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Growth Analysis of Differences in Shallot (*Allium ascalonicum* L.) Seedling Size

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Abstract. Choosing the right seed size is essential in shallot cultivation. Using good-quality seeds will increase the growth of shallots. Through growth analysis of various sizes of shallot seedlings, information will be obtained about the growth potential of shallots. This research aims to compare the growth patterns of shallot seedlings of varying sizes. The research was carried out from August to September 2023 at Br. Aseman, Sedang Village, Abiansemal District, Badung Regency, Bali and at the Plant Breeding and Seed Technology Laboratory, Faculty of Agriculture, Udayana University, Denpasar. This research used a one-factor randomized block design (RBD) with different treatment sizes of shallot seedlings, namely 3 g, 5 g, 7 g, 9 g, and 11 g. Each treatment was repeated 5 times, yielding 25 experimental units. The results showed that differences in the size of shallot seedlings very significantly influenced the initial growth of the seedlings (3-15 DAP). The heavier the weight of the shallot seeds, the higher the growth of the shallots. The plant growth analysis metrics, relative growth rate and net assimilation rate, reveal that the results do not differ significantly across observation time intervals. The treatment using seed size 11 g showed the highest increase in each parameter compared to other treatments at each observation time interval.

Keywords: plant growth analysis; shallots; shallot seed size

INTRODUCTION

Shallots (*Allium ascalonicum L.*) are one of the horticultural commodities consumed widely after chili. Shallots are a source of income for farmers, especially in fulfilling national consumption with high economic value (Baharuddin & Muhammad, 2021). In cultivation practice, shallot farmers generally use seeds they have propagated themselves or from sellers who do not use standard seed sizes, so selecting the right seed size is one of the essential things to implement in shallot cultivation. Increasing shallot growth in cultivation practices can be accompanied by the use of quality seeds (Hardiansyah & Guritno, 2022).

According to Addai & Anning (2015), the size of shallot seeds is categorized into three groups, namely, small (<5 g), medium (5-10 g), and large (>10 g). In contrast to Addai and Anning, in research conducted by Hardiansyah & Guritno (2022), the size of the seeds used was divided into three groups but with different weights, namely small-sized seeds (< 5 g), medium-sized seeds (8-10 g), and large seedlings (≥ 13 g). Differences in seed size will certainly cause differences in the growth of shallot plants. The size of the food reserves contained in the seed; the larger the seed, the more food reserves it carries, and the smaller the seed, the fewer food reserves (Rohim, 2019). Thus, in obtaining quantitative measures to follow and compare the growth of shallot plants in initial growth over time, plant growth analysis is important (Muyassir et al., 2020).

Plant growth analysis can be interpreted as a description of the components that support the understanding of the plant growth process. The decomposition of the components of the growth process is carried out based on their functions to study the role of each component in the growth process (Hunt in Sitompul, 2016). In analyzing plant growth, it is important to collect data and make notes on plant growth periodically. The purpose of plant growth analysis is to obtain data information about limiting factors in the plant growth process which is then used for the development of efforts to overcome these limiting factors. In this case, the information or data obtained is used to monitor plant growth and evaluate the success of plant cultivation (Sitompul, 2016). Thus this study aims to obtain information

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about differences in the initial growth of onion plants with various sizes of onion seedlings from time to time.

METHODS

The research was carried out from August to September 2023 at Banjar Aseman, Sedang Village, Abiansemal District, Badung Regency, Bali with coordinates 8°34'40"S 115°14'17"E which is located in the lowlands at an altitude of 101 m above sea level (asl). The oven process and measurements after the oven were carried out at the Plant Breeding and Seed Technology Laboratory, Faculty of Agriculture, Udayana University, Denpasar.

The tools used in this research include digital scales, ovens, rulers, knives, scissors and small shovels. The materials used are shallot seeds of the Bali Karet variety, envelopes, and planting media in the form of fertile soil.

This study used a one-factor randomized block design (RBD) with the treatment of differences in the weight of shallot seedlings consisting of A (3 g), B (5 g), C (7 g), D (9 g), and E (11 g). Each treatment was repeated 5 times to obtain 25 experimental units.

This research was carried out in several stages: 1) Preparation of Media and Planting Materials, 2) Planting, and 3) Maintenance. Shallot seeds were obtained from farmers in the Kelompok Tani Sejati, Songan Kintamani. Tubers that will be used for seeds include, single and healthy tubers, free from disease, without defects, seeds that have been stored for 2 months, and have seed weights according to treatment: 3 g, 5 g, 7 g, 9 g, and 11 g. Media preparation is carried out by inserting planting media in the form of fertile soil into the raised bed. This seed selection stage is carried out by weighing the seeds with a digital scale. The prepared red onion seeds must be cut off ⅓ of the tip to accelerate the growth of the bulb shoots. Labels are installed after filling the planting medium in the planting area. The labels that have been prepared are installed by the existing treatment.

Shallot seeds that have been cut ⅓ of the end are then planted in raised bed that already contains planting media. Shallot seedlings are directly planted at a depth of 3-4 cm with a planting distance of 8 cm x 8 cm per sample and do not bury the top of the cut shallot.

The maintenance carried out during the research was watering and weeding. Watering is done once a day, in the morning, until the media around the plant is wet. Weeding is carried out simultaneously while watering the plants, using a manual method by pulling out weeds that grow between the plants by hand.

The observation parameters were observed in a destructive manner which was calculated 5 times every 3 days when the plants were 3, 6, 9, 12 and 15 days old within a 15 days observation period. The parameters observed in this study were 1) Plant height (cm), 2) Number of leaves (strands), 3) Leaf area (cm^2), 4) Total plant oven dry weight (g), 5) Relative growth rate ($g\ g^{-1}\ day^{-1}$), and 6) Net assimilation rate ($g\ cm^{-2}\ day^{-1}$).

Leaf area measurements were carried out using the gravimetric method with the formula from (Kusuma, 2012) (**Equation 1**).

$$LA = \frac{TLDW}{DWSL} \times ASLP \quad ....(1)$$

Description:
LA = Leaf Area;
TLDW = Total Leaf Dry Weight;
DWSL = Dry Weight of Sample Leaf Pieces;
ASLP = Area of Sample Leaf Pieces (p x l).

Measurement of Relative Growth Rate (RGR) and Net Assimilation Rate (NAR) is carried out using the formula of (Sitompul, 2016) (**Equation 2 & 3**).

$$LPR = \frac{LnW_2 - LnW_1}{t_2 - t_1} \quad ....(2)$$

$$LAB = \frac{W_2 - W_1}{t_2 - t_1} \times \frac{Ln\,A_2 - Ln\,A_1}{A_2 - A_1} \quad ....(3)$$

Description:
RGR = Relative Growth Rate;
NAR = Net Assimilation Rate;
W_2 = Dry Weight of Plants on Observation t_2;

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W_1 = Dry Weight of Plants on Observation t_1;
t_1 = Initial Observation Time;
t_2 = Second Observation Time;
A_1 = Initial Observation Plant Leaf Area;
A_2 = Second Observation Plant Leaf Area.

The observation results were analyzed statistically using analysis of variance (ANOVA). If there is a treatment that shows a real or very real effect, then proceed with the LSD test (least significant difference) at the 5% level.

RESULTS AND DISCUSSION

Based on analysis of variance parameters of plant height, number of leaves, and leaf area, the results showed a very significant effect at time intervals of 6, 9, 12, and 15 days after plant (DAP), so further tests were needed. Plant height in the research results showed that the highest results were in treatment E (11 g) at each observation time interval (**Figure 1**), with an average of 5.55 cm (3 DAP), 7.16 cm (6 DAP), 10, 62 cm (9 DAP), 13.43 cm (12 DAP), and 21.35 cm (15 DAP) (**Table 1**). In line with the research results by Rohim (2019) which found that growing shallots from large seeds produced the highest plant height at 42 DAP planting, namely 25.5 cm, compared to the small bulb treatment which produced a height of only 22.2 cm. The increase in plant height occurs because leaf organ formation increases with age and plays a role in photosynthesis to produce biomass for plant growth and development (Sutoyo & Astutik, 2022). Apart from that, with differences in the size of shallot seeds there will of course be differences in the food reserves contained in them. At the beginning of plant growth, the food reserves in the shallot seeds will be maximized according to their number, so that when initial growth is optimal, it will influence the subsequent growth process (Rohim, 2019).

Aside from plant height, the number of leaves and shoots in shallot plants is another indicator of strong growth (Nazirah & Libra, 2019). The results showed that the highest number of leaves in large seedling sizes, namely treatment E which experienced consistent increases (**Figure 1**), had a tendency to differ insignificantly from treatment D (9 g) and treatment C (7 g) and differed significantly from treatment A (3 g) and B (5 g) at each observation time interval. In the observation of 15 DAP, treatment D (9.27 strands) and E (8.52 strands) produced the highest number of leaves that differed nonsignificantly and differed significantly from the treatment of medium and small seedlings, namely A (3.07 strands), B (5.14 strands), and C (6.47 strands) (**Table 2**). Rohim's (2019) research obtained similar results, plants derived from large seedlings produced the highest number of leaves, namely 38 strands at 42 DAP and small seedlings produced the lowest number of leaves by only producing 20 leaves. Regarding the number of leaves and the size of onion seedlings, the more the number of shoots produced per plant, the more leaves produced. The number of leaves affects plant growth because the leaves are where plants carry out photosynthesis to produce energy that will be needed for the plant growth process. The greater number of leaves per plant will allow even distribution of the amount of light received by the leaves used in the process of photosynthesis (Marianti et al., 2019).

Mukhlis et al. in Fatimatuzahra et al. (2022) stated that the large number of leaves formed means that the leaves become wider, then the ability of the leaves to receive light for the photosynthesis process becomes greater. The results showed the highest increase in leaf area at 15 DAP observations (**Table 3**). Treatment B (139.00 cm^2), C (169.33 cm^2), and D (200.28 cm^2) which tend to show different results are not real and differ significantly with small seed size, namely treatment A (90.92 cm^2) and large seed size, namely treatment E (245.99 cm^2). The area of plant leaves influences light absorption by plants; the greater the leaf area, the greater the absorption

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of light absorption by plants. This causes the process of assimilating translocated to all parts of other plant organs also to become larger. This is supported by Rudi's statement in Purba et al. (2018) It asserts that because plant metabolism, resulting from sunlight, is increasing to meet plants' development requirements, leaf area is the primary factor of plant growth.

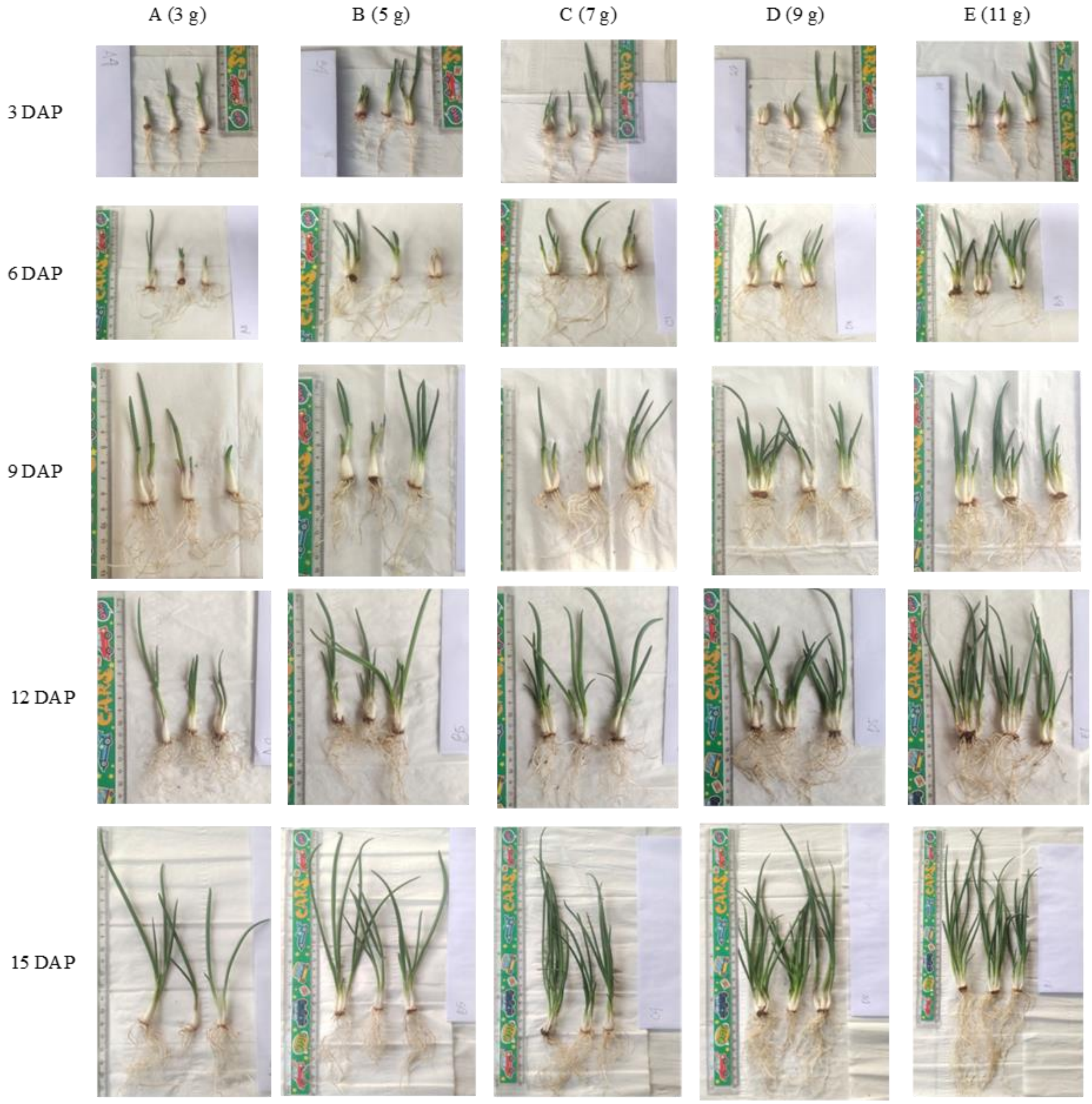

Figure 1. Shallot growth from differences in seedling size at observation time intervals

An increase in fresh weight and a buildup of dry matter are signs of plant growth. According to Haile and Ayalew (2018), the dry weight of plants is the result of assimilation that occurs during plant development. In contrast, the fresh weight of plants is the composition of nutrients and water absorbed by plants, with water accounting for the majority of the total weight. According to the study' findings, treatments C and D showed no significant difference on the third day of observation but were significantly different from treatments A, B, and E.Based on the results of the analysis carried out, on the 3rd

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day of observation, treatments C and D showed no significant difference. They were significantly different from treatments A, B, and E. On day 6, day 9, day 12, and day -15 show significantly different results for all treatments A, B, C, D, and E with an increase in each time interval. Treatment E (11 g) at each observation time interval showed the highest average value compared to other treatments (**Table 4**). During growth, plants undergo photosynthesis. To carry out photosynthesis, plants require sunlight and nutrients; the more sunlight and nutrients absorbed by plants, the greater the accumulation of photosynthetic or plant biomass, which will later produce dry weight (Khasanah et al., 2020). According to Rahmawati and Ladewa (2023), dry matter accumulation reflects plants' ability to bind solar energy during photosynthesis.

Table 1. Differences in seedling size to plant height parameters (cm) at observation time intervals

Treatment	Observation Time Intervals				
	3 DAP	6 DAP	9 DAP	12 DAP	15 DAP
A	4.65	4.41 c	6.10 d	8.86 c	13.80 c
B	4.70	4.49 b	8.22 c	10.30 b	16.58 b
C	5.02	7.67 a	9.20 b	11.19 b	19.39 a
D	4.36	5.78 b	8.28 c	12.77 a	19.53 a
E	5.55	7.16 a	10.62 a	13.43 a	21.35 a
LSD 5%	-	1.33	0.88	1.06	2.36

Note: Numbers followed by the same letter in the same column indicate that they are not significantly different in the least significant difference test at the 5% level

Table 2. Differences in seedling size to the parameter of number of leaves (strands) at the observation time intervals

Treatment	Observation Time Intervals				
	3 DAP	6 DAP	9 DAP	12 DAP	15 DAP
A	0.74	0.94 b	1.14 d	2.00 d	3.07 d
B	1.00	1.34 b	2.40 c	3.74 c	5.14 c
C	1.42	2.74 ab	4.00 b	4.07 c	6.74 b
D	2.22	2.00 b	4.27 b	6.27 b	9.27 a
E	1.73	3.60 a	5.54 a	7.67 a	8.52 a
LSD 5%	-	1.17	1.15	1.27	1.21

Note: Numbers followed by the same letter in the same column indicate that they are not significantly different in the least significant difference test at the 5% level

Based on the analysis of variance results from the treatment of different sizes of shallot seedlings, the results showed that the results had no significant effect on the relative growth rate parameters but had a tendency to increase at each observation time interval. This can be shown in the graph of relative growth rate results (**Figure 2**). Kustiawan et al. (2022), stated that nutrient intake by plant roots influences plant development rate; the faster the growth rate, the better the nutrient absorption.

Each plant's relative growth rate differs, this difference occurs because the rate of photosynthesis and the efficiency of biomass formation can affect plant weight, the higher

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the efficiency of plant biomass formation, the higher the relative growth rate (Lestari et al., 2021). The efficiency of light by leaves in biomass formation is related to increased leaf area. It is accompanied by an increase in the net assimilation rate, thereby influencing an increase in the relative growth rate (Mayasin et al., 2021). The relative growth rate can quantify the plant's initial efficiency, which serves as the starting capital for producing new plant material. Total plant biomass represents the complete plant's ability to produce new plant material (Sitompul, 2016).

Table 3. Differences in seedling size to leaf area parameters (cm^2) at observation time intervals

Treatment	Observation Time Intervals				
	3 DAP	6 DAP	9 DAP	12 DAP	15 DAP
A	23.74	36.83 b	19.68 c	41.66 c	90.92 d
B	50.00	30.43 b	41.79 b	79.80 b	139.00 c
C	58.60	66.61 a	78.14 a	69.55 b	169.33 bc
D	84.47	60.35 ab	67.84 a	85.90 b	200.28 b
E	101.62	88.41 a	82.35 a	114.15 a	245.99 a
LSD 5%	-	35.02	20.99	18.46	44.77

Note: Numbers followed by the same letter in the same column indicate that they are not significantly different in the least significant difference test at the 5% level

Table 4. Differences in seedling size to plant total oven dry weight parameters (g) at observation time intervals

Treatment	Observation Time Intervals				
	3 DAP	6 DAP	9 DAP	12 DAP	15 DAP
A	0.07 d	0.08 e	0.09 e	0.11 e	0.14 e
B	0.12 c	0.14 d	0.16 d	0.19 d	0.25 d
C	0.18 b	0.19 c	0.21 c	0.24 c	0.34 c
D	0.21 b	0.23 b	0.25 b	0.30 b	0.41 b
E	0.28 a	0.31 a	0.33 a	0.38 a	0.51 a
LSD 5%	0.03	0.03	0.02	0.04	0.04

Note: Numbers followed by the same letter in the same column indicate that they are not significantly different in the least significant difference test at the 5% level

According to Gardner, et al. in Mahmudi et al. (2022) The amount of dry matter produced per unit leaf area per unit time, also known as the net assimilation rate, represents the average efficiency of leaf photosynthesis. The net assimilation rate parameter did not change substantially at any observation time interval, according to the analysis of variance performed on shallot seedlings of varied sizes. Based on (**Figure 3**). Treatments using small sized seeds, namely 3 g and 5 g, experienced an increase in the net assimilation rate at 3-6 DAP and 6-9 DAP before finally decreasing at the next time interval. This happens because the food reserves stored in small seeds have been used up for initial growth. Furthermore, from treatments with seed sizes of 7 g, 9 g, and 11 g, there was a slight decrease after the initial growth at 3-6 DAP, but there was an increase in growth at the following time interval, This was facilitated by the seeds' ability to store nutrients.

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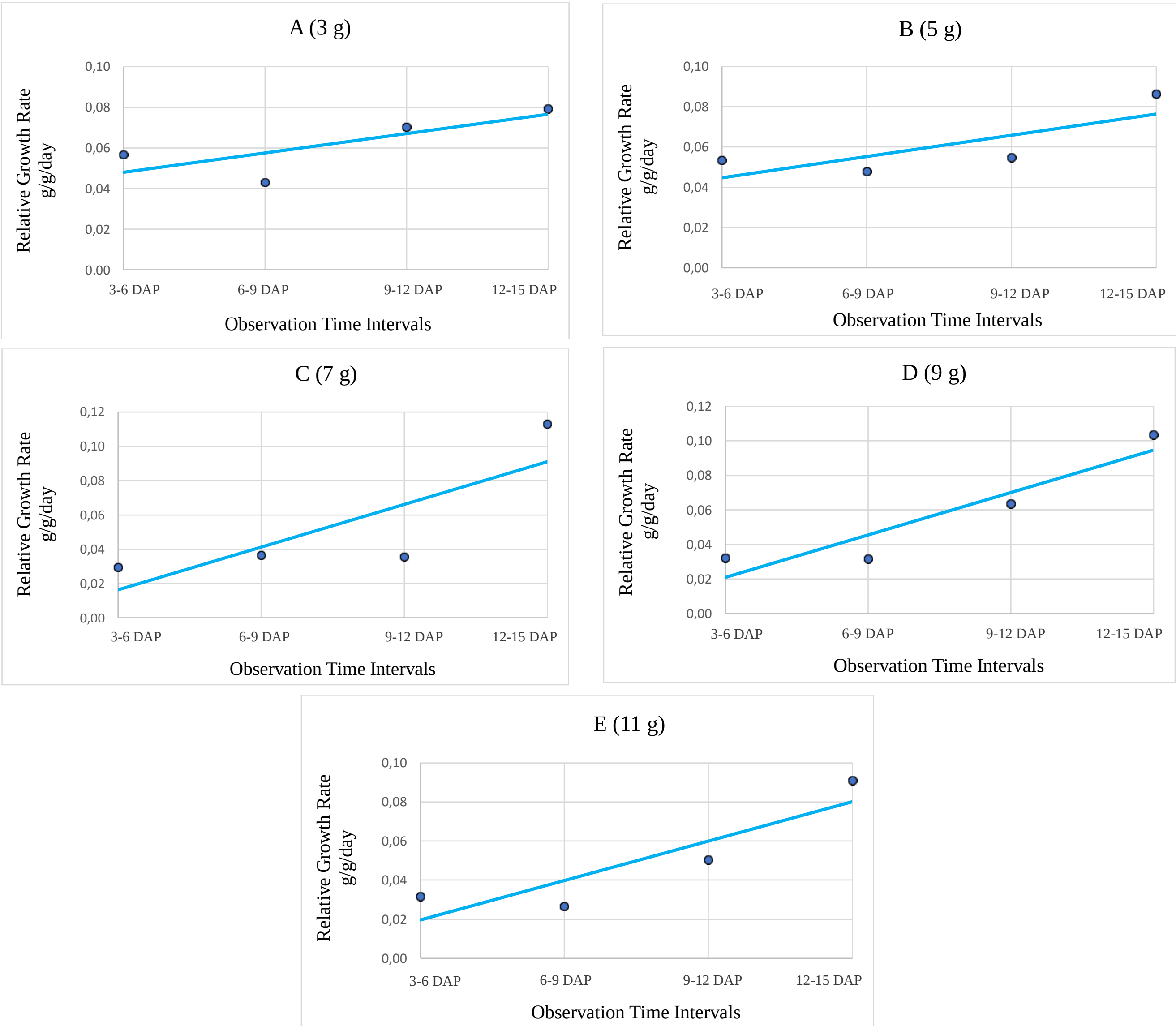

Figure 2. Graph of the effect of differences in shallot seed size on relative growth rate ($g.g^{-1}. day^{-1}$)

Apart from the different food reserve factors, according to Nurmuliana & Akib (2019), Because the majority of the leaves are exposed to direct sunlight while the plant is still young, the absorption rate is highest at this stage. The higher the net assimilation rate, the drier matter accumulates. In line with this, Safitri et al. (2018) changes in the net assimilation rate affect leaf area development and photosynthesis transmission to all regions of the plant. As the leaves grow wider, the net assimilation rate will increase. In addition, the decrease and increase in the net assimilation rate are not only influenced by the intensity of light received by plants but also related to the availability of nutrients that can be absorbed by plants (Zainuddin et al., 2022). The higher value of net assimilation rate is influenced by an increase in relative growth rate, because the addition of plant new material is closely related to the plant's ability to photosynthesis (Mayasin et al., 2021).

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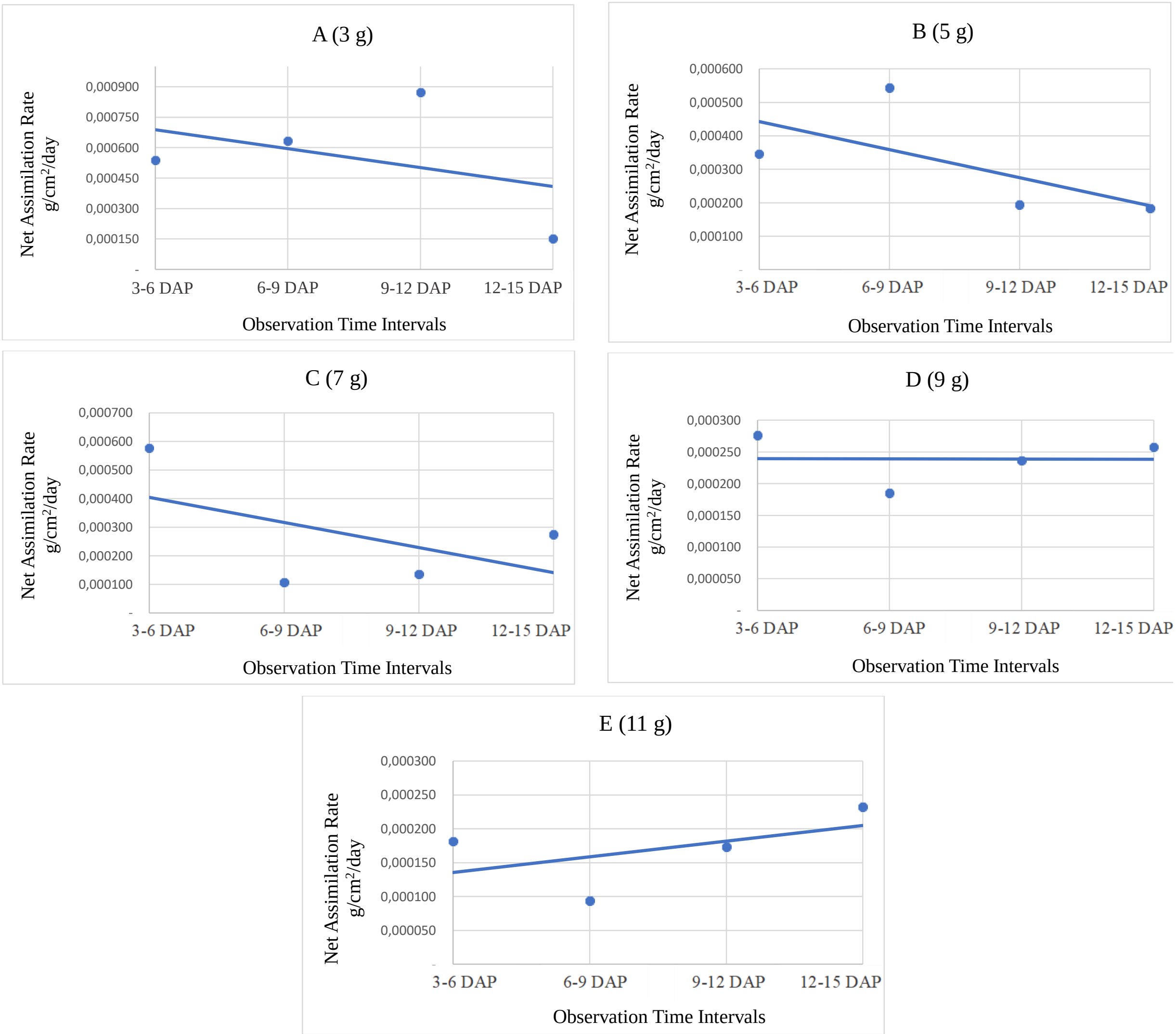

Figure 3. Graph of the effect of differences in shallot seed size on net assimilation rate (g $cm^{-2}.day^{-1}$)

CONCLUSION

The growth of shallots from treating different seed sizes in the 15-day observation time interval increased. Treatment using a seed size of 11 g showed the highest increase and had a significant effect on plant height (21,35 cm), number of leaves (8,52), leaf area (245,99 cm^2), and total plant dry weight (0,51g). However, when differences in seed size were treated on growth analysis parameters namely, net assimilation rate and relative growth rate the outcomes were not significantly impacted at any observation period.

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