100%, and 0%. However, there was no significant difference between the treatments with *Trichoderma harzianum* concentrations of 50%, 100%, and 0%. Furthermore, the treatment with a 1-hour soaking duration showed significantly different results compared to the 3-hour and 6-hour soaking durations, while the results between the 3-hour and 6-hour treatments were not significantly different.

Table 1. Vigor index of bulbil porang (*Amorphophallus muelleri* Blume.) at 5 DAP with various concentrations of *Trichoderma harzianum* and soaking duration

Soaking Duration	Concentration of *Trichoderma harzianum**					Average
	0% (K1)	25% (K2)	50% (K3)	100% (K4)	0% (KA)	
1 hour (L1)	26,67 ± 11,54	60 ± 20	66,67 ± 11,54	86,67 ± 11,54	73,33 ± 11,54	62,67 ± 23,74 [a]
3 hours (L2)	46,67 ± 11,54	66,67 ± 11,54	86,67 ± 11,54	93,33 ± 11,54	86,67 ± 11,54	76 ± 20,24 [b]
6 hours (L3)	60 ± 20	73,33 ± 11,54	93,33 ± 11,54	100 ± 0	93,33 ± 11,54	84 ± 18,88 [b]
Average	44,44 ± 19,43 [a]	66,67 ± 14,14 [b]	82,22 ± 15,63 [c]	93,33 ± 10 [c]	84,44 ± 13,33 [c]	

***)Notes:** Values followed by different letters in the same row are significantly different according to Duncan's test at 5% level

The treatments with different concentrations of *Trichoderma harzianum* showed significantly different results. However, there was no significant difference between the treatment of 50% *Trichoderma harzianum* concentration and 0% concentration (auxin). Furthermore, the treatments of 1-hour and 3-hour soaking durations showed no significant difference, while both were significantly different from the 6-hour treatment (Table 2).

Table 2. Sprouting time of bulbil porang (*Amorphophallus muelleri* Blume.) with various concentrations of *Trichoderma harzianum* and soaking duration

Soaking Duration	Concentration of *Trichoderma harzianum**					Average
	0% (K1)	25% (K2)	50% (K3)	100% (K4)	0% (KA)	
1 hour (L1)	6,53 ± 0,25	4,75 ± 0,44	4,05 ± 0,60	3,91 ± 0,38	4,66 ± 0,33	4,78 ± 1,02 [b]
3 hours (L2)	5,53 ± 0,30	5,29 ± 0,95	3,84 ± 0,73	3,08 ± 0,94	4,41 ± 0,62	4,43 ± 1,13 [b]
6 hours (L3)	5,2 ± 0,42	4,21 ± 0,20	3,47 ± 0,41	2,61 ± 0,34	3,58 ± 0,63	3,81 ± 0,94 [a]
Average	5,75 ± 0,66 [d]	4,75 ± 0,71 [c]	3,79 ± 0,57 [b]	3,20 ± 0,78 [a]	4,22 ± 0,63 [b]	

***)Notes:** Values followed by different letters in the same row are significantly different according to Duncan's test at 5% level

Based on Table 3, the treatment with a concentration of *Trichoderma harzianum* 0% is significantly different from the concentrations of 25%, 50%, 100%, and 0%. There were no significant differences between the treatments of *Trichoderma harzianum* concentrations of 25%, 50%, and 0%, but the 100% concentration was significantly different from the other three treatments. Furthermore, the treatments with soaking durations of 1 hour, 3 hours, and 6 hours showed significantly different results.

Table 3. Number bulbil porang shoots (*Amorphophallus muelleri* Blume.) with various concentrations of *Trichoderma harzianum* and soaking duration

Soaking Duration	Concentration of *Trichoderma harzianum**					Average
	0% (K1)	25% (K2)	50% (K3)	100% (K4)	0% (KA)	
1 hour (L1)	4,54 ± 0,18	4,83 ± 0,18	4,92 ± 0,06	5,12 ± 0,32	4,96 ± 0,06	4,87 ± 0,69[a]
3 hours (L2)	4,71 ± 0,06	5,17 ± 0,19	5,42 ± 0,19	5,83 ± 0,28	5,33 ± 0,31	5,29 ± 0,42[b]
6 hours (L3)	5 ± 0,37	5,42 ± 0,47	5 ± 0,69	5 ± 0,64	5,79 ± 0,40	5,75 ± 0,72[c]
Average	4,75 ± 0,71[c]	3,79 ± 0,57[b]	3,20 ± 0,7[a]	4,22 ± 0,63[b]	5,36 ± 0,44[b]	

***)Notes**: Values followed by different letters in the same row are significantly different according to Duncan's test at 5% level

Based on Figure 1, the concentration of *Trichoderma harzianum* at 0% is significantly different from the concentrations of 25%, 50%, 100%, and 0%. The treatment with a concentration of 25% *Trichoderma harzianum* was significantly different from the concentrations of 50%, 100%, and 0%. Then, in the treatment with a 100% concentration, there was a significant difference compared to all other concentrations. Between the treatment with a concentration of *Trichoderma harzianum* 50% and 0%, there was no significant difference. Furthermore, the treatments with soaking durations of 1 hour, 3 hours, and 6 hours showed significantly different results.

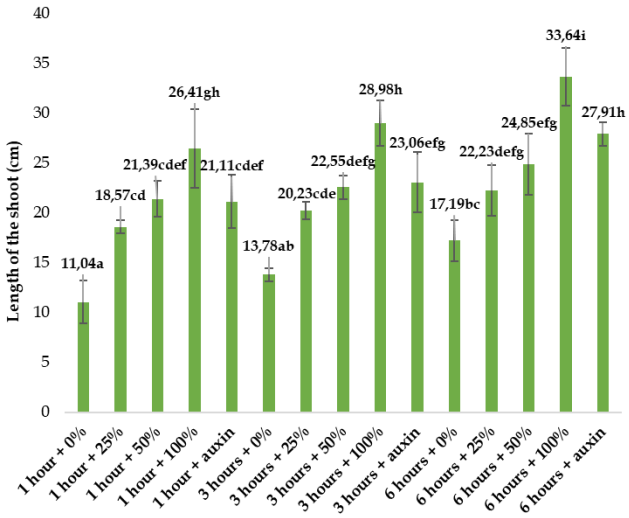

Figure 1. Length of bulbil porang shoots (*Amorphophallus muelleri* Blume.) with various concentrations of *Trichoderma harzianum* and soaking duration. Notes: Values followed by different letters above bars are significantly different according to Duncan's test at 5% level

Based on Figure 2, the treatment with a concentration of 0% *Trichoderma harzianum* is not significantly different from the 25% concentration but is significantly different from the 50%, 100%, and 0% concentrations. The treatment with a concentration of 25% *Trichoderma harzianum* did not show a significant difference compared to the 50% concentration, but it did show a significant difference compared to the 100% and 0% concentrations. Then, in the 50% concentration treatment, there was no significant difference compared to the 0% concentration. In the treatment with 100% concentration, there was a significant difference compared to the 0% concentration of both water and auxin, 25% concentration, and 50% concentration. Furthermore, the treatments with soaking durations of 1 hour, 3 hours, and 6 hours showed significantly different results.

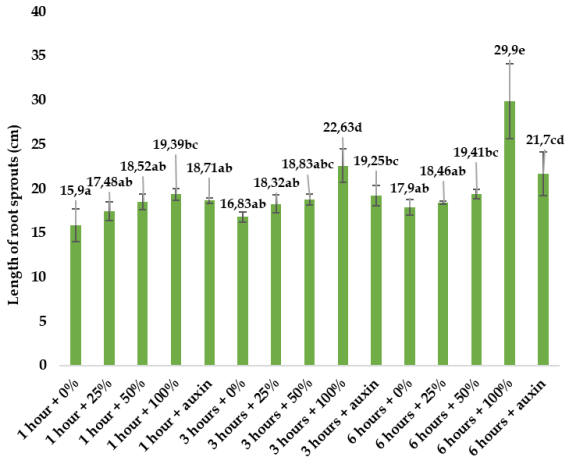

Figure 2. Length of the roots of bulbil porang sprouts (*Amorphophallus muelleri* Blume.) with various concentrations of *Trichoderma harzianum* and soaking duration. **Notes:** Values followed by different letters are significantly different according to Duncan's test at 5% level

DISCUSSION

The analysis of the vigor index is focused on 5 DAP because it is the first count based on ISTA (2010). The treatment with concentrations of *Trichoderma harzianum* at 50%, 100%, and 0% (auxin) with soaking durations of 3 hours and 6 hours achieved a porang bulbil vigor index of 86.67%-100% at 5 DAP, which was better and significantly different on average from the 0% (water) and 25% concentration treatments. This high vigor index indicates a faster, normal, and simultaneous growth ability (Noflindawati *et al*., 2017). This is supported by the presence of auxin hormones. Nuari *et al*. (2023) state that *Trichoderma harzianum* is capable of producing phytohormones such as auxins and gibberellins, as well as various types of enzymes such as amylase, protease, cellulase, and chitinase, which play a role in the metabolic activation of dormant tissues. Lytic enzymes and metabolites such as amylase can break dormancy by enhancing imbibition capacity and providing a potential energy source.

The treatment with a 100% concentration of *Trichoderma harzianum* yielded the highest vigor index, which was 100% because it contained 126.13 ml/L IAA or the equivalent of 100 mg/L synthetic IAA. Juliarti *et al*. (2023) research shows that the best percentage of porang sprout growth is produced at an auxin concentration of 100 mg/L. The results that did not differ significantly in the 50%, 100%, and 0% (auxin) treatments were because, at this point, the influence of *Trichoderma harzianum* had reached its maximum effect, so increasing the concentration further did not have a significant impact. This can be referred to as the plateau effect, where after reaching a certain dose, the plant's response does not experience significant improvement even with increased dosage (Goswami *et al*., 2022). Soaking for 6 hours resulted in the highest vigor index, which was 100%. The duration of soaking can affect the vigor of the bulbil because sufficient water is needed to initiate germination in the bulbil. The absence of a significant difference between 3-hour and 6-hour soaking indicates that imbibition and hormone absorption has reached an optimal point within 3 hours, so longer soaking does not have any further effect on the porang bulbil.

The time of bud emergence is a sign of the end of the dormancy period. Morphologically, the dormancy period of bulbil ends 20-22 weeks after harvest (WAH), marked by the appearance of shoots (Afifi *et al*., 2019). At a concentration of 100%, it shows the shortest sprouting time for porang bulbil and is significantly different from other concentrations. This is caused by *Trichoderma harzianum* stimulating the production of IAA, which is a plant growth and development hormone (Bader *et al*., 2020). The increase in the concentration of *Trichoderma harzianum* as a PGR stimulant with soaking duration will affect growth, specifically the initial emergence of shoots (Hutahayan, 2015). At a soaking duration of 6 hours, it also showed the shortest sprouting time for porang bulbil and was significantly different from the soaking durations of 1 hour and 3 hours. Longer soaking increases the permeability of the bulbil to the active compound *Trichoderma harzianum*, thereby reducing the lag phase of germination. This proves that during the early growth of the plant, longer soaking is required so that the plant can grow and develop more quickly (Gultom, 2021). However, despite this, the combination of *Trichoderma harzianum* treatment and soaking duration did not significantly affect the sprouting time of porang bulbil. This is because one of the factors, either the concentration of *Trichoderma harzianum* or the soaking duration,

has a more dominant characteristic, causing the two factors not to work synergistically. If one factor covers another factor, then the interaction shown will not be significant (Lubis *et al*., 2018).

The parameters of vigor index and sprouting time show that *Trichoderma harzianum* at a concentration of 100% yields higher results due to the stimulation of metabolic activation. A higher vigor index, such as 100%, indicates that the bulbil has a shorter sprouting time, namely 2.61 DAP. This indicates a correlation between the vigor index and the sprouting time of porang bulbil. The vigor index has a close relationship with the sprouting time because it reflects the physiological quality of the seeds in germination and growth. A higher vigor index indicates seeds with better metabolism, optimal respiration rates, and improved water absorption, thereby accelerating germination time. On the other hand, seeds with low vigor indices tend to experience delays in the germination process due to low energy reserves or the presence of inhibiting stress factors (Marcos-Filho, 2015).

The number of shoots significantly increased with the treatment of 100% *Trichoderma harzianum* concentration (Table 3), indicating the ability of *Trichoderma harzianum* to stimulate the production of phytohormones auxin and cytokinin, which induce the differentiation of apical meristem cells into adventitious shoots (Contreras-Cornejo *et al*., 2009). The higher the auxin, the more it causes cell division, stimulating the formation of shoots and thereby increasing the number of shoots in porang plants (Gultom, 2021). Auxin concentration affects growth, specifically the number of shoots (Murdaningsih *et al.,* 2019). A soaking duration of 6 hours resulted in the highest number of shoots and was significantly different from shorter soaking durations because it encouraged more optimal absorption of *Trichoderma harzianum* in the porang bulbil. The longer the immersion in auxin PGR, the more auxin is absorbed by the porang bulbil, leading to cell division that stimulates bud formation, thereby increasing the number of buds (Gultom, 2021). Although not significantly influential, the combination of *Trichoderma harzianum* concentration treatment and soaking duration can affect the number of shoots due to the presence of IAA in *Trichoderma harzianum*, which plays a role in cambium activity in cell division and tissue formation (Davies, 1995).

The highest shoot elongation in the L3K4 treatment was 33.64 cm compared to the control treatment at only 11.04 cm (Figure 1), which is related to the IAA's ability to promote cell elongation. The mechanism of action of IAA is by influencing the flexibility of the cell wall, allowing water to enter through osmosis, and promoting cell elongation. Furthermore, there is a collaboration between auxin and gibberellin that stimulates the development of vascular tissue and promotes cell division, thereby encouraging stem elongation (Rusmin, 2011). Soaking for 6 hours also optimizes *Trichoderma harzianu*m in stimulating IAA production and the secretion of hydrolytic enzymes that degrade the parenchyma cell wall, facilitating the translocation of glucose as energy to the shoot elongation zone.

The significant difference between 100% *Trichoderma harzianum* and auxin (KA) in Figure 2 indicates that *Trichoderma harzianum* not only replaces the role of auxin but also provides additional compounds such as siderophores that enhance iron availability, an important cofactor in lignin synthesis for shoot structure stability. The overall effect of *Trichoderma harzianum* on plants enhances the growth of shoots and roots (Hamdhan *et al*., 2021). The longest root length of the shoots in the L3K4 treatment, which was 29.9 cm (Figure 2), reflects the role of *Trichoderma harzianum* in modulating root growth through IAA production and increased nutrient availability. *Trichoderma* sp. acts as a decomposer, soil biological fertilizer, and parasite to other fungi with its mechanism of action being the infection of plant roots. Roots infected by *Trichoderma* sp. will grow more and enhance nutrient absorption, especially phosphorus (Musdalifah *et al.,* 2023). IAA stimulated by *Trichoderma harzianum* promotes root elongation, secondary root initiation, and root hair formation, and enhances root response in plants, thereby increasing the role of roots in nutrient absorption (Fitria *et al.,* 2021). The concentration of *Trichoderma harzianum* also increases the activity of nitrate reductase enzymes in the roots, which convert nitrate into ammonium forms that plant can use directly (Herlina, 2009). A 6-hour immersion facilitates *Trichoderma harzianum* into the bulbil tissue, inducing a systemic response that enhances the allocation of photosynthates to the roots. This mechanism is supported by the increased expression of the AUX1 and PIN1 genes, which regulate the polarity of auxin transport to the root elongation zone (Harman *et al*., 2021).

The treatment with 100% *Trichoderma harzianum* showed a significant difference compared to the water control (K1) and the auxin control (KA), indicating that *Trichoderma harzianum* not only stimulates primary root growth but also increases root hair density for nutrient absorption efficiency. *Trichoderma harzianum* can positively influence root development, growth, and plant production. This indicates the role of *Trichoderma harzianum* as a PGR (Ruslan *et al*., 2024). In this study, the number of shoots, shoot length, and root length of the shoots showed a positive correlation. The increase in one of

these parameters is followed by other parameters, which may be caused by several interrelated factors. Factors such as the availability of nutrient reserves in the bulbil play an important role in the growth of shoots. Bulbils with more shoots tend to have more food reserves, which can support the growth of shoots and roots. The more numerous and larger buds have more food reserves to stimulate bud growth. The availability of carbohydrates can be used for the cell division process obtained from the smooth activity of the apical meristem, thereby affecting growth (Febrianto *et al*., 2019). IAA is a hormone that regulates the growth of shoots and roots. Auxin produced at the tip of the shoot will move downward, stimulating cell elongation in the roots. Therefore, the longer the shoot, the more auxin is transported to the roots, promoting further growth (Taiz *et al*., 2022).

The process of breaking dormancy is continuous with the growth of buds. *Trichoderma* can stimulate the production of auxin hormones in the form of IAA (Indole Acetic Acid) through the tryptophan pathway. The role of auxin hormones is to stimulate cell elongation. The application of exogenous auxin will increase the activity of endogenous auxin, thereby promoting cell division and causing buds to appear earlier (Alfiansyah *et al*., 2015). *Trichoderma* sp. can produce lytic enzymes (Nuari *et al*., 2023). Lytic enzymes and metabolites such as amylase can break dormancy by enhancing imbibition capacity and providing a potential energy source. To end dormancy and start sprouting, an imbibition process is required so that the bulb skin will soften and cytoplasmic hydration occurs. Next, the enzymes become active, especially the enzyme amylase, which will convert food reserves (carbohydrates) into energy for cellular activity and growth (Sutopo, 2002).

The catabolic process produces energy and nutrients, which will be followed by the formation of protein compounds. Proteins play a role in the formation of new cells followed by the process of cell differentiation, resulting in the formation of buds (Supardy *et al.,* 2016). *Trichoderma harzianum* can positively influence root development, growth, and plant production. This indicates the role of *Trichoderma harzianum* as a Plant Growth Enhancer (Ruslan *et al*., 2024), with *Trichoderma harzianum* resulting in dormancy breaking and good bud growth. One of the factors that can influence the optimization of *Trichoderma harzianum*'s work in breaking dormancy and promoting the growth of porang bulbil shoots is the timing of its application. The duration of soaking affects how maximally the PGR can be absorbed by the bulbil, so an appropriate soaking duration will result in effective absorption, leading to optimal bulbil sprout growth (Tefa, 2017).

CONCLUSION

The various concentrations of *Trichoderma harzianum* and different soaking durations have a significant effect on the vigor index, sprouting time, number of shoots, shoot length, and root length of porang bulbil shoots. However, the interaction between *Trichoderma harzianum* and soaking duration only significantly affects the length of shoots and the length of shoot roots. In the cultivation through porang bulbil, to break dormancy and good sprout growth, it is recommended to use a concentration of 100% *Trichoderma harzianum* with an immersion time of 6 hours.

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