Quality of Garlic Bulbs with Irrigation Application according to Plant Needs

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Abstract. The irrigation technique that has been done by farmers so far has not been optimal in increasing garlic production. This study aims to evaluate the quality of garlic tubers with irrigation applications according to plant needs. The experiment was carried out in Lembang, West Java, in 2020. The method used in this study was a group design of 6 treatments with four replications. Treatment A (daily ET accumulation within two days), B (daily ET accumulation within three days), C (daily ET accumulation within four days), D (daily ET accumulation within five days), E (daily ET accumulation within six days), F (farmers' irrigation practices). The plant data obtained were analyzed using Analysis of Variance (ANOVA) at the 5% level. Data analysis was performed using the PKBT - STAT 1.01 program. The results showed that the tuber diameter in treatment B (daily ET accumulation within three days) was significantly greater than control. Weight, weight loss, and water content were not significantly different between all treatments. The volatile content in all treatments was significantly higher than control.

1. Introduction

The productivity of garlic in Indonesia still needs to be improved by improving varieties, cultivation techniques, fertilization, and irrigation. Vegetable growers worldwide are continually under increasing pressure to optimize irrigation and nutrient management [1]. The irrigation technique that has been done by farmers so far has not been optimal in increasing garlic production. Irrigation and water management models are needed for the efficient watering of crops on the land. In addition, new advances in remote sensing technology, offering data and management, offer opportunities to optimize decision-making in terms of watering regimes, especially in the absence of water quality [2].

Optimized irrigation scheduling to better match applied water to crop requirements can reduce the wasteful use of water and energy, improve water use efficiency, and increase gross profit margin. The water demand in plants can be estimated by calculating the plant evapotranspiration rate (ET) because the ET value is the value of water demand given to plants as a substitute for water lost through evapotranspiration. ET values are calculated based on the FAO method. This method calculates the plant's water requirements by considering the physical characteristics of the soil and the depth of roots of each phase of plant growth. Within ± 120 days of local garlic growth, farmers generally water it at intervals of 3-5 days, considering the availability of irrigation water and the cost for watering. Thus, the value of ET per day must be accumulated per certain period so that the plant's water needs can be fulfilled maximally but at an economical watering cost.

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The cultivation of garlic can positively contribute to the local economy of rural areas, but needs tools to help in decision making for more efficient use of water (3). Adaptation of plants to environmental conditions is very important to produce crops under conditions of sustainable climate change. Significant differences were found in the crop water stress index and water consumption. On the other hand, local cultivars show lower yield potential and more stable production in water supply environments [4]. However, given the increased cost of the energy used by the irrigation systems, the reduction of water availability for agriculture, and the low profitability of barley, farmers have shown interest in using regulated deficit irrigation. Thus, improving irrigation water productivity and coping with droughts is a priority objective to improve yield and profitability [5, 6].

Garlic contains bioactive compounds such as organosulfur, phenol with biological activities , namely antioxidant, anticancer, anti obesity, and antifungal [7]. Several quality parameters of garlic are the bulb diameter, bulb weight, number of cloves, the content of nutrients, and active compounds beneficial to the body. In addition to cultivation techniques and varieties, harvest age affects the size and quality of the tuber produced. The nutrition content of garlic on 100 g of dried tuber: 68% water, 3.5 g protein, 0.3 g fat, 1 g ash, Ca 29 mg, P 202 mg, 529 mg K [8]. This research aims to evaluate the quality of garlic tubers with irrigation applications according to plant needs.

2. Materials and Methods

The experiment was carried out in Lembang, West Java, from January 2020 to September 2020. Garlic bulb seeds that have been prepared are separated from the cloves; Bulbs used are class B types with a diameter of 3-4 cm. The beds are watered with sufficient water before the seeds are planted to maintain soil moisture. The spacing of the planting holes used is 12.5 cm x 12.5 cm. Each hole is inserted one clove of source then covers the hole with a little soil. After the seeds are planted, the straw mulch is placed transversely over certain doses and intervals. Watering time is done in the morning when the water evaporates in the soil, and the air temperature is low.

Meanwhile, pesticide spraying for plant pest control is carried out at 4-day intervals starting at 14 days after planting. Each time the application of the active pesticide used is different and adjusted to the type of HPT that is likely to attack. Weeding is done by cleaning the planting area from weeds that grow. Weeding is done every week starting at the age of 14 days after planting. Weeding must be stopped at the period of ± 100 days after planting or has entered the generative phase because it will interfere with the formation and enlargement of tubers. The method used in this study was a 6 treatment randomized block design with four replications. Treatment A (daily ET accumulation within two days), B (daily ET accumulation within three days), C (daily ET accumulation within four days), D (daily ET accumulation within five days), E (daily ET accumulation within six days), F (farmers' irrigation practices). Physically experimental parameters were weight, diameter, weight loss. Chemical parameters were moisture content, ash content, Total Soluble Solute (TSS), and Volatile content. The plant data obtained were analyzed using Analysis of Variance (ANOVA) at the 5% level. Data analysis was carried out using the PKBT–STAT 1.01 program.

3. Results and Discussion

Quality will influence consumer acceptance of a product. Size is one quality parameter that determines market prices. Table 1 shows the weight of garlic bulbs ranging from 21.24 - 34.33 mm. Bulbs with the largest weight in treatment D (34.33 mm), while the smallest bulb weight in treatment A was 21.24 mm, but not significantly different between all treatments. The diameter of the garlic bulbs from all treatments was greater than 4 cm, with the largest diameter in treatment B. (44.89 mm) and significantly different from the control treatment (farmer method). Weight loss during storage showed results that were not quite different between all treatments. The productivity of garlic bulbs is influenced by the amount of water given. The optimum irrigation treatment in the tuber formation phase gave the highest yield. Reducing the amount of water in this phase affects the quality and quantity of tubers [9].

Table 1. Physical Parameters of Garlic Bulbs from Six Treatments

Threatment	Weight (g)	Diametre (mm)	Weight loss (%)
A	$21.24^{a} \pm 4.63$	$42.29^{ab} \pm 2.39$	$13.32^{a} \pm 5.56$
B	$26.88^{a} \pm 3.16$	$44.89^{a} \pm 2.27$	$17.89^{a} \pm 5.83$
C	$22.16^{a} \pm 3.38$	$42.64^{ab} \pm 2.16$	$21.84^{a} \pm 6.84$
D	$34.33^{a} \pm 7.72$	$43.20^{ab} \pm 2.97$	$15.21^{a} \pm 5.83$
E	$24.87^{a} \pm 5.88$	$43.66^{ab} \pm 3.63$	$16.27^{a} \pm 3.12$
F	$22.56^{a} \pm 5.57$	$42.08^{b} \pm 3.50$	$11.83^{a} \pm 5.93$
LSD 5%	13.59	2.69	10.95

Fig. 1. Garlic Bulb of Six Treatments

The influence of the type of fertilizer such as the content of nitrate and the duration of irradiation affect the growth of plants and the condition of the garlic bulbs produced [10]. The maize plant height, leaf area index, above-ground biomass and yield did not significantly decrease due to the decrease in fertilizer application. Fertilization management increased the nutrients and rainfall use efficiency and net profit [11]. The water content between all treatments was not significantly different, which ranged

between (61.96% - 63.49%). Meanwhile, the ash content of garlic bulbs in all treatments was significantly lower than the farmer's technique. The TSS content ranges from 36.80 - 38.55 Brix. The quality of the harvests and the significant differences found in this study (weight of barley and maize grains, and calibres size of bulbs in onion) did not affect the price perceived by the farmer. Due to this, the deficit irrigation reached a higher profitability than full irrigation methods in the scenarios with lower availability of irrigation water (≤5000 m3 ha−1). Therefore, the use of these methods at great scale may increase the profitability of farms located in water scarcity areas through a more efficient use of land and irrigation water [12].

Table 2. Garlic Bulb Chemical Parameters of Six Treatments

Treatment	Water (%)	Ash (%)	TSS (Brix)	Volatile content (ppm)
A	63.49^{a}± 1.67	1.10^{b}± 0.05	37.10^{b}± 0.12	255.60^{b}± 29.69
B	62.22^{a}± 0.72	1.13^{b}± 0.02	37.85^{ab}± 0.10	284.33^{a}± 7.15
C	63.42^{a}± 1.32	1.23^{b} ± 0.15	36.80^{b}± 0.43	266.00^{ab}± 18.49
D	62.09^{a} ± 1.48	1.10^{b}± 0.07	37.10^{b}± 0.12	244.69^{bc}± 16.76
E	63.36^{a}± 1.06	1.16^{b}± 0.07	38.50^{a}± 1.41	269.80^{ab}± 13.90
F	61.96^{a}± 1.41	1.39^{a}± 0.12	38.55^{a}± 0.87	222.87^{c}± 8.43
LSD 5%	1.92	0.15	1.15	17.95

In table 2, volatile content in treatment B was significantly higher than other treatments, namely 284.33 ppm. Garlic contains sulphur compounds, including a chemical called alliin which makes raw garlic feel bitter. The use of fertilizers affects the sulphur content in garlic. The use of fertilizers containing sulphur at a dose of 30 kg/ha shows a high sulphur content. In comparison, the use of fertilizers that contain lots of Nitrogen is less good for the sulphur content of garlic. TIBBP, the technology from IVEGRI, has been proven to increase garlic bulb quality compared to the farmer's conventional technology. Tawangmangu Baru, cultivated with TIBBP, has a 32.69% bigger diameter and is 11.5 grams heavier than Tawangmangu Baru, which is produced with the farmer's conventional technology [13, 14]. The ET value in the application of garlic irrigation shows a rather low sensitivity, which allows certain formulas to calculate the ET of plants. The other research reported that irrigation at 20 days intervals showed better performance over-irrigation at 10 days intervals and control [15, 16].

4. Conclusion

The diameter of bulb in treatment B (daily ET accumulation within three days) was significantly greater than the control. Weight, weight loss, and water content were not significantly different between all treatments. The volatile content in all treatments was significantly higher than control (farmers' irrigation practices).

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