The Effect of Watering Techniques for Increasing the Yield of Shallots (*Allium cepa* L) in Dry Land

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Abstract. Climate change that occurs requires secondary irrigation, to meet water needs by plants from existing water sources (springs, or existing irrigation. This study aims to see the effect of irrigation on increasing the production of shallot bulbs of the Lansuna variety. The study was conducted in the dry season of 2017 in Minahasa Regency. The layout of the experiment used a Randomized Block Design 2 treatment with 5 replications per plot measuring 4m x 4m. Pressurized watering was carried out per day for 4 hours with watering intervals every 3 days. For comparison, the existing technology only depends on the rainfall that occurs. randomized so that there are 250 clumps to be analyzed. This can also be seen in the existing 0.5 ha technology. Observation parameters include the weight of stover at harvest, the average number of tubers per plant, and tuber yield of tons/ha. Data were analyzed using the T-test The results of the analysis showed that the weight of shallots at harvest was 3.4g heavier and real eda by way of farmers (1.48g). The number of tubers per plant was not affected by irrigation techniques, but the weight of the shallot bulbs increased by 48.9% and the yield per ha increased by 48.40% from the rainfall that occurred during the study.

1 Introduction

Shallot in tropical is one type of variety in the Aggregatum group a commodity that people consume every day. In the market, the price of shallots fluctuates due to availability in the market depending on the season. In the dry season, the availability of shallots is limited, and the price is high. Many vegetable farmers source their income from selling shallots because the crop is harvested quickly and the price is relatively profitable, thus helping the family's economy. The government even includes this commodity as a strategic commodity to be developed in Minahasa. A lot of government assistance has been given to shallot farmers, in the form of seeds and production facilities for existing farmers, to achieve self-sufficiency in shallots.

Existing farmers cultivate shallots on dry land. This can be seen in the shallot cultivation center in Tonsewer Village, Tompaso District, Minahasa Regency. Water sources from

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agriculture on dry land are highly dependent on the rainy season. As a result, the results obtained are still low. The problem is that farmers often experience crop failure when the dry season comes quickly. Lack of water availability causes dryness of shallots which can inhibit their growth. According to [1], the impact of water shortage on plants differs according to cultivar, and duration of drought stress. [2] The response of plants to lack of water can be seen from the inhibition of plant growth. It is known that water is the main component of cells and tissues because 90% of cells are composed of water. Shallots have short roots so they are susceptible to water shortages in topsoil, this condition requires irrigation to maintain water availability in plant roots [3]. [4] high frequency and volume of irrigation increase water around the roots. During the dry season, plants need additional water. Watering in the rainy season is only to rinse the leaves from the dust that sticks to the shallots.

The results of the study [5] stated that 100% high-volume irrigation had a higher harvest weight and was significantly different from conventional irrigation. The best irrigation frequency based on total harvest weight is twice a day. The best frequency based on the parameters of plant height growth, number of fresh leaves, and harvest weight of sample plants are watering once a day [6]. The planting season in North Sulawesi changes and is difficult to predict based on the prevailing seasons in the area. The rainy season sometimes comes quickly and ends quickly, so the experience of dry land farmers often experiences crop failures or low production due to lack of water. Whereas the growth of shallots requires sufficient water throughout its life. Shallots are almost 90% awakened from the water. So the growth and development of plants and their products require a lot of water. The results of the study [7] showed that the frequency of watering and the type of cultivar affected growth and yield.

Conditions like this require secondary irrigation which is used to meet the water needs of shallots throughout the growing period until harvest [8]. In dry land, water enters the technological component which is inputted to meet the water needs of shallot plants. Drought is related to the availability of water which is an important factor in plant growth. Secondary irrigation can utilize river water resources, drilled wells, shallow wells, and springs. The harvested water is collected in reservoirs and used when needed. The use of PVC pipes in distributing water in plants is more water-efficient than other methods. The use of sprinklers in irrigation is seen as an effective and water-saving method of irrigation. Shallot irrigation using this method is applied according to the plant's water needs based on the plant growth phase.

The effect of irrigation frequency on yield, root water uptake, shoot density, etc., has been investigated for various crops [9-12], but the information is scarce for dry or semi-arid shallots. Facts on the ground show that the potential for water available at the location has not been optimally utilized by shallot farmers because it is constrained by electricity that drives an expensive electric pump. But with the development of battery and solar cell technology that is increasingly advanced, the use of more advanced technology in agriculture continues to be developed. In this paper, the researcher conveys the results of the research on water harvesting and then the water is used to meet the water shortage needed by shallots in dry land using pressurized irrigation through sprinklers, this is seen as an efficient irrigation method. Because the water from the pump is directly leaked, the distribution of water is uneven to the plants due to the limited water being lost due to translocations in the soil, so it is necessary to conduct an efficient irrigation study so that not a lot of water is wasted or is not utilized by plants.

2 Method

The climate characteristics in Kawangkoan District, Tonsewer Village have two seasons, namely the dry season and the rainy season. The rainy season in this area starts from

November to April with an average of 23 days per month with an average rainfall of 244.53 mm per month. In the dry season, the rainfall is less than 13 days per month with an average rainfall of 177.53 cm per month. The minimum humidity per month is 80.50%. The research location is at an altitude of 800 above sea level. The dominant soil types are regosol and andosol with a pH of 4.5-7.5.

The research started in 2017. The irrigation treatment test used high-yielding Lansuna varieties that grew well in the research location. The layout of the assessment in the field used a randomized block design with 5 replications with 2 treatments, namely P1: pressurized shallots watered for 4 hours per day with an interval of 3 days of watering. For comparison P2: water sources depend on climate and rainfall during the study. The size of the onion bulbs planted is approximately 1.8 cm in diameter. Breaking dormancy in shallot bulbs was done by cutting the shoots 0.5cm before planting. Treatment to prevent infectious diseases in seedlings was carried out by mixing 100 kg of shallot seeds with 100 g of mancozeb fungicide then the seeds were put in a plastic bag and stored for 2 days before planting. Planting space 20 x 25 m. Fertilization was carried out on the beds 7 days before planting at a dose (N 80 kg, P205 100-125 kg/ha K2O 100-120 kg/ha), then fertilizing 10-15 days after planting was done at 85 N by stocking. on the bed, then 35 - 35 days after 85 kg N is applied and sprinkled on the bed. Weeding depends on weed conditions. Harvest, when the plants reach the age of 60-70 DAP or 60% of shallot stems, fall off. Withering is done for 7 - 14 days in the sun.

Data collection technique. Data were observed for each 4mx4m treatment plot. Each plot observed 10 clumps of plants which were sampled randomly. A total of 250 clumps were observed. The same thing is also observed in the existing technology where the water source only comes from rainfall of an area of 0.5 ha. The observation data collected are (1). weight of fresh leaves (burner) per clump, (2) Weight of tubers at harvest (3). The average number of tubers per plant (4). The yield of tubers tons per ha. analysis of the effect of irrigation treatment on crops observed weather data, rainfall, rainy days, and humidity during the study. The data obtained were analyzed statistically by T-test.

3 Results and discussion

3.1 Fresh weight of leaves at harvest per clump

Shallots are plants that require sufficient water and cannot stand waterlogging. dry land conditions cause plant stress [13]. The availability of water is sufficient for producing plants with a high yield and quality of shallot bulbs. Shallots are very sensitive to water shortages during the growing season. According to [14], a decrease below 25% of the optimal water capacity decreases yield. keeping soil water content below optimal levels throughout the growing season can improve water use efficiency.[15]. limited groundwater conditions limited water reduced growth. Availability of water and fertilization determines the increase in plant weight, plant height, number of tillers, tuber diameter, and fresh tuber weight. tuber dry weight per clump. Proper irrigation management is essential to conserve water resources, quantitatively and qualitatively, and to produce more food with available water [4]. Irrigation scheduling is important in irrigation area management [16]. especially in semi-arid areas which are affected by drought due to limited water sources.

The results of the analysis presented in Table 1 show that the weight of the stover leaves at harvest time of the shallot plants was 3.4 grams heavier and significantly different at the 95% T test level compared to the plants kept by farmers at 1.48 grams. This shows that the addition of water to shallots plays an important role in influencing the weight of the stover at harvest. This great effect is because 90% of shallots are made up of water. Adequacy of water throughout its life cycle affects the increase in plant biomass.

This supplemental irrigation application technique according to treatment can provide sufficient and evenly distributed water around the plant which results in an almost double increase in biomass compared to plants whose water comes from existing rainfall According to [1] water is the main constituent of the plant body. The water content varies between 70-90%. Age, species, tissue, and environment affect the water content of plants. Plants need sufficient water during the growth phase.

When water availability is limited, growth is reduced. Besides being determined by the availability of water, plant weight is determined by the application of fertilization, this factor has a significant effect on plant height, the number of tillers per clump, tuber diameter, and weight of fresh tuber per clump. bunches and dry weight of tubers per clump [17]. water and nutrients are sufficient to trigger plant growth [18] stated that the function of N nutrients is to form protein and chlorophyll, the function of P is as a source of energy for growth and development of the vegetative phase, and Ca functions to activate the formation of root hairs and strengthen stems, the function of K formation protein and carbohydrates. S function helps in the formation of amino acids and other growth processes, there are also microelements Fe, and Zn which are available and absorbed by plants for vegetative growth. The results of the study [19] showed that the factor that affected the dry weight of soybean stover was the level of drought stress. Furthermore, it is said that the lower the level of drought stress treatment causes a decrease in the biomass produced so that the dry weight of the furnace is lower. Lack of water reduces vegetative development and plant yield by reducing leaf development, thereby reducing canopy photosynthesis. Photosynthetic activity produces photosynthate to support plant growth and development. photosynthate residues are translocated to plant zinc. thereby increasing the yield and weight of the stove formed. The greater the amount of photosynthesis produced, the higher the yield. according to [1] that the higher the photosynthetic yield, the greater the accumulation of photosynthate in the plant sink.

Table 1. Fresh weight of leaves at harvest per clump, number of tubers per clump, tuber weight per clump, and yield per ha in watering treatment.

Treatment	Fresh weight of leaves at harvest per clump (g)	Number of tubers per plant	Bulb weight per clump (g)	The yield of tubers per ha Ton
P1	3.40[a]	5.24[a]	94.52[a]	11.342[a]
P2	1.48[b]	5.20[a]	46.24[b]	5.49[b]

Note: followed by the same letter in the same column are not significantly different according to the T-test at the 5% level.
-P1 was addition irrigation
-P2 was existing water sources (depend to the weather)

3.2 Bulb weight per clump

Bulb weight per clump was strongly influenced by irrigation treatment, it can be seen from the results of the T-test analysis presented in Table 1 that the addition of P1 irrigation increased the weight of shallot bulbs by an average of 94.52 g per clump, which was higher and significantly different from the results obtained. farmers get an average tuber weight at harvest of 46.24 g per plant. This shows that only by increasing the availability of water continuously the weight of shallot bulbs increases twofold. [7] stated that the weight gain of shallot bulbs was affected by water. [21] stated that the frequency of watering treatment had a significant effect on the fresh weight of tubers. This is because it determines the results of photosynthesis and cell division. which is sufficient during the growth phase and the generative phase of photosynthesis occurs optimally so that the sink prepared by the plant is filled. it can be seen that the weight of the onion bulbs increases.

3.3 Shallot yield per ha

Likewise, the results of the analysis of tuber yields per ha (Table 1). It can be seen that the effect of irrigation using sprinkling is significant, 11.342 tons per ha, which is significantly higher than regular irrigation from the yield of shallot bulbs at 5,490 tons per ha. It is seen that the yield increase is up to two times just because of changing the irrigation technique. The results of [8] state that the frequency of watering affects the growth and yield of shallots. [20] stated that it takes 156 liters of water to produce 1 kg of onion bulbs. Meanwhile, the results of the study [22] reported that the average water use of shallot farmers was 4,122 m^3 per ha. [4] stated cultivation techniques used by farmers (empirical irrigation and fertilization practices) can contribute to the waste of water resources and negative impacts on the environment (pollution of ground and surface water by chemicals). This work relates to the study of the impact of different irrigation schedules on the water balance components of shallot crops in the sub-Saharan zone.

The response of plant varieties to adapt to drought stress depends on the intensity and period of stress, growth phase, and plant genotype. The frequency of watering was significantly different on the parameter of hydrogen peroxide produced by the highest shallot. The frequency of watering once every 5 days resulted in the highest ascorbate peroxidase enzyme activity and was significantly different from other treatments [23]. Enzymes are a form of plant defense to maintain a complex system of several types of antioxidants that arise when plants experience environmental stress. If the plant's metabolic system is maintained, the source and zinc system can run normally so that plants can produce optimally.

4 Conclusion

Shallot cultivation in dry land has limited water availability, so efficient water management is needed. The cultivation technology package by adding a supplementary irrigation component using pressurized water increases the weight of the shallot stover, the weight of tubers per plant, and the weight of tubers per ha the result is a 2-fold increase compared to the existing technology. This shows that shallot production at the study site still has the potential to be doubled from the existing technology.

The development of shallots in dry land can be cultivated throughout the year if drilled wells are available or water is available around the water plantations, it can be harvested for supplementary irrigation if there is insufficient rainwater in the dry season. Supplementary irrigation delivers water through pipes and uses a water pump. Pressurized water with sprinkler application can be applied to increase yield and harvest certainty.

Reference

1. Gardner, F.P., Perace, R.B., dan Mitchell, R.L. *Fisiologi Tanaman Budidaya* (Penerjemah: Susilo, H. Jakarta: UI Press. 1991)
2. Wu, Y., & D.J. Cosgrove. Adaptation of Roots to Low Water Potential by Change in Cell Wall Extensibility and Cell Wall Proteins. J. of Exp. Bot. **51350**, 1543 – 1553, (2000)
3. Patel dan Rajput. ‘Effect of deficit irrigation on crop growth, yield and quality of onion in subsurface drip irrigation, Int. J. Plant. Prod., **73**, 417–436, (2013)
4. A.Mermoud, TD.Tamini dan H. Yacouba. ‘Impacts of different irrigation schedules on the water balance components of an onion crop in a semiarid zone’, Agricultural Water Management, **77**, 282–295 (2005)

5. Rejekiningrum, P., & Kartiwa, B. Pengembangan Sistem Irigasi Pompa Tenaga Surya Hemat Air Dan Energi Untuk Antisipasi Perubahan Iklim di Kabupaten Bantul, Daerah Istimewa Yogyakarta. J.Tanah Dan Iklim **412**, 159 (2020)
6. Fauziah, R., Susila, A. D., & Sulistyono, E. Budidaya Bawang Merah (Allium ascalonicum L.) pada Lahan Kering Menggunakan Irigasi Sprinkler pada berbagai Volume dan Frekuensi. J. Hortikultura Indonesia, **71** (2016)
7. Ariska, N., Rachmawati, & Diah. Pengaruh Ketersediaan Air Berbeda Terhadap Pertumbuhan dan Hasil Tiga Kultivar Bawang Merah (*Allium cepa* L). Agrotek Lestari, **42,** 42–50 (2017)
8. Haryati, U. Teknologi Irigasi Suplemen untuk Adaptasi Perubahan Iklim pada Pertanian Lahan Kering. J.Sumberdaya Lahan, **81**, 43–57 (2014)
9. M. Imtiyaz Response of six vegetable crops to irrigation schedules. Agric. Water Manage (2000).
10. Camposeo dan Rubino. Effect of irrigation frequency on root water uptake in sugar beet. Plant Soil (2003)
11. Jordan et al., Effect of irrigation frequency on turf quality, shoot density, and root length density of five bentgrass cultivars. Crop Science. (2003)
12. B. Hanson et al. Response of garlic to irrigation water. Agriculture Water Manage. (2003)
13. M.A. Pasigai, A.R. Thaha, Maemunah, Nasir, B., Lasmini, S. A., dan Bahrudin. Teknologi Budidaya Bawang Merah Varietas Lembah Palu (2016)
14. B. Pejic, Gajic, B., Bosnjak, D., Stricevic, R., Mackic, K., & Kresovic, B. Effects of water stress on water use and yield of onion. Bulgarian J. of Agriculture Science, **202**, 71-76 (2014)
15. T.T. Tolossa. Onion yield response to irrigation level during low and high sensitive growth stages and bulb quality under semi-arid climate conditions of Western Ethiopia. Cogent Food & Agriculture, **71** (2021)
16. M.S. Al-Jamal. Yield-based, irrigated onion crop coefficients Appl. Eng. Agric. (1999)
17. Cahaya, N., Trisnaningsih, U., & Saleh, I. Respon pertumbuhan dan hasil bawang merah (allium ascalonicum) kultivar bima brebes terhadap bokashi brangkasan kedelai. J. Pertanian Presisi (Journal of Precision Agriculture), **52**, 126–137 (2021)
18. Hadisuwito, S. *Membuat Pupuk Kompos Cair* (Penerbit Agromedia Pustaka, Jakarta, 2007)
19. I. F. Faradisa, B. Sukowardojo, G. Subroto. Pengaruh Cekaman Kekeringan Terhadap Hasil Dan Mutu Fisiologis Dua Varietas Kedelai (*Glycine Max* L. Merr). Agritrop J. Ilmu-Ilmu Pertanian., 119-124 (2014)
20. Arifin, Z., & Saeri, M. Pengelolaan Air dan Mulsa pada Tanaman Bawang Merah di Lahan Kering (Water Management and Mulch on Shalot in Dry Land). J. Hortikultura, **292**, 159 (2020)
21. A. Sumarianti, K. D. Jayanti dan Y. Tanari. Pengaruh frekuensi penyiraman terhadap pertumbuhan dan hasil bawang merah (*Allium cepa* L.). Agrovigor: J. Agroekoteknologi, **151,** 39–43 (2022)
22. Usman, A. Efisiensi Penggunaan Air Irigasi Sumur Pompa Artesis Pada Usahatani Lahan Kering Di Lombok Timur Nusa Tenggara Barat. Jurnal Ekosains, **103**, 8–14 (2012)
23. Rahmawati, N., Mawarni, L., & Sari, N. U. Physiological character analysis of two shallot varieties at various watering frequencies. *IOP Conference Series: Earth and Environmental Science*, **7824** (2021)