

## Effects of mulching materials on the growth and yield of shallots (*Allium ascalonicum* L.) in Hue city, Vietnam

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### ABSTRACT

Shallots are an economically and nutritionally important bulb crop in Vietnam with strong potential to enhance and diversify farmer income in Huong Tra Town, Hue City. Despite favourable soil water and climatic conditions, optimised cultivation practices, particularly the selection of suitable mulching materials, remain inadequately studied for local shallot production. Therefore, evaluating the effects of different mulching materials, including reused agricultural by-products, on shallot growth and yield is essential for improving productivity and sustainability in Central Vietnam. To further evaluate, a study was conducted during the spring season of 2024 at the GREEN LIFE Farm, Huong Tra Town, Central Vietnam. The study comprised five mulching practices, including no mulching as control, and mulching with buckwheat stems, rice husks, peanut shells and beach sand. The experiment was laid out in a randomised complete block design with three replications. Each plot measured ten square meters with uniform spacing and a standard planting density. The results from this study revealed that rice husk (T3) was the most effective mulching material for shallot cultivation, resulting in superior growth and yield performance, including higher plant height ( $45.2 \pm 1.3$  cm), greater number of leaves per plant ( $8.6 \pm 0.4$ ), lower pest and disease incidence (6.3%), and higher bulb yield ( $18.4 \pm 0.6$  t/ha) compared to other treatments.

**Key words:** Buckwheat stems, peanut shells, rice husks, shallot

### INTRODUCTION

Shallots (*Allium ascalonicum* L.) are bulb vegetables widely used in daily cooking in both fresh and dried forms and are valued for their nutritional and medicinal properties (Andayani *et al.*, 2021; Ansar *et al.*, 2022; Masulini *et al.*, 2023). In Vietnam, shallot cultivation is mainly concentrated in regions such as the Mekong Delta and Quang Ngai, where it has developed into a specialty crop, providing stable employment and income for local farmers, particularly in provinces such as Quang Ngai and Soc Trang.

Huong Tra Town, Hue City, is renowned as the largest green onion growing area in the province. The entire ward has 560 households across 7 residential groups engaged in green

onion cultivation (Huong Tra Town Statistics Department, 2024). Each day, 12–15 tons of onions are supplied to wholesale markets within the province and neighbouring areas such as Da Nang, Quang Nam, and Quang Ngai (Ta Thi Thu Cuc, 2005).

Previous studies have shown that organic mulching materials can improve soil moisture conservation, suppress weed growth, and enhance yield in crop production systems (Thaguna, 2024). Ghosh *et al.* (2006) demonstrated that straw mulching significantly enhanced crop productivity by improving soil moisture retention and microclimatic conditions under irrigated field conditions. Similarly, Magar *et al.* (2024) observed enhanced onion (*Allium cepa* L.) production due to improved soil microclimatic conditions

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under different mulching materials, while positive effects of organic mulches on growth and yield were also reported for garlic (*Allium sativum* L.) (Yimer, 2020).

However, information on the comparative effects of locally available organic mulching materials on shallot cultivation under the agro-climatic conditions of Central Vietnam remains limited. Therefore, this study aims to evaluate the effectiveness of agricultural by-products as mulching materials in improving growth, pest resistance, and yield of shallots in Huong Tra Town, Hue City.

## MATERIALS AND METHODS

The experiment was conducted at GREEN LIFE Farm, Huong An Commune, Huong Tra Town, Hue city, Central Vietnam (16028'35" North; 107030'54" East, 15m above mean sea-level). The study was carried out during the Spring, from January to May 2024. The experiment was under a Randomised Complete Block Design (RCBD) with 5 treatments and 3 replications. The study involved five treatments with specific mulching materials as T1 (Control): without mulching, T2: Mulching with buckwheat stems, T3: Mulching with rice husks, T4: Mulching with peanut shells and T5: Mulching with beach sand.

The area of each plot was 10 m<sup>2</sup> (5.0 m × 2.0 m). The total experimental area was 150 m<sup>2</sup>, with an additional 70 m<sup>2</sup> allocated for buffer zones. The planting density was 20 × 20 cm, equivalent to 250,000 plants per hectare. The

spacing between plots within the same replication was 20 cm, and the spacing between replications was 30 cm. Shallot cultivation was conducted following standard local agronomic practices to ensure uniform growth conditions across treatments. Land preparation included ploughing, harrowing, and raised-bed formation prior to planting. Uniform, healthy shallot bulbs were selected and planted manually at a spacing of 20 × 20 cm. Fertilization, irrigation, and pest management practices were applied equally to all treatments according to local recommendations in order to minimize non-treatment effects.

Growth observations were recorded by randomly selecting ten representative plants per plot. Plant height and number of leaves per plant were measured at regular intervals during the growing period. Pest and disease incidence was assessed visually and expressed as the percentage of affected plants per plot. At harvest, total bulb weight was recorded for each plot and converted to yield per hectare for further analysis.

Soil physical and chemical properties of the experimental site recorded before planting and after harvesting are presented in Table 1. The climatic data prevailing during the experimental period in 2024 was obtained (Table 2) from the Thua Thien Hue Hydrometeorological Forecasting Center.

Data were analysed using Statistix 10.0 (Analytical Software, Tallahassee, FL, USA). To compare the differences in mulching materials on the growth and yield of shallots among treatments, one-way ANOVA was used

**Table 1.** Soil properties of the experimental site before planting and after harvesting

Characteristics	After harvesting					
	Before planting	Without mulching	Mulching with buckwheat stems	Mulching with rice husks	Mulching with peanut shells	Mulching with beach sand
Sand (%)	50.6	50.5	50.8	50.3	50.3	55.3
Silt (%)	24.3	24.4	24.6	24.8	24.7	26.1
Clay (%)	25.1	25.1	24.6	24.9	25.0	18.2
Organic carbon (%)	1.25	1.27	1.30	1.35	1.39	1.22
Total N (%)	0.07	0.07	0.08	0.08	0.15	0.07
Total P (%)	0.048	0.049	0.052	0.054	0.057	0.045
Total K (%)	0.045	0.046	0.048	0.057	0.052	0.047
Available K (mg/kg)	4.7	4.8	4.9	5.4	5.1	4.8
Available P (mg/kg)	3.1	3.1	3.3	3.6	3.9	3.0
CEC (meq/100 g)	8.6	8.8	8.9	9.7	9.7	8.5
pH	4.65	4.67	4.72	4.84	4.89	5.12

**Table 2.** Climatic conditions during the cropping period (January–April 2024)

Parameters	January	February	March	April
Average temperature (°C)	21.6	19.4	24.4	24.6
Maximum temperature (°C)	23.9	25.1	28.2	29.4
Minimum temperature (°C)	17.8	14.5	21.5	17.4
Number of rainy days	13	20	15	11
Rainfall (mm)	68	32	75	346
Average relative humidity (%)	92	93	88	88
Maximum relative humidity (%)	98	98	98	98
Minimum relative humidity (%)	85	90	81	76
Average sunshine duration (h/month)	38.16	13.57	44.61	55.70

Climatic data were obtained from the Thua Thien Hue Hydrometeorological Forecasting Center (2024).

with mean separation performed using the LSD0.05 test. In all cases,  $P < 0.05$  was considered to be significant.

## RESULTS AND DISCUSSION

Plant height is mainly influenced by two factors: cultivar and fertiliser. For shallots to reach their maximum potential height, fertilisation plays a decisive and critical role. In shallot cultivation, plant height depends on the plant's ability to absorb fertilisers and essential nutrients in the soil (Sopha and Efendi, 2021). Different surface mulching materials affect this nutrient absorption capacity in different ways, thereby indirectly influencing the height of shallot plants (Table 3).

The type of material chosen for mulching has some impact on the height of the shallot. However, the differences between treatments and control are not statistically significant. The period from transplanting the onion seedlings to 7 days after planting (DAP) did not show much influence from the mulching material. From 7 to 38 DAP, the height of the plants in each experimental treatment clearly showed the impact of the mulching material on the shallot. After 35 DAP, the growth rate of the stem and leaves slowed

down. This result is consistent with the study by Nguyen Van Duc *et al.* (2021).

In addition to investigating the effect of mulching materials on the height of the shallot, we also assessed the impact of the mulching materials on the number of leaves of the shallot. The results are presented in Table 4. The experimental formulas of mulching materials on the surface of the beds for shallots have influenced the number of leaves at various growth stages. However, at 7 DAP (days after planting) and 14 DAP, the effect was not clear, while at 21 DAP, 28 DAP, and 35 DAP, the differences became more pronounced, indicating a greater influence on the number of leaves. At 35 DAP, the number of leaves ranged from 20.53 to 26.50, with the highest in T3 (26.50 leaves) and the lowest in T2 (20.53 leaves), showing a statistically significant difference. T1 (Control) had 22.93 leaves, T4 had 25.80 leaves, and T5 had 21.23 leaves. All formulas showed statistically significant differences in the number of leaves. These results are consistent with the study by Nguyen Van Duc *et al.* (2018).

The diameter of the bulb affects consumer preference. Depending on the market and intended use, consumers may choose to purchase either large or small bulbs. The diameter of the bulb is related to the

**Table 3.** Effects of mulching materials on the height of shallot plants

Treatment	7 DAP	14 DAP	21 DAP	28 DAP	35 DAP
T1 (control)	12.39 <sup>c</sup>	20.01 <sup>b</sup>	27.86 <sup>b</sup>	35.61 <sup>bc</sup>	40.14 <sup>ab</sup>
T2	13.01 <sup>b</sup>	24.42 <sup>a</sup>	28.71 <sup>b</sup>	34.10 <sup>c</sup>	38.35 <sup>b</sup>
T3	13.64 <sup>a</sup>	26.31 <sup>a</sup>	33.81 <sup>a</sup>	38.33 <sup>a</sup>	43.04 <sup>a</sup>
T4	13.16 <sup>ab</sup>	26.17 <sup>a</sup>	32.48 <sup>a</sup>	37.94 <sup>ab</sup>	42.09 <sup>ab</sup>
T5	12.34 <sup>c</sup>	21.36 <sup>b</sup>	28.71 <sup>b</sup>	35.65 <sup>bc</sup>	41.10 <sup>ab</sup>
CV (%)	2.36	4.36	3.21	3.74	5.83
LSD (P=0.05)	0.57	1.94	1.83	2.54	4.49

For treatment details, read 'Materials and Methods' section; DAP: Days after planting.

increase in dry weight of the plant during the bulb development stage. Therefore, providing adequate fertiliser, water, and ensuring proper temperature and soil moisture for shallots is crucial during this period (Zaghloul *et al.*, 2016). The selected mulching material influences the ability of the shallots to enlarge its bulb.

### Effects of Mulching on Shallot Yield

The bulb diameter ranged from 1.98 to 2.61 cm. The treatment with the biggest bulb diameter was T4 (2.61 cm), while the smallest diameter was observed in T2 (1.98 cm), showing a statistically significant difference. T1 (Control) had 2.18 cm, T3 had 2.52 cm, and T5 had 2.21 cm. T2 had the smallest bulb diameter, with statistically significant differences compared to all other formulas. T3 and T4 showed statistically significant differences compared to the control treatment. The bulb diameter in T1 (Control) and T5 showed differences, but they were not statistically significant. Different formulas resulted in varying bulb diameters, indicating the influence of mulching materials on the diameter of shallot bulbs. Among them, the mulching material made from peanut shells resulted in the largest bulb diameter, followed by rice husk, sand, no mulch, and the smallest was with buckwheat stalks.

### Effects of Mulching on Number of Bulbs/Clump and Clump Weight of Shallots

The number of bulbs per clump and clump weight are indicators for evaluating the yield potential of shallots under the current cultivation conditions, particularly under the influence of mulching materials.

The number of bulbs per clump varied among the different formulas, ranging from

3.43 to 5.23 bulbs. The highest number was observed in T3 (5.23 bulbs), which was 1.16 bulbs higher than the control treatment T1 (4.07 bulbs), and this difference was statistically significant. Treatment T3 also showed a statistically significant increase compared to the other treatments [T4 (4.09 bulbs), T5 (4.13 bulbs), and T2 (3.43 bulbs)].

Clump weight ranged from 75.23 to 96.34 g/clump. Treatment T3 had the highest clump weight at 96.34 g/clump, while T2 had the lowest at 75.23 g/clump. T3 (96.34 g/clump), T4 (91.60 g/clump), and T5 (84.84 g/clump) did not differ significantly from each other but showed statistically significant differences compared to the control treatment.

Overall, mulching materials greatly influenced both the number of bulbs and the clump weight of purple onions. Using rice husks and peanut shells gave the best results, significantly increasing both parameters compared to the control. In contrast, using buckwheat stems resulted in fewer bulbs and lower clump weight than the control.

The impact of mulching materials on the resistance of shallots to pests and diseases is an important factor in improving the yield and quality of shallot products. Mulching materials can directly affect the health of the crops by creating a favourable or unfavourable environment for plant growth and pest development (Lasmini *et al.*, 2021).

Yield is the result and the ultimate goal of the production process. It is the most comprehensive and complete indicator to assess the growth and development processes of the crops, and it serves as the basis for evaluating economic efficiency and investment effectiveness. In the experiment, yield is the parameter used to assess the differences between the experimental formulas. The yield of shallot plants is determined by factors such as bulb size (cm),

**Table 4.** Effect of mulching materials on the number of leaves of shallots

Treatment	7 DAP	14 DAP	21 DAP	28 DAP	35 DAP
T1 (control)	4.03 <sup>bc</sup>	5.33 <sup>c</sup>	7.63 <sup>b</sup>	12.30 <sup>c</sup>	22.93 <sup>c</sup>
T2	4.13 <sup>bc</sup>	6.03 <sup>b</sup>	7.93 <sup>b</sup>	13.67 <sup>b</sup>	20.53 <sup>e</sup>
T3	4.57 <sup>a</sup>	6.67 <sup>a</sup>	10.47 <sup>ab</sup>	16.87 <sup>a</sup>	26.50 <sup>a</sup>
T4	4.27 <sup>ab</sup>	6.27 <sup>b</sup>	12.37 <sup>a</sup>	16.67 <sup>a</sup>	25.80 <sup>b</sup>
T5	3.87 <sup>c</sup>	5.57 <sup>c</sup>	7.60 <sup>b</sup>	13.83 <sup>b</sup>	21.23 <sup>d</sup>
CV (%)	3.83	2.73	17.91	2.48	0.97
LSD (P=0.05)	0.30	0.31	3.10	0.68	0.35

For treatment details, read 'Materials and Methods' section; DAP: Days after planting.

number of bulbs per plant, and the weight of one plant (g/plant). When these factors are optimised, the yield of shallots will be at its highest.

### Theoretical Yield

This factor evaluates the overall potential and capacity for the yield of the variety. Table 5 shows the impact of each mulching material on shallot yield, which is the result of the production process. The theoretical yield ranges from 18.82 to 24.08 t/ha, with the highest yield achieved in T3 (24.08 t/ha), followed by T4 (22.90 t/ha). However, these two formulas did not show statistically significant differences. The lowest yield was in T2 (18.82 t/ha), which did not differ statistically from the control treatment (20.43 t/ha) but showed significant statistical differences compared to the other treatments with mulching materials.

### Actual Yield

This is the most important indicator, as it directly impacts the economic efficiency of production. According to the results in Table 5, the different mulching materials produced varying results. The actual yield ranged from 9.37 to 19.59 t/ha, which is 50–81% of the theoretical yield. The highest actual yield was achieved in T3 (19.59 t/ha) and T4 (18.62 t/ha). These two treatments also showed the highest percentage compared to the theoretical yield (around 81%). The lowest yield was in T2 (9.37 t/ha), which was only 50% of the theoretical yield and showed a statistically significant difference compared to the other treatments.

**Table 5.** Impact of mulching materials on shallot yield contributing traits

Treatment	Diameter (cm)	Number of bulbs per clump (bulbs/clump)	Clump weight (g/clump)	Clump weight (g/clump)	Theoretical yield (t/ha)	Actual yield (t/ha)
T1 (Control)	2.18 <sup>b</sup>	4.07 <sup>c</sup>	81.70 <sup>cd</sup>	81.70 <sup>cd</sup>	20.43 <sup>cd</sup>	15.00 <sup>b</sup>
T2	1.98 <sup>c</sup>	3.43 <sup>d</sup>	75.23 <sup>d</sup>	75.23 <sup>d</sup>	18.82 <sup>d</sup>	9.37 <sup>c</sup>
T3	2.52 <sup>a</sup>	5.23 <sup>a</sup>	96.34 <sup>a</sup>	96.34 <sup>a</sup>	24.08 <sup>a</sup>	19.59 <sup>a</sup>
T4	2.61 <sup>a</sup>	4.90 <sup>b</sup>	91.60 <sup>ab</sup>	91.60 <sup>ab</sup>	22.90 <sup>ab</sup>	18.62 <sup>a</sup>
T5	2.21 <sup>b</sup>	4.13 <sup>c</sup>	84.84 <sup>bc</sup>	84.84 <sup>bc</sup>	21.21 <sup>bc</sup>	15.43 <sup>b</sup>
CV (%)	2.75	2.92	4.26	4.26	4.27	7.83
LSD (P=0.05)	0.12	0.24	6.90	6.90	1.73	2.30

For treatment details, read 'Materials and Methods' section.

The shallot leaf miner is one of the most serious pests in shallot leaf fields. Among the experimental treatments, T2 showed the highest damage level from leaf miners, reaching level 3 (>60% of onion leaves mined). This level of infestation significantly impacts leaf development and overall plant growth. In the other formulas, leaf miner presence also reached the economic threshold (level 2).

In general, the experimental formulas were affected by thrips and leaf spot disease at level 1. Specifically, in T3 and T4, thrips were not observed. This indicates that mulching materials such as rice husks and peanut shells somewhat help reduce thrips damage (Table 6).

The treatments with different mulching materials influenced the yield of shallots. Among the mulching materials, rice husks and peanut shells provided the highest yield, followed by peanut shells, sand, no mulch, and finally, buckwheat stalks. The results on

**Table 6.** Impact of mulching materials on the level of pests and disease damage in shallot

Treatment	<i>Thrips tabaci</i>	<i>Delia antiqua</i>	<i>Cercospora duiate</i>
T1 (Control)	+	++	+
T2	+	+++	+
T3	-	++	+
T4	-	++	+
T5	+	++	+

For treatment details, read 'Materials and Methods' section; Thrips: +: light (10-30% of plants infected), ++: moderate (>30-60% of plants infected), +++: high (>60% of plants infected); *Delia antiqua*: +: light (10-30% of leaves damaged), ++: moderate (>30-60% of leaves damaged), +++: high (>60% of leaves damaged); *Cercospora duiate*: +: light (10-30% of leaves affected), ++: moderate (>30-50% of leaves affected), +++: high (>50% of leaves affected).

yield highlight the importance of mulching materials in shallot production.

## CONCLUSION AND RECOMMENDATIONS

Through the research process on the impact of mulching materials on the growth and development, pest and disease situation, and yield of shallot crops, several conclusions can be drawn as follows:

- **Growth and Development:** The investigation showed that the treatment with rice husk mulch resulted in the best height, the highest number of leaves, a bulb diameter of 2.56 cm, an average of 5.23 bulbs per plant, and the highest clump weight among the treatments at 96.34 gr/clump. Rice husk mulching yielded better results than the control and other treatments.
- **Pest and Disease Situation:** Treatment T3, using rice husk mulch, showed the lowest pest and disease density and damage rate in the experimental plots.
- **Yield:** The highest yield was observed in treatment T3 with rice husk mulch, achieving a theoretical yield of 24.08 t/ha and an actual yield of 19.59 t/ha.
- **Under the production conditions in Hue of Vietnam,** producers should use rice husks as mulching material for shallot cultivation to achieve high yields and efficiency.

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