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Shoot Emergence, Leaf Expansion, and Corm Growth in *Amorphophallus muelleri* Blume Treated with Hydropriming and Shading

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ABSTRACT

A bulbil, as planting material, is difficult to stimulate to grow in a dormant state. This study examines the hydropriming effect on shoot emergence and the shading treatments on leaf and cormel growth during the vegetative stage. The priming was carried out by soaking the bulbils in distilled water for 0, 3, 6, 12, and 24 hours and the shading treatments at 0, 40, and 80 percent. The results show that the imbibition occurred immediately during the first 3 hours and continued to increase up to 24 hours. The bulbil re-drying process reached the pre-treatment water content in less than three days. Significantly the earlier emergence was observed in the plants exposed to the 80% shading. The petiole sheath breakup was not affected by the hydropriming and shading. The konjac planted in the shading treatment produced more sprouts, longer but slender petioles, larger but thinner leaves, and larger cormel size. The differences in fresh and dry weight were more related to tuber moisture content than the direct effect of the shading treatment. The SPAD value of konjac leaves immediately increased within a few days after the application of the NPK fertilizer and consistently lasted for four weeks.

INTRODUCTION

Indonesian konjac is a wild plant that grows in several places in the Indonesian archipelago (Dwiyono & Djauhari, 2021a). In Indonesia, *Amorphophallus muelleri* produces the highest amount of glucomannan compared to other genera (Harijati, Mastuti, Chairiyah, Roosdiana, & Rohmawati, 2018). This Araceae family is cultivated as a source of glucomannan, a natural biologically active substance with high economic value as a functional food and medicinal plant (Chua et al., 2012; Wahidah, Afiati, & Jumari, 2021). Konjac glucomannan (KGM) is a water-soluble fiber-rich polysaccharide suitable for diet programs (Shi et al., 2020), treating obesity (Mohammadpour et al., 2020), and lowering blood cholesterol levels (Dwiyono & Djauhari, 2021b). Konjac plants are cultivated for their tubers, where KGMs accumulate.

Although KGM has been widely used, research on the biology and cultivation of this species is still limited (Chua, Baldwin, Hocking, & Chan, 2010). The konjac plants can be cultivated using three materials: true seed, bulbils, or cormel. The reproductive organs in common plants produce the actual seed. The bulbils are unique vegetative reproductive organs that develop in certain positions, namely in leaf axils, leaflets, and leaf branches in konjac (Harijati & Ying, 2021). The cormel is a small bulb not used for food or raw materials because they are too small. Still, commercial konjac farms often use cormel instead of bulbils and true seeds as planting material because the cormel grows faster in vegetative growth (after shoot emergence).

In this study, bulbils, sourced from *porang* farmers in the Province of South Sumatra, were used as planting material, and the variety was unknown. Nurshanti et al. (2022) argue that in konjac cultivation, the use of bulbil planting material

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is the best option compared to the actual seed and cormel planting material because the bulbil emerges earlier, showing more uniform growth compared to the cormel or true seed and growing almost as fast as the cormel. It took about a month for shoot emergence after the bulbils were planted under normal conditions.

Zhao et al. (2010)Japan and South East Asia as a food source and as a traditional medicine. Flour extracted from the corm of this species is used in Far Eastern cuisine to make noodles, tofu and snacks. In traditional Chinese medicine (TCM argue that bulbils are a robust plant material because, as they grow, they are exposed to heat, rain, wind, and UV rays for a long time, sterilize them naturally. The bulbil has a 3-4 month dormancy period, which will end, indicated by the shoot growth (Afifi, Harijati, & Mastuti, 2019). Some treatments can shorten the planting materials' dormancy period, such as cormel, bulbils, and seeds (Elsadek & Yousef, 2019). Seed priming is a physiological process of controlled seed hydration to promote adequate pre-germinative metabolic processes, efficient nutrient absorption, and efficient water use, breaking dormancy under drought stress (Dawood, 2018; Hussain, Farooq, & Lee, 2017).

Priming can break dormancy by stimulating various metabolic activities and biochemical changes in the seed necessary to initiate germination (Abdallah, Musa, Mustafa, Sjahril, & Riadi, 2016). One environmentally friendly, simple, and inexpensive seed priming method is hydropriming, where the seeds are soaked in plain water and dried to their original moisture content before sowing (Singh et al., 2015). Hydropriming is a pre-germinative treatment to increase seed water content via imbibition for triggering early physiochemical metabolic processes to speed up germination after the pre-treated seeds are planted (Marthandan et al., 2020). It can also be applied to other planting materials, such as the bulbil of the konjac plant. In many seeds, the hydropriming treatment successfully fastens shoot emergence.

Konjac is a perennial crop (Hetterscheid, Heng, Zhonglang, Mekkerdchoo, & Claudel, 2020). The cultivated konjac mostly has annual growing cycles, i.e., starting from sowing the planting material, shoot emergence, development of single or multiple leaves, leaf senescence, death of shoot, and ending with corm dormancy. The konjac tubers are harvested after two or more growing cycles, depending on tuber size development (Shenglin, Xuekuan, & Purwadaria, 2020). Chua, Hocking, Chan, & Baldwin (2013) point out that the source-sink transition in the corm occurs after the leaflet emergence and ends before the leaves' complete expansion. The mobilization of KGM is initiated at the periphery of the corm and continues inwards to the center of the corm. Corm dormancy occurs during the dry season in the tropical climatic zone. Therefore, it used to be thought that the dormancy period was associated with the unavailability of water. Seeds and plants often go through abiotic stress during their life cycles under natural environments that affect growth and productivity.

At present, Indonesia has the largest area of rubber and oil palm plantation in the world (Carlson et al., 2017). There are substantial cumulative idle areas between rows of rubber trees and oil palms in the two types of plantation. Intercropping alters the composition of the soil bacterial community, leading to a relative balance of beneficial bacteria and reducing the incidence of soft rot disease (Wu et al., 2018). Plants will respond differently to growth and development to shade; this depends on the species and variety. Setiawan et al. (2021) state that shading conditions and light intensity can affect the morphology features, yields, and plant phenotypes. Jeeatid, Techawongstien, Suriharn, Bosland, & Techawongstien (2017) argue that in paprika (*Capsicum annum L.*), the plant growth, fruit yield, and capsaicin are affected by the shading conditions (Díaz-Pérez, 2013). The idle areas are situated under the canopy of the perennial crops. This study aimed to (a) examine the effects of hydropriming for shortening the dormancy period before planting and (b) evaluate the responses of konjac plants exposed to different levels of shading treatments.

MATERIALS AND METHODS

The Experimental Site, Planting Material, and Growing Substrate

The research was conducted from July to October 2021 at 104°46'44" East Longitude; 3°01'35" South Latitude with an average: air temperature of 33.37°C, air humidity of 52.14%, rainfall of 146.97 mm in the tropical lowlands during the rainy season in South Sumatra, Indonesia. The growing medium used was a mixture of topsoil and organic ameliorants in a ratio of 50:50 (v/v). The organic ameliorants used consisted of decomposed goat manure and chicken manure, rice husk charcoal, and decomposed rice husk with a basic volume ratio of 2:2:1:1.

Experimental Design and Research Procedures

This study used a split-plot design. The treatment combinations were repeated three times, each replicate consisting of three plants. The shade treatment as the main plot, composed of 0%, 40%, and 80% shade, used a 2 m x 4 m shade house with black polyethylene plastic and 4-inch PVC pipe as support, 40% and 80% density levels. Five durations of bulb soaking in the hydropriming treatment as subplots (W0) as the control without treatment, 3 hours (W1), 6 hours (W2), 12 hours (W3), and 24 hours (W4) in a plastic measuring 7 cm x 9 cm with a water ratio of 2 times the weight of the bulbil. The initial weight of bulbils was weighed before the soaking treatment. Afterwards, the soaked bulbils were wrapped in moistened cheesecloth for three days. The increase in weight reflected the amount of water absorbed by the bulbils through imbibition activity. Fresh weight changes over the three days were monitored daily. The excess water on the bulbils' surface was dried naturally, left at room temperature, and carried out indoors under bright conditions.

Bulbils were planted on day 3 after soaking at a depth of 2 cm below the surface of the media in polybags 25 cm in diameter and 30 cm high, but the polybags were only filled to 25 cm. This pot experiment was conducted outdoors. Watering was carried out when it did not rain to maintain the media moisture after the bulbils were planted. Inorganic fertilizers were applied after the whole leaf opening and during leaf enlargement 6 weeks after planting (WAP) and 10 MST. The amounts per plant at each application were 2.87 g N, 1.12 g P_2O_5, and 1.63 g K.

Data Collection and Analysis

The collected data included bulbil fresh weight gain due to imbibition (BWI), bulbil weight loss after discontinuation of hydropriming treatment (BWL), shoot emergence time (TSE), petiole midrib break (PSB), number of sprouts per bulbil (NBS), leaf thickness (LT), leaf area (LA), SPAD value (SV), petiole length (PL), petiole diameter (PD), number of bladelets (NBL), cormel diameter (CD), cormel length (CL), cormel fresh weight (CFW), cormel dry weight (CDW), cormel moisture content (CWC), longest root (LR), root fresh weight (RFW), root dry weight (RDW) and root moisture content (RWC).

The allometric measurements used digital micrometer calipers (Vernier SH20). The SPAD values were measured using a chlorophyll meter (Konica Minolta SPAD-502 Plus). The direct measurement of LA used the LIA32 program, developed by Kazukiyo Yamamoto, Nagoya University, Japan. The dry weight was obtained using an oven at 80°C for 48 hours. Light intensity measurements using a UNI-T UT383 light meter and air temperature and humidity using a UNI-T UT333, measured at 09:30, 12:30, and 15:30, were monitored twice a week. The collected data were processed and analyzed using the SAS 9.0 program (SAS Institute Inc., Cary, North Carolina, US). The significant differences among the treatment levels were tested using the Least Significant Difference (LSD) test at $P \leq 0.05$.

RESULTS AND DISCUSSION

Bulbil Imbibition Process and the Length of Immersion Time in the Hydropriming Process

In this study, the imbibition process was observed immediately (within 3 hours) after the bulbils of konjac plants were soaked in distilled water, as indicated by the increase in fresh weight of the bulbils (Fig. 1). Furthermore, the rise in bulbil moisture content was related directly to the duration of soaking, the increase varying from 2% to 4% of fresh weight, depending on the level of hydropriming treatment. The highest percentage increase was obtained in the treatment W4, i.e., after 24 hours of soaking, the bulbil moisture content increased to 4%. However, the decrease in fresh weight occurred after the bulbil soaking treatment was stopped, and the observations were made over 3 days to 3%.

3 Seed priming could control seed hydration in water or a solution with a low osmotic potential to initiate germination metabolism without a radical protrusion. The hydration treatment in hydropriming is conducted relatively short, just enough to trigger the early metabolic process to initiate germination yet prevent further root emergence, followed by re-drying the seeds to their original weight (Sher et al., 2019). However, the bulbil's fresh weight dropped below the pre-hydropriming treatment immediately after the treatments were terminated. It fell to 3% within 3 days, meaning that the bulbils of the konjac plant should have been immediately planted after the termination of the immersing treatment. The rapid drop in the bulbil water content at post-immersion treatment might have caused structural

damage to some cells in the treated bulbils. Yet, the bulbils normally grew and developed after the planting, indicating that the germination and other growth phase were not seriously affected.

Indirect Shading Effects and Probable Bulbil Dormancy

The pre-planting hydropriming treatment did not increase the shoot emergence in konjac plants, but the heavy shading treatment (80%) accelerated the shoot emergence (Table 1). On the other hand, moderate shading (40%) did not significantly affect the shoot emergence. It is currently unclear whether the increase is related directly to the low light intensity or results from the microclimate inside the shade house. The microclimate includes lower air temperature, humidity, evapotranspiration rate, and substrate water content.

The microclimate data during the study were the average air temperature without the shade was 33.65°C, the 40% shade was 33.37°C, and the 80% shade was 31.86°C. The average air humidity without the shade was 52.14%, the 40% shade was 53.33%, the 80% shade was 64.80%, and rainfall was 146.97 mm (BPS Provinsi Sumatera Selatan, 2021). The 40% shading treatment had almost the same mean temperature and air humidity values as without the shading treatment. The 80% shading treatment had the lower mean temperature and the highest mean air humidity values compared to the two treatments. This condition caused a high substrate water content that spurred the emergence of bulbil shoots. Although the heavy shade treatment (80%) slightly increased the emergence of shoots on bulbils of konjac plants, the average shoot emergence was still around 28 days. Meanwhile, based on the previous research, the bulbils in normal conditions (the bulbils stored without being treated directly by planting) the shoots appeared 30 days after planting (DAP).

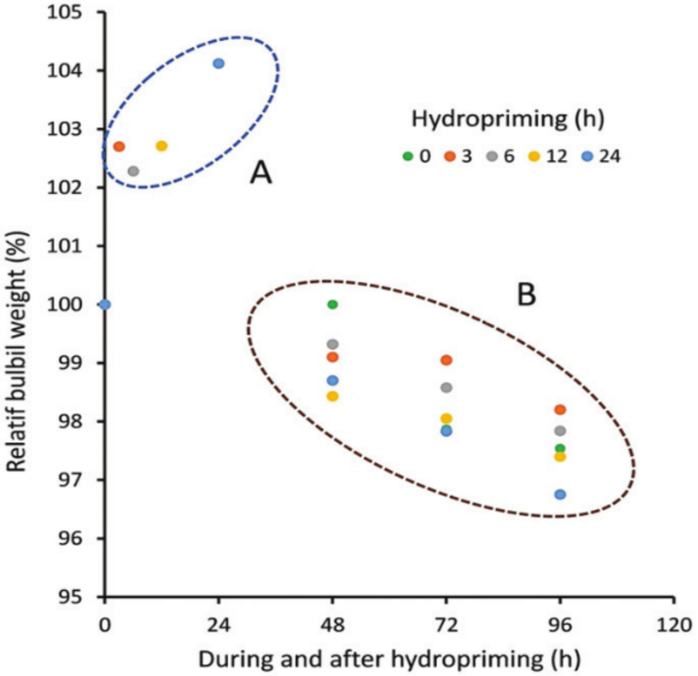


Fig. 1. Changes in water status during (A) and after (B) hydropriming treatments in bulbil of the konjac plant (*Amorphophallus muelleri*).

Table 1. Shoot emergence and petiole sheath breakup in konjac plant (*Amorphophallus muelleri*) as affected by hydropriming and shading treatments

Shading level	**Hydropriming treatment (hour)**					**Average ± SE**
(%)	**0**	**3**	**6**	**12**	**24**	
			Shoot emergence (day)			
0	31.67 ± 3.18 a	36.33 ± 1.36 a	36.00 ± 1.04 a	36.33 ± 3.94 a	34.33 ± 1.20 a	34.93 ± 0.90 a
40	29.17 ± 3.61 ab	32.67 ± 4.11 a	39.00 ± 1.53 a	33.83 ± 1.59 a	34.17 ± 1.76 a	33.77 ± 1.58 a
80	26.67 ± 1.09 b	28.50 ± 2.75 b	28.83 ± 0.83 b	29.17 ± 4.60 b	26.33 ± 1.96 b	27.90 ± 0.58 b
Average ± SE	29.17 ± 1.44 a	32.50 ± 2.26 a	34.61 ± 3.02 a	33.11 ± 2.10 a	31.61 ± 3.73 a	
LSD$_{.05}$	3.93					
			Petiole sheath breakup (day)			
0	37.00 ± 2.75 a	42.17 ± 1.20 a	42.33 ± 1.86 a	42.17 ± 3.59 a	38.50 ± 1.32 a	40.43 ± 1.12 a
40	36.00 ± 3.33 a	40.33 ± 2.42 a	43.67 ± 1.20 a	39.50 ± 1.80 a	40.33 ± 1.48 a	39.97 ± 1.22 a
80	35.67 ± 1.01 a	36.00 ± 2.60 a	35.83 ± 0.60 a	33.83 ± 4.38 a	38.00 ± 1.44 a	35.87 ± 0.66 a
Average ± SE	36.22 ± 0.40 a	39.50 ± 1.83 a	40.61 ± 2.42 a	38.50 ± 2.46 a	38.94 ± 0.71 a	

Remarks: Data was presented as mean ± standard error from 45 samples of 3 replicates, The means followed by different small letters within each column indicate significant differences among shading treatments. The means followed by similar small letters indicate insignificant differences among averages at the LSD$_{.05}$

Table 2. The average number of sprouts per bulbil in konjac plant (*Amorphophallus muelleri*) as affected by hydropriming and shading treatments

Shading level	**Hydropriming treatment (hour)**					**Average ± SE**
(%)	**0**	**3**	**6**	**12**	**24**	
			Average number of sprout/bulbil			
0	2.17 ± 0.44 b	2.17 ± 0.17 b	2.17 ± 0.17 b	2.17 ± 0.17 b	2.83 ± 0.44 ab	2.30 ± 0.13 b
40	2.17 ± 0.17 b	2.00 ± 0.50 b	1.17 ± 0.17 c	2.33 ± 0.33 b	2.33 ± 0.33 b	2.00 ± 0.22 b
80	3.67 ± 1.20 a	3.17 ± 0.44 a	2.83 ± 0.44 a	4.17 ± 0.73 a	3.17 ± 0.44 a	3.40 ± 0.23 a
Ave ± SE	2.67 ± 0.50 a	2.44 ± 0.36 a	2.06 ± 0.48 a	2.89 ± 0.64 a	2.78 ± 0.24 a	
LSD$_{.05}$	0.54					

Remarks: Data was presented as mean ± standard error from 45 samples of 3 replicates, The means followed by different small letters within each column indicate significant differences among shade treatments. The means followed by the same small letters indicate insignificant differences among averages at the LSD$_{.05}$

Under heavy shading treatment using black polyethylene nets, the temperature of the growing substrate becomes lower, humidity inside the net house increases, the evaporation rate decreases, and eventually, substrate moisture remains higher. Moreover, continuous water availability in the growing substrate enhances water uptake into the bulbil. Sher et al. (2019) report that imbibition activates cell metabolism, inhibitor metabolism, and breaking seed dormancy. Otherwise, the seed (in general) remains dormant if its water content is kept at approximately below 15% (Long et al., 2015). Baskin & Baskin (2004) clarify that the dormant seeds could not germinate within a certain period under standard physical environmental factors, i.e., water availability, temperature, light, or darkness. The seeds and bulbils may also require several exogenous cues to determine whether to break or remain dormant.

Meanwhile, neither the single treatment nor the interaction between hydropriming and shading significantly affected petiole breakage (Table 1). The petiole sheath breakup occurred 5 to 10 days after the shoot emergence. However, a longer period was observed in the konjac plant with earlier shoot emergence, i.e., 20 days, and vice versa for the plant with later shoot emergence, i.e., 40 days (Fig. 2). Therefore, higher variability during the shoot emergence was moderated by inversed time until the petiole sheath breakup.

Petiole sheath breakup did not significantly affect by both hydropriming or shading treatments. Therefore, the breakup time seems more genetically controlled than the effects of environmental factors. However, further research on this matter is necessary to be thoroughly done. Despite differences in the time of shoot emergence, the sheath breakups occurred almost simultaneously amongst the plants exposed to full sunlight, 40% or 80% shading. This finding supports the argument that petiole sheath breakup is genetically controlled. Meanwhile, Strømme, Schmidt, Olsen, & Nybakken (2019) reveal that the sheath breakup occurs early at higher temperatures under controlled conditions.

The number of sprouts per bulbil was significantly higher in the 80% shade treatment compared to the 40% shade and no shade (full direct sunlight) (Table 2). The low light intensity brought about a low evaporation rate, causing high soil moisture, which stimulated the emergence of sprouts.

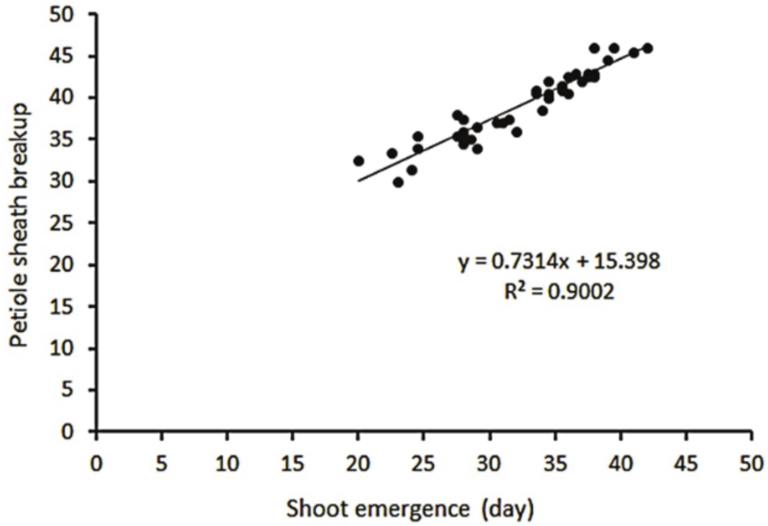


Fig. 2. Shoot emergence and petiole sheath breakup in konjac plant (*Amorphophallus muelleri*) grown using bulbil as planting material

The surface of the bulbils has many eyes called tubercles. When exposed to water, they are divided into white and black tubercles. The white tubercles can produce buds, while the black tubercles cannot (Harijati & Ying, 2021). The 80% shading level with 20% sunlight results in lower air temperature, which is associated with low soil temperature, causing the substrate moisture to remain high. This substrate condition with high water content can stimulate the emergence of bulbil buds. Each bud that emerges will uniquely develop into a compound leaf consisting of three double leaflets and can later increase to several leaflets. The petiole is thick and very long, considered a stem in most cases. The konjac plants in 80% shade produced more shoots per bulb. These results confirm that the konjac can be cultivated under conditions of low light intensity, such as between rows and under the canopy of rubber or oil palm trees.

The shading treatment at 80% significantly increased the leaf area at the expense of a decrease in leaf thickness at 40% and 80% shading (Fig. 3). The leaf blade enlargement in heavily shaded environments is a plant mechanism for capturing more sunlight. The wider the leaf, the more surface area it can absorb sunlight.

The konjac plants grown under shading conditions produce larger and thicker cormel diameters. Meanwhile, the variations in the fresh and dry weight of the cormel were more related to the water content than the shading effects. Qin et al. (2019) find that the photosynthetic capacity, plant growth (plant height, leaf width, petiole diameter, leaf area), and the tuber production of konjac plants under 50-70% shade treatment, are higher than those of konjac plants grown without shade. Appropriate shading can enhance plant growth by improving the microenvironment. Increased ambient temperature, relative humidity, and concentration can accelerate growth. Light also affects the transportation and distribution of photosynthates among plant organs. Under weak light, the proportion of photosynthate exported from the leaves decreases, and the proportion of distribution to supporting structures increases, which is beneficial for shaded plants to compete for light. This is an adaptive response, resulting in reduced photosynthate distribution to organs.

Response to NPK Fertilizer

The konjac plants were responsive to NPK fertilizer, as indicated by a continuous increase in the leaf SPAD value up to 27 days after the fertilizer application, regardless of the differences in sunlight intensity (Fig. 4). However, it was unclear why the SPAD value in plants exposed to 40% shading was lower. Meanwhile, the SPAD value of the 80% shaded plant was higher than the control plants exposed to full direct sunlight before the NPK application.

The leaf SPAD value in konjac plants immediately increased within a few days until 4 weeks after the NPK fertilizer was applied, regardless of the differences in sunlight intensity. Zhang et al. (2020) state that high rates of separated or compound-NPK increased the SPAD value, but the organic fertilizer did not increase the SPAD value in kiwi fruit. Moe, Htwe, Thu, Kajihara, & Yamakawa (2019) find similar results in rice.

The low light intensity due to the shading treatment enhanced leaf enlargement yet caused the leaf to become thinner. Rezai, Etemadi, Nikbakht, Yousefi, & Majidi (2018) state that the leaf blades of the *Salvia officinalis* plant are more significant, and the chlorophyll content are higher under 50% shading level than those of the plants grown under full sunlight. In most cases, an increase in chlorophyll content is equivalent to an increase in SPAD value. Similar results are reported by Liu et al. (2020) that the *Schima superba* is better adapted to low light conditions.

Though the shading treatments affected petiole length and diameter, the number of leaves was not affected. Under the shading conditions of both 40% and 80%, the petiole was significantly elongated but slender (Table 3). The petioles elongated significantly but became slender in konjac plants at 40% and 80% shade. According to Casal & Fankhauser (2023), plants increase the elongation of stems or petioles as a response and strategy to avoid shade in the process of growth and development. Meanwhile, different shading treatments had a significant effect on the total dry mass of leaves per tree of clove seedlings aged 24 months. Leaf dry mass decreased at 80% shade compared to 60% shade and without shade (Setiawan et al., 2022). In contrast, *Rudbeckia laciniata* plant is less responsive to the shading treatments. It does not affect the leaf area and petiole length, yet the leaf thickness and the SPAD value increase (de Queiroz, & Maricle, 2020).

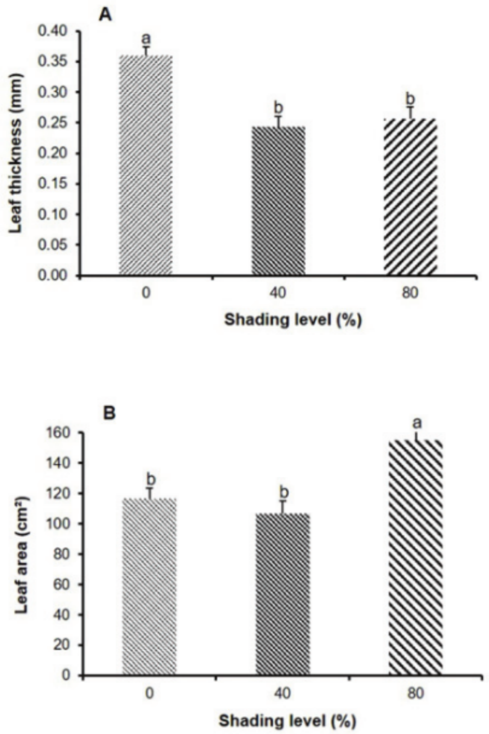
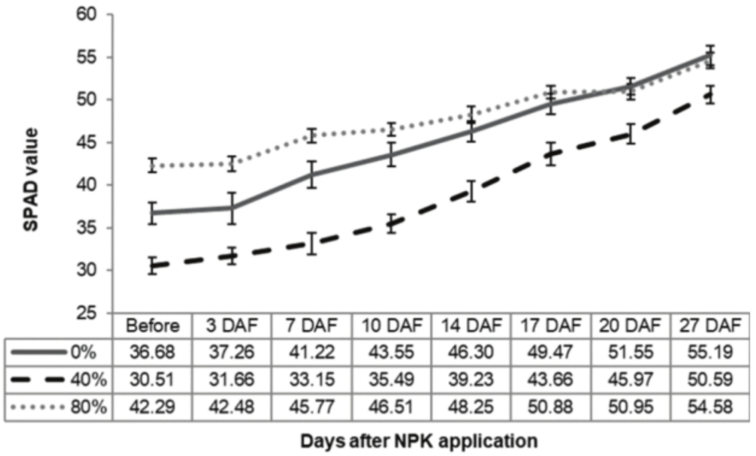


Fig. 3. Leaf thickness (A) and leaf area (B) as affected by shading treatments in the konjac plant (*Amorphophallus muelleri*)



	Before	3 DAF	7 DAF	10 DAF	14 DAF	17 DAF	20 DAF	27 DAF
—— 0%	36.68	37.26	41.22	43.55	46.30	49.47	51.55	55.19
– – 40%	30.51	31.66	33.15	35.49	39.23	43.66	45.97	50.59
····· 80%	42.29	42.48	45.77	46.51	48.25	50.88	50.95	54.58

Fig. 4. Immediate increase of SPAD value after NPK fertilizer was applied in konjac plant (*Amorphophallus muelleri*). DAF: Days after NPK application

The konjac plant adapted well to low light intensity under up to 80% shading conditions. It produced a larger cormel size, as indicated by the larger cormel diameter and thickness in the first year of cultivation (Table 4). The corm of the konjac plant was harvested after three years of cultivation.

However, the root length was not significantly different between the shaded and non-shaded plants. Meanwhile, the variation in fresh and dry weight of the shoot and cormel was more related to the water content than the effect of shading treatments (Table 5).

Table 3. Effects of shading treatments on petiole size and number of leaves in konjac plant (*Amorphophallus muelleri*)

Shading level (%)	**Petiole**		**Number of leaves**
	Length (cm)	**Diameter (mm)**	
0	9.91 ± 0.71 c	5.55 ± 0.22 a	6.43 ± 0.38 a
40	11.19 ± 0.74 b	4.86 ± 0.29 b	6.17 ± 0.55 a
80	18.78 ± 1.00 a	4.97 ± 0.15 b	6.50 ± 0.42 a
LSD$_{.05}$	1.13	0.35	

Remarks: Mean ± Standard error from 45 samples of 3 replicates. Values followed by different letters within each column are significantly different at LSD$_{.05}$

Table 4. Cormel size and root length in konjac plant (*Amorphophallus muelleri*) grown at different shading levels

Shading level (%)	Cormel		Root length (cm)
	Diameter (mm)	Thickness (mm)	
0	18.89 ± 1.81 a	16.03 ± 1.57 a	26.83 ± 3.69 a
40	16.42 ± 1.97 b	13.46 ± 1.78 b	26.36 ± 6.36 a
80	21.11 ± 1.25 a	18.11 ± 1.17 a	27.48 ± 2.95 a
LSD$_{.05}$	2.38	2.16	

Remarks: Mean ± Standard error from 45 samples of 3 replicates. Values followed by different letters within each column are significantly different at LSD$_{.05}$

Table 5. Shoot and cormel fresh weight, dry weight, and water content in konjac plant (*Amorphophallus muelleri*) grown at shading level

Shading level (%)	Fresh weight (g)	Dry weight(g)	Water content (%)
		Shoot	
0	5.34 ± 0.93 ab	0.88 ± 0.12 a	82.84 ± 2.12 a
40	4.34 ± 1.17 b	0.62 ± 0.15 b	83.78 ± 4.62 a
80	6.67 ± 1.05 a	0.74 ± 0.09 ab	87.81 ± 1.54 a
LSD$_{05}$	1.53	0.18	
		Cormel	
0	3.70 ± 0.83 a	0.64 ± 0.14 a	82.54 ± 1.11 b
40	2.44 ± 0.78 a	0.33 ± 0.14 b	87.10 ± 2.43 a
80	3.32 ± 0.58 a	0.61 ± 0.15 a	81.07 ± 3.21 b
LSD$_{.05}$		0.22	4.43

Remarks: Mean ± Standard error from 45 samples of 3 replicates. Values followed by different letters within each column are significantly different at LSD$_{.05}$

In line with the opinion of Hariyono, Ali, & Nugroho (2021), the environment is one of the determining factors in plant growth and development in addition to genetic factors. At a 75% high shading rate, the received radiation energy is lower than the radiation energy at the shade level, which is lower at 25% to affect the microclimate conditions around the plant.

CONCLUSION AND SUGGESTION

Hydropriming treatment was not effective in increasing bulbil germination. The shade of 80% slightly inhibited the emergence of shoots. The number of sprouts was higher in bulbils grown on a wetter substrate at 80% shading. The petiole rupture was not affected by hydropriming or shading treatments. The shade treatment lengthened the petiole and increased the leaf enlargement but reduced the leaf thickness. The leaf SPAD values in konjac plants immediately increased within a few days to 4 weeks after the NPK fertilizer application without regard to the differences in the shade levels. The konjac plants grown in the shade produced larger cormel. The study suggests that the bulbils planted should be in the nursery under warm and full sunlight conditions before being transplanted to the field under shaded conditions, i.e., under the canopy of rubber trees in a plantation.

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