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Applied Nitrogen Fertilization and Irrigation on Improving Shallot (*Allium ascolanicum* L.) Growth and Yield on Dry Land in Mesuji, Lampung Province, Indonesia

Mu'addin, Paul Benyamin Timotiwu*, Tumiar K. Manik and Agustiansyah

Agronomy Graduate Student, Faculty of Agriculture, Universitas Lampung, Indonesia.

***Correspondence:**
Paul Benyamin Timotiwu, Sumantri Brojonegoro 1, Bandar Lampung 35145, Lampung, Indonesia, Tel: +62 813 1562 3072.

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ABSTRACT

This field research was conducted from June to August 2022 at the research station of Agriculture Extension, Mesuji District, Mesuji Regency, Lampung Province, Indonesia. The study aimed to determine the effect of nitrogen fertilization and irrigation on different levels of treatment on shallot growth and yield in dry land. The experiment was a factorial design in a striped plot with three replications. The first factor was nitrogen fertilizer levels, namely 0 kg N/ha (N0), 80 kg N/ha (N80), 160 kg N/ha (N160) and 240 kg (N240); the second factor was irrigation with four levels, namely 25% ETc (W25), 50% ETc (W50), 75% ETc (W75) and 100% ETc (W100). The variables observed were plant height, number of leaves, fresh weight of tubers, diameter of tubers, dry weight of tubers and harvest index. The results showed that the significant effect of treatment was more due to the main effect of nitrogen fertilizer and irrigation factors. Nitrogen fertilizer has a significant effect on plant height, fresh weight of tubers, tuber diameter, dry weight of tubers and harvest index, while the number of leaves and canopy cover have not been significantly affected. The irrigation treatment significantly affected all observed variables, while only the dry weight variables of tubers showed a noticeable interaction effect of nitrogen fertilization and irrigation. The best treatment to support the growth and yield of shallots in dry land results from fertilizing nitrogen (N) 160 kg N/ha and irrigating 75% Etc.

Keywords
Dryland, Irrigation, Lampung, Nitrogen, Shallot.

Introduction
Shallots (Allium ascolanicum L.) are a national strategic commodity in the horticulture sector that is essential in maintaining inflation and national economic growth. The need for shallots continues to increase in line with the increase in population. Based on the national census in 2019 [1], the Indonesian population consumes shallots, an average was 27.72 kg/capita/year. Another factor that causes an increase in the need for shallots is the development of food-processed industries with shallots as the ingredient. Shallot production in Lampung Province in 2019 reached 3,634 tons, while the projected demand reached 25,576 tons.

Mesuji Regency, with an area of 2,184 km^2 [2], has the potential for dry land of 21,863.5 ha and temporary uncultivated land covering an area of 10,325.6 ha [3]. Dry land is land that is not flooded at most times of the year or throughout the year [4]; this is an agroecosystem with great potential in agricultural business, food crops, horticulture, annual crops and animal husbandry [5].

Using dry land as a farming business for horticultural commodities often encounters various obstacles characterized by sensitivity to erosion, low soil fertility, limited water, and low fertilizer and subsoil moisture. In addition, climate change also harms the production system of horticultural commodities [6]. Biophysical constraints of land can be overcome by soil fertility management, soil conservation and rehabilitation, and efficient water resource management [5].

Land fertility indicates land-providing nutrients for plants in adequate and balanced quantities. Therefore, the fertility level of the land will affect crop production and yield. Increasing land fertility can be done by adding nutrients through nitrogen fertilization. Nitrogen (N) is an essential nutrient in large quantities to ensure plant growth and development. It is a constituent of important organic compounds such as amino acids, proteins, nucleic acids and energy. In addition, N is part of chlorophyll, which plays a role in plant photosynthesis.

Sprinkler irrigation is an alternative method of providing more efficient water than surface irrigation. Distributing the water requires compressive energy sourced from the pump and is an essential factor in determining the performance of the sprinkler [7]. Sprinkler irrigation is defined as giving water to plants that resemble rain by spraying water into the air [8]. Sprinkler irrigation has the advantage of being able to be used on various land topography and fertilization or pest control at one time, thereby reducing labour costs. Sprinkler irrigation is very suitable for dry land but requires considerable costs, especially for the first provision of irrigation support facilities [7].

Information on the use of nitrogen fertilizer (N) and irrigation in site-specific shallot cultivation is still minimal, so this study was conducted to obtain information on the effect of nitrogen fertilization and irrigation, as well as to determine the dose of nitrogen fertilizer use and the right volume of irrigation in supporting optimal shallot growth and yield on dry land.

Materials and Methods

The research was carried out in the Research station of Agriculture Extension Mesuji District, Mesuji Regency, Lampung Province, located at -3.88611 LS, 105.42667 BT, with an elevation of 20 meters above sea level and at the Seed Laboratory of the Faculty of Agriculture, University of Lampung. The study was conducted from June to August 2022. This study used a strip plot design within a completely randomized group design. The nitrogen factor was the first factor with four levels, namely, 0 kg N/ha (N0), 80 kg N/ha (N80), 160 kg N/ha (N160) and 240 kg (N240), while the irrigation factor was the second factor with 4 levels, namely; 25% ETc (W25), 50% ETc (W50), 75% ETc (W75) and 100% ETc (W100), each treatment is repeated three times. Etc is crop evapotranspiration. The data were processed with the R statistical program for the ANOVA; if significant, further tests were carried out with the LSD (Least Significant Difference) at 5%. The research was carried out with the following steps: determining plant water requirements, land preparation, installing sprinkler irrigation, and implementing cultivation. The estimation of plant water requirements is based on the equation of [9] in equation (1).

$$ETc = ETo \; x \; Kc \qquad (1)$$

Where:
ETc: plant evapotranspiration (mm/day)
ETo: reference evapotranspiration (mm/day)
Kc: plant coefficient

The determination of the reference evapotranspiration (ETo) value is carried out by collecting climate data for 22 years (2000-2022) using satellite data from NASA power data access viewer (https://power.larc.nasa.gov/) while the evapotranspiration rate was calculated using the Penman-Monteith method inside the FAO ETo Calculator application. The value of the plant coefficient (Kc) of shallot plants on dry land refers to the study by [10]. The water requirements of shallot plants are presented in Table 1.

Table 1: Water Needs of Shallot Plants Based on Growth Phase.

Growth phase	days after planting	ETo (mmday)	Crop coefficient (Kc)	ETc (mm/day)
Initiation	10	3,43	0,7	2,40
Vegetative	20	3,43	0,9	3,09
Tuber development	15	3,43	1,2	4,12
Maturing	15	3,43	1,2	4,12

Sprinkler discharge measurements are first carried out by direct measurement in the field, conducted by measuring the amount of water released by sprinkler nozzles at a specific time. The water requirements of shallot plants in each growth phase are calculated by multiplying according to the treatment level, namely 25% of the Etc (W25), 50% (W50), 75% (W75) and 100% (W100). Sprinkler bulk rate and sprinkler operational time are calculated using equation (2) and equation (3) [11] as follows:

$$Sprinkler\ bulk\ rate = (n \text{ x } q)/A \qquad (2)$$

Where:
n: number of sprinkler heads
q: sprinkler discharge (m^3 / hour)
A: area (m^2)

Operational Time = (water supply requirement)/(sprinkler bulk rate) (3)
Preliminary tillage is carried out for weed controlling using a 4-wheeled tractor. The formation of experimental plots was carried out using hoes with plot dimensions of 2.5 m x 1 m x 0.2 m. The plots were sprinkled with organic fertilizer at a dose of 2.5 kg / plot (10 tons / ha) and dolomite 0.25 kg / plot (1 ton / ha), then hoeing is carried out again to mix the materials and loosen the soil to be ready for planting.

Shallot planting material was the Bima Brebes variety from the shallot centre in Brebes Regency, Central Java. Before the seedlings were planted, sorting was carried out first; then, seedlings were cut 1/3 of the ends of the seedlings. Seedlings were treated with pesticides with the active ingredient carbosulfan at a dose of 5 gr/kg dissolved in water and soaked for 30 minutes. Planting shallot seedlings is carried out in the afternoon with a planting distance of 20 cm x 15 cm with one bulb per planting hole.

The water source used in sprinkler irrigation is boreholes that are accommodated using holding ponds. Water from the holding pond is pumped using a submersible machine and flowed through a 1-inch pipe that functions as the main line, a 3/4-inch pipe as a divider (lateral) and a 1/2-inch pipe where the sprinkler nozzle was installed. The type of sprinkler used in the experiment was an impact sprinkler with all-way watering (360^o). The sprinkler nozzles installation height from the ground was about 40 cm, supported by a wooden post. Two sprinklers were installed in the middle of the experimental plots. The experimental layout is presented in Figure 1.

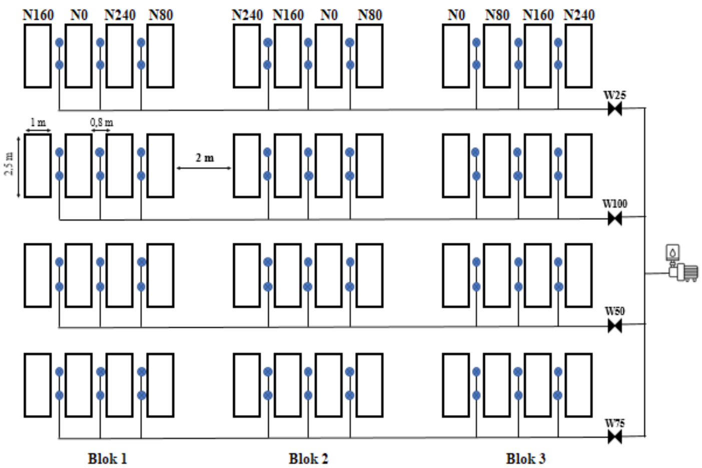

Figure 1: Experiment Design Layout.

Watering time and watering interval are determined based on the potential moisture content of the soil measured by a manometer reading on the tensiometer device installed in the field. Watering shallot plants at the age of 1 - 30 DAP is carried out when the manometer reading has shown 10 - 15 Cbar, while watering at the age of more than 30 DAP until harvest is carried out when the manometer reading has shown 30 - 40 Cbar with a frequency of watering one time in the afternoon.

The nitrogen source (N) fertilizer used in the experiment was urea fertilizer with a N = 46% content. Fertilization is carried out two times application, at the age of 14 DAP and 28 DAP. The level of nitrogen fertilization treatment is divided into four dose levels, including; 0 kg N/ha (N0/no fertilization), 80 kg N/ha (N80) or 21.74 gr/plot, 160 kg N/ha (N160) or 43.48 gr/plot and 240 kg N/ha (N240) or 65.22 gr/plot. KCl fertilizer was applied with a 125 kg/ha dose and SP-36 with 125 kg/ha.

Field observation data included plant height, number of leaves and canopy cover, while variable data of shallot yield (production) included; the fresh weight of tubers, the diameter of tubers, dry weight of tubers and harvest index. Canopy cover measurement is done by taking canopy images using an Android smartphone. The image observations of the shallot canopy were processed using the Windows-based application called the Easy Leaf Area application [12].

Results and Discussion

The analysis of variance (ANOVA) on the observation variables of shallot plant growth showed a single influence of nitrogen fertilization factors and irrigation than the interaction effect of nitrogen fertilization (N) and irrigation. The results of ANOVA of the average leaf height, number of leaves and canopy cover of shallot plants are presented in Table 2.

Plant Height

The effect of nitrogen (N) fertilization on the average plant height is presented in Table 2. The results have not shown a noticeable effect at the age of 30 DAP (days after planting), but at the age of 40 DAP, the effect of N fertilization showed a significant effect on the height of shallot plants. Fertilization of 80 kg N/ha increased the average plant height by 10.05% compared to no N fertilization (0 kg N/ha). This result is in line with [13] stated that the application of 69 kg N/ha increased the height of shallot plants by about 10% and [14] application of 150 kg N/ha increased plant height by about 12%.

The application of irrigation significantly affected the average height of shallot plants at both 30 DAP and 40 DAP. Irrigation of 50% ETc (W50) increased average plant height by 7.3% at 30 DAP and 9.97% at 40 DAP compared to irrigation of 25% ETc (W25) [15-17] reported that irrigation water levels showed a significant influence on the height of shallot plants.

Number of Leaves and Canopy Cover

Observing the number of leaves and canopy cover in Table 2, shallot plants did not show any noticeable effect of nitrogen (N) fertilization on the number of leaves and canopy cover at both 30 DAP and 40 DAP. This result was different compared to several studies, including [13,18-20], that stated nitrogen fertilization has a significant effect on increasing the number of shallot leaves number. The effect of nitrogen fertilization on leaf number and canopy cover at 30 DAP and 40 DAP might be more related to genetic factors of the shallot varieties. According to [21], the success of plant growth is influenced by genetic factors related to the inheritance of plant traits and related environmental factors with the environmental conditions under which the plant grows.

Irrigation significantly affected leaves number and canopy cover (Table 2) of shallot plants at both 30 DAP and 40 DAP. Irrigation of 50% ETc (W50) increased leaves number by 9.75% at 30 DAP and 6.91% at 40 DAP compared to 25% ETc (W25). Irrigation of up to 75% ETc (W75) yielded the highest average relative leaves number of 24.93 (blades/plant) at 30 DAP and 34.24 (blades /plant) at 40 DAP. The lower volume of irrigation caused the number of shallots is also lower. According to [22], as an initial response when plants experience water scarcity, the growth of plant active cells is limited to conserve available water by reducing the number and growth of leaves as a mechanism of tolerance to drought.

Canopy cover is an essential indicator of plant growth and water use stages in horticultural crops [23]. Increasing the number of leaves will increase their canopy cover and determine the rate of photosynthesis. Photosynthesis in the canopy takes place by intercepting light energy and assimilating CO_2, and thus, the arrangement of plant material optimizes light interception, which will inherently lead to increased productivity [23]; irrigation of 50% ETc (W50) increased average canopy cover by 33.23% at 30 DAP and 25.86% at 40 DAP compared to 25% ETc (W25).

Table 2: Average Plant Height, Number of Leaves and Canopy Cover of Shallot Plants.

Treatments	Plant height (cm/plant)		Number of leaves (bleads/plant)		Canopy coverage (%)	
	30 DAP	40 DAP	30 DAP	40 DAP	30 DAP	40 DAP
Nitrogen						
0 kg N/ha (N0)	31,524ᵃ	37,227ᵇ	21,216ᵃ	30,937ᵃ	20,885ᵃ	33,953ᵃ
80 kg N/ha (N80)	32,690ᵃ	40,967ᵃ	24,062ᵃ	31,445ᵃ	22,943ᵃ	34,959ᵃ
160 kg N/ha (N160)	33,721ᵃ	41,001ᵃ	25,072ᵃ	33.741ᵃ	24,488ᵃ	36,986ᵃ
240 kg N/ha (N240)	33,373ᵃ	40.219ᵃ	24,166ᵃ	32.753ᵃ	22,700ᵃ	36,859ᵃ
LSD 5%	2,52	2,13	3,06	1,90	3,73	5,54
CV	7,66%	5,35%	12,96%	5,96%	16,43%	12,88%
Irrigation						
25% ETc (W25)	30,902ᵇ	36,693ᵇ	21,305ᶜ	28,726ᶜ	17,904ᵇ	29.063ᵇ
50% ETc (W50)	33,158ᵃ	40,354ᵃ	23,382ᵇ	30,711ᵇ	23,853ᵃ	36.578ᵃ
75% ETc (W75)	33,587ᵃ	41,200ᵃ	24,933ᵃ	34,235ᵃ	26,222ᵃ	40.228ᵃ
100% ETc (W100)	33,662ᵃ	41,167ᵃ	24,895ᵃ	34,204ᵃ	23,037ᵃ	36,889ᵃ
LSD 5%	1,14	1,90	1,44	1,04	4,53	6,55
CV	3,46%	4,78%	6,09%	3,25%	19,93%	18,10%

Remarks: Numbers followed by the same letter in the same line is not significantly difference based on the LSD test at α=5%.

Irrigation of 75% ETc (W75) resulted in the highest average canopy cover of 26.22% at 30 DAP and 40.23% at 40 DAP. According to [25], good water status helps maximize canopy formation; the more leaves the plant produces, the more tubers will develop later.

Good soil moisture availability and adequate absorption of N elements have the effect of increasing vegetative growth through cell division and elongation [26]. From the variables observed in the growth of shallot plants above, it is known that irrigation significantly influences plant height, number of leaves and canopy cover. In contrast, nitrogen fertilization only significantly affects plant height at the age of 40 DAP.

The results of ANOVA on several variables observing the yield of shallot plants showed that nitrogen fertilization and irrigation each had a significant effect on the fresh weight of bulbs, bulb diameter, dry weight of bulbs and harvest index (Table 3).

Table 3: Average Fresh Weight of Bulbs, Bulb Diameter and Harvest Index of Shallot Plants.

Treatments	Tubers fresh weight (gr/plant)	Tuber diameter Umbi (cm/tuber)	Harvest index
Nitrogen			
0 kg N/ha (N0)	32,368ᵇ	1,958ᵇ	0,722ᶜ
80 kg N/ha (N80)	44,831ᵃ	2,169ᵃ	0,822ᵃᵇ
160 kg N/ha (N160)	51,167ᵃ	2,258ᵃ	0,850ᵃ
240 kg N/ha (N240)	49,944ᵃ	2,245ᵃ	0,805ᵇ
LSD 5%	6,44	0,13	0,03
CV	14,46%	6,09%	4,08%
Irrigation			
25% ETc (W25)	32,758ᶜ	1,877ᵇ	0,744ᵇ
50% ETc (W50)	51,611ᵃ	2,262ᵃ	0,808ᵃ
75% ETc (W75)	52,581ᵃ	2,299ᵃ	0,827ᵃ
100% ETc (W100)	41.361ᵇ	2,193ᵃ	0,819ᵃ
LSD 5%	5,60	0,24	0,05
CV	12,58%	11,27%	6,57%

Remarks: Numbers followed by the same letter in the same line is not significantly difference based on the LSD test at α=5%.

Fresh Weight and Diameter of Tubers

Nitrogen fertilization and irrigation showed different significant effects on the average tubers' fresh weight and tubers' diameter (Table 3). Nitrogen fertilization of 80 kg N/ha (N80) increased the average fresh weight of tubers by 38.5% and the average diameter of tubers by 10.78% compared to no N fertilization (N0) [13].

The application of 69 kg N/ha increased the average weight of tubers by about 26% and the diameter of tubers by about 12%. Nitrogen supply can increase the metabolic rate so that more carbohydrates are synthesized and thus increase tubers' weight [20]. The increase in tuber diameter is inseparable from the role of nitrogen (N) in forming chlorophyll, thereby increasing the rate of photosynthesis and producing photosynthetic stored as tubers. Applying 50% ETc (W50), irrigation increased the average fresh weight of tubers by 57.55% and the average diameter of tubers by 20.51% compared to 25% ETc (W25). The lower the volume of irrigation given will result in a smaller diameter of tubers. According to [27], there is a positive linear relationship between water stress and tuber weight, which means water stress negatively, affects the weight of individual tubers.

Dry Weight of Tubers

The increase in the dry weight of tubers is determined by how much photosynthate the plant produces during the tuber formation process. The results of ANOVA showed a discernible influence of nitrogen fertilization and irrigation, as well as an interaction with the dry weight of shallot bulbs (Table 4). Based on Table 4, in the conditions without nitrogen (N0) with a low volume of irrigation, the average dry weight of tubers per plant is smaller. Vice versa, nitrogen fertilization that is lower in water deficit conditions (W25) caused the dry weight of tubers per plant to be lower.

Table 4: Interaction of Nitrogen Fertilization and Irrigation on Average Dry Weight of Shallot Bulbs (log(x) transformation).

Nitrogen	Irigattion			
	25% ETc (W25)	50% ETc (W50)	75% ETc (W75)	100% ETc (W100)
0 kg N/ha (N0)	0,529ᵇᶜ	0,754ᵃᴮ	0,823ᵃᶜ	0,817ᵃᴮ
80 kg N/ha (N80)	1,096ᵇᴬ	1,286ᵃᴬ	1,381ᵃᴬᴮ	1,321ᵃᴬ
160 kg N/ha (N160)	0,900ᶜᴬᴮ	1,448ᵃᵇᴬ	1,534ᵃᴬ	1,311ᵇᴬ
240 kg N/ha (N240)	0,863ᵇᴮ	1,302ᵃᴬ	1,364ᵃᴮ	1,274ᵃᴬ
LSD 5% = 0,16				
CV of interaction = 8,11%				

Remarks: Numbers followed by the same lowercase letter on the same line and the same uppercase letter on the same column are not significantly different based on the LSD test at α=5%.

Treatment without nitrogen fertilization (N0) and irrigation of 25% ETc (W25) resulted in the lowest dry weight of tubers of 0.53 (3.39 gr/plant). In comparison, fertilization of 160 kg N/ha (N160) nitrogen fertilization with irrigation of 75% ETc (W75) produced the most considerable tuber dry weight of 1.53 (33.88 gr/plant). The interaction of nitrogen fertilization and irrigation has a significant effect on the average dry weight of shallot bulbs. According to [28], the groundwater regime affects the availability of the form of nitrogen (N), so the time of watering or rain in connection with the application of fertilizer N has a strong influence on the availability of N in the soil.

Harvest Index

The harvest index (HI) measures success in partitioning the results of photosynthate assimilation. An increase in the crop harvest index means an increase in the economic portion of the crop at a certain level [29]. A single effect of nitrogen fertilization (N) and irrigation markedly affected the average crop index (Table 3). This result is in line with the report of [26], which states that there is no interaction effect on the shallot harvest index but is more influenced by the main effect of irrigation and nitrogen treatment.

Nitrogen fertilization of 80 kg N/ha (N80) increased the average harvest index by 13.85% compared to no N fertilization (N0), and irrigation of 50% ETc (W50) increased the average harvest index by 8.6% compared to 25% ETc (W25). A high harvest index is associated with increased photosynthesis in response to increased nitrogen fertilization, thereby increasing assimilate production and partitioning in tubers [13]. The highest shallot harvest index due to water availability is attributed to water supply promoting plant growth and development through increased production of different dry matter and economical partitioning of carbohydrates to sink organs [30].

The irrigation factor significantly influences the growth phase and yield of shallot plants. In contrast, the nitrogen fertilization factor is more likely to significantly affect the production phase due to the transfer of photosynthates from the organ sink to the source organ during the tuber formation phase. N nutrients are required by plants in large quantities compared to other nutrients [31] and are constituents of many fundamental cell components. N deficiency limits cell division, expansion, chloroplast development, chlorophyll concentration, and enzyme activity [19]. In addition, the absorption rate of N from the soil by plants is strongly influenced by environmental factors, including soil temperature, air temperature, aeration, pH, the composition of other nutrients, water stress and plant species themselves [32].

The Relationship of Growth and Yield Variables

Correlation analysis was carried out to see the close relationship between growth variables and shallot yields in nitrogen fertilization treatment and irrigation. Two variables are said to be correlated when a change in the value of one variable will be followed by a regular change in the value of the other variable in the same or opposite direction. The degree of closeness of the relationship between variables is seen in the correlation coefficient (r) value. The results of the correlation analysis of growth variables and yield of shallot plants in nitrogen fertilization treatment and irrigation are presented in Tables 5 and 6.

Table 5: Correlation of Growth Variables and Yield of Shallot Plants in Nitrogen Treatment.

Variables	PH	NoL	CC	TFW	TD	TDW	HI
PH	1,00	0,18	0,35	0,66*	0,78**	0,71**	0,79**
NoL		1,00	0,01	0,44	0,42	0,24	0,37
CC			1,00	0,51	0,25	0,55	0,25
TFW				1,00	0,88***	0,84***	0,88***
TD					1,00	0,80**	0,89***
TDW						1,00	0,83***
HI							1,00

Remarks: PH= plant height, NoL= number of leaves, CC= canopy cover, TFW= tubers fresh weight, TD= tubers diameter, TDW= tubers dry weight, HI= harvest index

Table 6: Correlation of Growth Variables and Yield of Shallot Plants in Irrigation Treatment.

Variables	PH	NoL	CC	TFW	TD	TDW	HI
PH	1,00	0,71**	0,76**	0,65*	0,84***	0,64*	0,68*
NoL		1,00	0,61*	0,44	0,69*	0,55	0,68*
CC			1,00	0,70*	0,86***	0,83***	0,77**
TFW				1,00	0,77**	0,87***	0,64*
TD					1,00	0,78**	0,68*
TDW						1,00	0,70*
HI							1,00

Remarks: PH= plant height, NoL= number of leaves, CC= canopy cover, TFW= tubers fresh weight, TD= tubers diameter, TDW= tubers dry weight, HI= harvest index

Based on Table 5, the correlation of growth variables and yield in nitrogen fertilization treatment is only shown in plant height variables (TT) which have a significant positive correlation with all yield variables (Tubers fresh weight, tubers diameter, tubers dry weight, and harvest index), while the correlation between yield variables showed a significant positive correlation on all variables. Nitrogen fertilization treatment is more likely to play a role in tuber development, including; the fresh weight of tubers, the diameter of tubers, the dry weight of tubers and the harvest index. The nitrogen requirement of shallots largely depends on the yield. An average of 65% of the total N in aboveground biomass is in tubers at harvest, while 35% is in leaves [30]. In Table 6, irrigation treatment, the correlation of growth and yield variables mostly showed a significant positive correlation.

Irrigation plays a vital role in shallot plants' growth and yield. Sufficient water through irrigation can maintain water balance in the root zone. Water availability also plays a role in maintaining turgor pressure, and turgor pressure plays an essential role in growth, development, mechanical support, signalling, organ movement, flowering and stress response [32].

Shallot is categorized as a sensitive plant to water availability because shallot plants have a shallow and sparse root system, where most of them are in the topsoil layer, so they require frequent irrigation in small amounts [34]. Watering frequency is fundamental in maintaining water balance in the root zone [35], and watering is sought to maintain soil flexibility higher than -12.5 kPa [36]. Conditions of excessive water availability due to rainfall and irrigation cause runoff, percolation and poor aeration systems that can inhibit the growth and development of shallot plants.

Conclusion

From the recent research, the single influence of nitrogen fertilization factor (N) has a natural effect on plant height, fresh weight of tubers, the diameter of tubers, dry weight and harvest index. Meanwhile, the number of leaves and canopy cover did not significantly affect it. Irrigation has a significant effect on all growth variables and yield variables of shallot plants. Nitrogen fertilization and irrigation have a noticeable effect on increasing the dry weight of shallot bulbs. The best treatment to support shallots' growth and yield is fertilizing nitrogen (N) 160 kg N/ha and irrigating 75% ETc. Irrigation is needed for shallot plants in all phases of growth and yield (production), while nitrogen fertilization (N) is more likely to increase yield in the form of bulbs.

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