

Effect of different seed treatments methods on the growth and yield of shallots (*Allium ascalonicum* L.)

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Abstract

Seed treatment is an effective strategy for improving seed vigor, plant establishment, and crop productivity. However, information regarding the effectiveness of peptide-based seed treatment methods on shallot (*Allium ascalonicum* L.) remains limited. This study evaluated the effects of different seed treatment methods using Golden Grow and keratin hydrolysate peptide on the growth and yield of shallots. The experiment was conducted in Songan B Village, Kintamani, Bali, Indonesia, using a randomized block design with three seed treatment methods and nine replications. The treatments consisted of: (Sa) farmers' conventional practice by cutting one-third of the bulb tip, (Sb) coating bulbs with a solution containing 1 mL Golden Grow L⁻¹ water and 2 mL peptide L⁻¹ water, and (Sc) briefly dipping bulbs in the same solution before planting. Growth variables, physiological traits, yield components, and bulb productivity were analyzed using analysis of variance followed by the least significant difference test at the 5% level. The conventional cutting treatment (Sa) produced superior vegetative growth, resulting in the highest leaf chlorophyll content (74.58 SPAD units), relative water content (87.96%), and number of leaves (53.74). In contrast, the coating treatment (Sb) consistently produced the highest yield performance, including bulb weight per clump (118.93 g), number of bulbs per clump (18.65), yield per plot (4.28 kg), and estimated yield per hectare (14.27 t ha⁻¹). These findings indicate that coating shallot bulbs with Golden Grow and keratin hydrolysate peptide is a promising seed treatment approach for enhancing yield while maintaining favorable plant growth, offering an environmentally friendly alternative for sustainable shallot production.

Keywords: *Allium ascalonicum* L; Growth; Yield; Seed Treatment

1. Introduction

Shallot (*Allium ascalonicum* L.) is one of the most economically valuable vegetable crops globally, serving as a crucial source of income for farmers and a valuable nutritional component for human consumption. However, achieving high growth and productivity remains challenging due to issues such as non-uniform seed vigor, slow early-stage growth, and environmental stresses that limit crop development and yield [1]. Consequently, enhancing seed performance prior to planting has become a vital strategy for sustainably increasing crop productivity. Among various pre-planting technologies, seed treatment has garnered increasing attention for its ability to improve seed physiological quality, accelerate germination, and support successful seedling establishment across diverse environmental conditions. Recently, peptide-based biostimulants have emerged as promising alternatives to conventional growth promoters, owing to their capacity to regulate cellular metabolism, stimulate enzymatic activity, enhance nutrient uptake, and improve plant tolerance to abiotic stress [2]. Despite these advantages, information regarding the effectiveness of various peptide-based seed treatment methods on shallot production remains limited. Furthermore, the influence of application techniques on plant growth, bulb yield, and post-harvest quality has not yet been comprehensively

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evaluated. Therefore, this study aims to examine the effects of various peptide-based seed treatment methods on the growth, yield, and quality of shallots, thereby providing scientific evidence to support the development of efficient and eco-friendly seed treatment technologies for sustainable shallot production.

2. Material and methods

This study will be conducted on farmers' fields in Songan B Village, Kintamani Subdistrict, Bangli Regency, Bali Province, and at the Agronomy Laboratory of Udayana University. The study will last for 6 months, from October 2025 to March 2026, covering preparation, planting, maintenance, observation, harvesting, post-harvest handling, and soil analysis. This study uses a one-factor randomized block design (RBD) with 9 replications. The factor used was shallot seed treatment (S), consisting of three levels, namely:

- Sa = Before planting, the seeds are treated according to the farmers' method (cutting off one-third of the tuber tip).
- Sb = Before planting, the seeds are coated with a solution of 1 ml Golden Grow per liter of water and 2 ml peptide per liter of water.
- Sc = Before planting, the seeds are briefly dipped into a solution of 1 ml Golden Grow per liter of water and 2 ml peptide per liter of water.
- Thus, with 3 treatments and 9 replicates, 27 experimental plots were required.

This study was conducted through stages comprising seed preparation and treatment, land preparation, planting, crop maintenance, harvesting, and laboratory analysis. Seed preparation involved selecting relatively uniform shallot seeds of the Basokin variety and subjecting them to the specified seed treatment levels. Land preparation included plowing followed by the application of basal fertilizer, the construction of raised beds, and the installation of silver mulch. Planting was carried out by placing shallot seeds into planting holes at the designated spacing. Crop maintenance followed Good Agricultural Practices (GAP) for shallots. Harvesting involved the random selection of 10 shallot clumps. Samples were selected using the stratified random sampling method to avoid edge effects. Laboratory analysis involved evaluating the harvest based on research variables, including bulb weight per clump, number of bulbs per clump, weight per bulb, bulb height, fresh bulb weight per clump, dry bulb weight per clump, yield per plot, yield per hectare, weight loss over four weeks, bulb moisture content per clump, and vitamin C content. The data were analyzed using Analysis of Variance (ANOVA) at a 5% significance level to determine the effect of the treatments, followed by the Least Significant Difference (LSD) test at a 5% significance level to identify differences between treatment levels.

3. Results

3.1. Leaf Chlorophyll Content and Leaf Relative Water Content

Regarding leaf chlorophyll content, the seed treatment showed the highest value for Sa (74.58 SPAD units), followed by Sb (68.88 SPAD units), with the lowest value observed in Sc (68.50 SPAD units); however, Sa did not differ significantly from the other treatments, with an 8.88% increase observed between Sc and Sa. Regarding leaf relative water content, the seed treatment showed the highest value for Sa (87.96%), followed by Sb (87.08%) and the lowest for Sc (81.10%); however, Sa did not differ significantly from the other treatments, with an increase of 8.46% observed between Sc and Sa (Table 1).

Table 1 Effect of Seed Treatment on Leaf Chlorophyll Content and Leaf Relative Water Content

Seed Treatment (S)	Leaf Chlorophyll Content (SPAD unit)	Leaf Relative Water Content (%)
Sa	87.96 a	74.58 a
Sb	87.08 a	68.88 a
Sc	81.10 a	68.50 a
LSD 5%	10.70	15.09

Note: Values followed by the same letter in the same column indicate no significant difference according to the Least Significant Difference (LSD) test at the 5% level.

3.2. Plant Height, Number of Leaves and Leaf Thickness

Regarding plant height, the seed treatment showed the highest value for Sc (44.53 cm), followed by Sb (42.04 cm), with the lowest value observed for Sa (41.43 cm); Sc did not differ significantly from the other levels, although an increase of 7.48% was observed between Sa and Sc. Regarding the number of leaves, the seed treatment showed the highest value for Sa (53.74 leaves), followed by Sb (51.70 leaves), with the lowest value observed in Sc (50.79 leaves); however, the differences among all seed treatments were not statistically significant, with an increase of 5.81% observed between Sc and Sa. Regarding leaf thickness, the seed treatment showed the highest value for Sb (4.79 mm), followed by Sc (4.25 mm), with the lowest value observed in Sa (4.23 mm); however, the differences among all seed treatments were not statistically significant, despite a 13.24% increase from Sa to Sb (Table 2).

Table 2 Effect of Seed Treatment on Plant Height, Number of Leaves and Leaf Thickness

Seed Treatment (S)	Plant Height (cm)	Number of Leaves (leaf blade)	Leaf Thickness (mm)
Sa	41.43 (6.44) a	53.74 a	4.23 (2.16) a
Sb	42.04 (6.50) a	51.70 a	4.79 (2.27) a
Sc	44.53 (6.62) a	50.79 a	4.25 (2.16) a
LSD 5%	10.60 (0.66)	4.41	1.26 (0.27)

Note: Values followed by the same letter in the same column indicate no significant difference according to the Least Significant Difference (LSD) test at the 5% level. The numbers outside the parentheses indicate the original data, while the numbers inside the parentheses indicate the

3.3. Shallot Weight per Clump, Number of Shallot per Clump and Weight

Regarding Shallot weight per clump, the seed treatment showed the highest value for Sb (118.93 g), followed by Sc (116.30 g), with the lowest value observed for Sa (106.31 g); Sb did not differ significantly from the other levels, although an increase of 11.87% was observed between Sa and Sb. Regarding the number of shallot per clump, the seed treatment showed the highest value for Sb (18.65 units), followed by Sa (17.56 units), with the lowest value observed for Sc (17.22 units); however, the difference between Sb and the other treatments was not statistically significant, with an 8.30% increase observed between Sc and Sb. Regarding seed treatment, the weight per shallot was highest for Sc (6.72 g), followed by Sb (6.34 g), and lowest for Sa (6.01 g); however, Sc did not differ significantly from the other treatments, with an increase of 11.81% observed between Sa and Sc (Table 3).

Table 3 Effect of Seed Treatment on Shallot Weight per Clump, Number of Shallots per Clump and Weight per Shallot

Seed Treatment (S)	Shallot Weight per Clump (g)	Number of Shallots per Clump (unit)	Weight per Shallot (g)
Sa	106.31 a	17.56 a	6.01 a
Sb	118.93 a	18.65 a	6.34 a
Sc	116.30 a	17.22 a	6.72 a
LSD 5%	16.97	2.06	0.87

Note: Values followed by the same letter in the same column indicate no significant difference according to the Least Significant Difference (LSD) test at the 5% level.

3.4. Yield per Plot and Yield per Hectar

Regarding yield per plot, the seed treatment showed the highest value for Sb (4.28 kg), followed by Sc (4.19 kg), with the lowest value observed for Sa (3.83 kg); Bu did not differ significantly from the other treatments, although an increase of 11.75% was observed between Sa and Sb. Regarding yield per hectare, the seed treatment Sb showed the highest value (14.27 tons), followed by Sc (13.95 tons), while Sa showed the lowest (12.76 tons); Sb did not differ significantly from the other treatments, with an 11.83% increase observed between Sa and Sb (Table 4).

Table 4 Effect of Seed Treatment on Yield per Plot and Yield per Hectar

Seed Treatment (S)	Yield per Plot (kg)	Yield per Hectar (ton)
Sa	3.83 a	12.76 a
Sb	4.28 a	14.27 a
Sc	4.19 a	13.95 a
LSD 5%	0.61	2.04

Note: Values followed by the same letter in the same column indicate no significant difference according to the Least Significant Difference (LSD) test at the 5% level.

4. Discussion

The farmer-style seed treatment involving cutting off the top third of the bulb (Sa) showed the best growth trends in terms of leaf count (53.74 leaves), leaf chlorophyll content (74.58 SPAD units), and leaf relative water content (87.96%); however, plant height was greatest with the quick-dip treatment using a solution of 1 ml Golden Grow/L water and 2 ml peptide/L water (Sc), yielding 44.53 cm, while the seed coating treatment using the same solution (Sb) showed the best result only for leaf thickness (4.79 mm). The favorable growth observed in the Sa treatment indicates that cutting the bulb tip stimulates leaf development by reducing apical dominance, thereby allowing shoots to emerge earlier than in other treatments; this aligns with research by [3], which found that cutting the top of shallot bulbs accelerates growth compared to the control. The higher leaf count in the Sa treatment suggests that the treated seeds effectively utilized photosynthates produced during photosynthesis for growth, as evidenced by the high leaf chlorophyll and relative water content. Leaf chlorophyll plays an active role in capturing solar energy for photosynthesis, a process that also requires high relative water content to serve as a substrate for the photosynthetic reaction.

Seed treatments involving coating (Sb) or quick dipping (Sc) resulted in greater leaf thickness compared to the farmers' standard method (Sa). The increased leaf thickness observed in seedlings treated with Golden Grow and peptides under both Sb and Sc methods indicates heightened metabolic activity, even though the difference was not statistically significant. This metabolic enhancement showed a sustained positive trend, evidenced by shoot fresh and dry weights as well as root fresh and dry weights, all of which tended to be higher in the Golden Grow and peptide treatments (Sb and Sc). This contrasts with the Sa treatment, which yielded higher values for leaf count, chlorophyll content, and relative leaf water content; however, at harvest, the Sb treatment produced the highest values for shoot and root fresh and dry weights. This indicates that a greater amount of photosynthate was stored and utilized for root and leaf tissue formation in the Sb treatment compared to Sa. These findings align with research by [4], which demonstrated that Golden Grow application yielded superior growth compared to the control. Similarly, a study by [5] found that removing one-third of the tuber significantly influenced plant height and dry weight per plant, indicating a reallocation of photosynthate toward the vegetative phase.

The highest yield per hectare (14.27 tons) was obtained from the seed treatment involving coating with a solution of 1 ml Golden Grow/L water and 2 ml peptide/L water (Sb). This high yield was supported by improvements in various yield components, including tuber weight per plot (4.28 kg), tuber weight per clump (118.93 g), and the number of tubers per clump (18.65 tubers). The high tuber weight and associated yield components are attributed to the synergistic positive effects of Golden Grow and peptide application on the physiological processes within the seeds. Golden Grow is known to contain Indole-3-butyric acid (IBA) a type of auxin which is highly beneficial for stimulating root and shoot formation in seeds [6]. According to [7], auxins play a role in cell division, thereby extending the water and nutrient absorption zones and regulating physiological processes related to tuber formation. The increased absorption surface area in the onion plants resulting from the seed coating treatment facilitated more optimal nutrient uptake and assisted the plants in accessing water, which is essential for photosynthesis.

Peptides used in seed coating treatments play a crucial role in increasing crop yields. These peptides contain compounds that function as nutrient sources (biofertilizers), crop protectants (bioprotectants), and growth regulators (biostimulants). Their biofertilizer function stems from the organic nitrogen (13–15%) and organic sulfur (1.6–2.0%) content found in poultry feathers, the primary raw material for the peptides. The nitrogen within the peptides promotes the formation of chlorophyll molecules in conjunction with magnesium thereby increasing the rate of photosynthesis [8]. The interaction between organic nitrogen and organic sulfur also produces a synergistic effect; according to [9], the presence of sulfur enhances nitrogen use efficiency for metabolism and boosts chlorophyll formation. Furthermore, sulfur serves as a key component in the synthesis of the amino acids cysteine, cystine, and methionine, which are

essential for building plant structures and supporting functions such as photosynthesis. Enhanced photosynthesis results in greater photosynthate production, allowing the plant to translocate these assimilates to storage organs particularly tubers ultimately leading to increased crop yields driven by the accumulation of these improved yield components.

5. Conclusion

Seed treatments resulted in varying effects on the growth and yield of shallots. The treatment following the farmers' practice cutting off one-third of the bulb tip (Ba) produced the best growth, whereas the treatment involving coating the bulbs with a solution of 1 ml Golden Grow/L water and 2 ml peptide/L water (Bb) yielded the highest results compared to the other treatments.

Compliance with ethical standards

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Disclosure of conflict of interest

No conflict of interest to be disclosed.

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