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Effects of Controlled Humidity on the Growth of Spring Onions

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Authors' contributions

This work was carried out in collaboration among all authorsAll authors read and approved the final manuscript.

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ABSTRACT

This study investigates the influence of environmental factors, specifically relative humidity on plant growth. The objective was to assess the impact of maintaining relative humidity levels between 60% and 70% on the growth of spring onions caried out at the Mindanao State University at Naawan - Integrated Developmental School campus. Key parameters such as leaf appearance and weight were measured for spring onions grown in two different environments: a mini greenhouse equipped with a commercial humidifier and an open field. The collected data was subjected to statistical analysis using the mean, T-test, and Mann-Whitney U test. The findings revealed that the average weight of spring onions grown in a controlled humidity environment was significantly higher than those grown in the open field, where the average relative humidity was below 40%. In terms of

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leaf appearance, 93% of the spring onions grown in controlled humidity exhibited normal conditions, compared to only 80% of those grown in the open field. In conclusion, for both parameters assessed in this study, spring onions grown in a controlled humidity environment demonstrated significantly better growth and quality than those grown in the open field, with a significant difference ($p<0.05$) observed between the two growth environments. Lastly, based on weather conditions, the study recommends the activation of humidifiers only during sunny weather, when relative humidity levels are considerably low. This research contributes valuable insights to the field of agricultural science and has potential implications for improving the yield and quality of spring onions.

Keywords: Controlled humidity; mini greenhouse; open field; leaf appearance; weight; relative humidity; spring onion.

1. INTRODUCTION

Spring onion *(Allium fistulosum L.)* belongs to subgenus Cepa, genus Allium and family Liliaceae and popularly known as scallion, welsh onion and Japanese bunching onion. These plants are grown throughout the world in a wide range of climates, from temperate to tropical conditions [1]. Spring onion *(Allium fistulosum L.)* is a leafy vegetable with great health benefits to human beings and an indispensable ingredient known for its flavor and aroma [2,3,4,5]. Since spring onion is one of the most commonly cultivated vegetables around the world, it is important to understand optimal growth conditions for this crop. [6].

Most plant problems are caused by environmental stress, either directly or indirectly. Many studies support that these environmental factors include temperature, humidity, drought, flooding, soil properties, agronomic factors, high salinity, cold, and heat [7,8]. The growth and development of onions are also influenced by various environmental factors, including temperature, light, and humidity [9]. A crucial factor in plant growth is the moisture content present in the air, which is scientifically referred to as relative humidity (RH). Relative humidity is a term that has been defined in numerous studies as the ratio of the current amount of water vapor present in the air to the maximum amount of water vapor the air could potentially hold at the same temperature [10-13]. Relative humidity of ambient air is a critical parameter for crop production as it influences the water balance and photosynthesis process in the plants [14]. Several studies have stated that humidity plays an important role in crop production as it influences the water balance, leaf transpiration, and photosynthesis processes in plants. Studies also show that a low level of humidity will lead to low moisture and increase stomatal resistance, which leads to a reduction in carbon dioxide uptake and photosynthesis rate, while a high humidity level will lead to mold and bacteria growth and can even cause development disorder [15,16,17,18,19,20]. Changes in the relative humidity and temperature can have a direct impact on the photosynthesis process, thus it will influence the growth and development of plants. This can pose a significant challenge for plants that have a limited ability to regulate their water loss that could lead to dehydration and potential damage to the plant.

Multiple studies reported that controlling humidity plays a crucial role in plant growth and yield [21,22,23,24]. In this study, a humidifier was used to control the humidity inside the greenhouse. The humidifier is made from widely available and cost-effective materials for the set up. It also can help maintain an optimal level of humidity within an enclosed compartment that be called a "mini greenhouse," ensuring the air retains sufficient moisture for healthy growth. A mini-greenhouse requires an upfront investment for construction and materials like bamboo, coco lumber, plastic, and humidifiers. It offers significant advantages, such as protection from pests and diseases. Conversely, open-field planting of spring onions has lower initial costs, needing only a fence and pot, and benefits from natural sunlight and air, crucial for plant health. The study aimed to determine the difference between the growth and quality of spring onions in humid and open air environment in terms of their leaf appearance and weight.

2. MATERIALS AND METHODS

The experiment comparing the spring onion plant growth in an open and closed environment was conducted at Mindanao State University at Naawan - Integrated Developmental School at Poblacion, Nawaan Misamis Oriental, 9023. This

well-equipped school provided a stable and secured environment for the spring onions to be planted, with sufficient sunlight exposure and rich loam soil nutrient. This study used a quantitative research approach and the pre-grown spring onions were planted and grown inside the mini greenhouse with a humidifier and in the open field. The structure of the mini greenhouse is composed of bamboo, coco lumber, and transparent plastic cover. Four (4) bamboos were used as pillars to ensure the stability and support of the mini greenhouse. Another support added is the coco lumbers that served as the foundation of the mini greenhouse. To enclose, transparent plastic covers are wrapped around the sides of the mini greenhouse to control the humidity inside. The mini greenhouse has an approximate size of 6ft x 4ft x 5ft. In contrast, the open field set up is directly exposed to the open environment and considered as the traditional method of planting. Both of the growth environments have 3 plant boxes sized containing 10 plants each.

Fig. 1. Set-up of humidifiers inside the mini-greenhouse

The humidifiers used are cost-effectively made by using a plastic Tupperware with 2 mist-makers attached. To control the humidity inside the mini greenhouse, a relative humidity of 60% to 70% was maintained for 30 days while growing the spring onion. This is based on the study conducted by Zheng et al. [25] suggesting that humidity levels between 60% to 70% maintains the optimal growth of plants. If the relative humidity exceeded the given standard humidity, the mini greenhouse was opened. However, if the relative humidity was lower than the standard humidity, the humidifiers were turned on. Humidifiers are only activated when the relative humidity levels inside the mini greenhouse are below 60% and turned off if the humidity exceeds 70%. The relative humidity for both plant sets was regularly monitored and measured every hour in the daytime, from 7:00 a.m. to 5:00 p.m., using an electronic hygrometer. As the spring onions were growing, observations were made that the spring onions in the open field were leaner compared to the spring onions inside the mini greenhouse. In addition, more spring onions in the open field failed to survive. The spring onions were grown for twenty-eight (28) days and harvested to determine and evaluate the results of weight and leaf appearance. Observations were analyzed using the mean, T-test, and Mann-Whitney U test.

3. RESULTS AND DISCUSSION

3.1 The Growth of Spring Onions in Terms of Weight in Controlled Humidity and in the Open Field

The growth of spring onions, quantified in terms of weight, under two distinct conditions revealed that the spring onions cultivated with controlled humidity exhibit a significantly higher average weight of 5.8 grams compared to 4.3 grams of spring onions in the open field. The data is based on a sample size of 30 spring onions for each group and the t-statistic for these groups is 2.8462, with a p-value of 0.0061 thus indicates the significant difference between the two growth set-ups. This study aligns with the findings of Lind et al. [26] which showed stable plant growth under controlled humidity levels of 55% to 95%. The research suggests that optimal plant growth can be achieved under regulated humidity. In this study, spring onions grown under controlled humidity conditions were larger and heavier than those grown under uncontrolled humidity. This highlights the effectiveness of humidity control in maximizing agricultural yield.

3.2 The Quality of Spring Onions in Terms of Leaf Appearances in Controlled Humidity and in the Open Field

Results showed that 93% of spring onions grown under controlled humidity were in a normal condition, with 18 in good condition, 1 excellent, 10 fair, and only 1 withered out of a sample size of 30. In contrast, in an open field environment, only 80% showed good conditions with 11 in good, 13 in fair conditions, and 3 withered. Both environments suffer plant wilting disease due to water loss. Plants were also affected by pest damages (e.g. caterpillars & locusts). However,

the plants inside the mini-greenhouse only suffered a minority of pest damage and wilting while plants in the open field were directly affected due to the open environment. Furthermore, the mean rank for leaf appearance was higher for the controlled humidity group (35.42) compared to the dependent group (25.58). Statistical analysis yielded a U-value of 302.5 and a significant p-value of 0.03, rejecting the null hypothesis and suggesting that the improved leaf appearance is likely due to controlled humidity. A similar study conducted by Mourik et al. [27] stated that controlling humidity is crucial for plant growth and yield. Both high and low humidity levels can affect plant health, with high humidity promoting diseases and pests, and low humidity causing rapid water loss and stress symptoms in plants. Therefore, controlling humidity is essential for overall plant health and significantly contributes to leaf appearance.

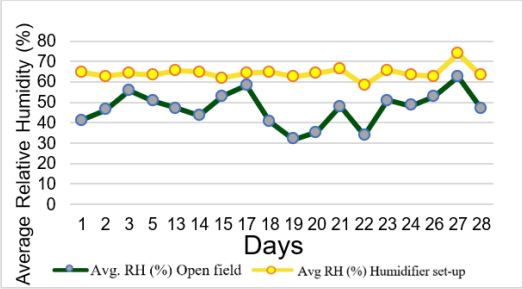

Fig. 2. The average relative humidity of the two treatments during activation hours of humidifiers

Findings (Fig. 1) showed the average relative humidity upon the usage of humidifiers inside the mini-greenhouse in comparison with the open field set-up. The results showed that the humidifier has maintained a consistent relative humidity inside the greenhouse ranging from 60%-70% during its activation hours which is commonly from 11 AM to 4 PM depending on the weather conditions and heat temperatures. On the other hand, the treatment without the use of a humidifier has an inconsistent range of relative humidity depending on the factors in the open environment, dropping to as low as 30% without the humidifier.

4. CONCLUSION

Findings revealed that spring onions cultivated under controlled humidity conditions show a marked improvement in both weight and leaf appearance compared to those grown in an open field. Findings highlight the importance of controlled humidity on maintaining the growth and enhancing the overall quality of the spring onions. The study also observed that plants in the controlled environment were generally healthier compared to those in the open field, which were less robust. This suggests that managing humidity is crucial for the health and productivity of spring onion crops. Moreover, the study found that humidifiers can only be useful during sunny conditions where relative humidity levels are considerably low. Future studies should explore how to improve humidifiers which will be able to control humidity effectively regardless of weather conditions and output, which could lead to more efficient farming practices and providing valuable insights for enhancing crop cultivation techniques.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Ramakrishna Y, Thapa M, Singh BK, Singh SB. Thapa M. Allium fistulosum (welsh onion): Spicing the cuisines of Mizo tribes. Allium and Umbelliferae Improvement Newsletter; 2012.
2. Muhammad SA, Adam AB, Onumashi U, Ahmad KB. Phytochemical screening of lettuce, spring onion and spinach cultivated at Farin Gada Farm land. Geotechnical and Geological Engineering. 2023;2(1):45–48.
3. Luu H, Green I, Lee LT. Effects of vermicompost on the growth and yield of spring onion (*Allium fistulosum* L.). Journal of Agricultural Sciences Belgrade. 2024; 69(1):31–44.
DOI: 10.2298/JAS2401031L
4. Chang et al. — Al-Khayri, M, Jain SM, Johnson DV. Advances in plant breeding strategies: Vegetable crops volume 10: Leaves, flowerheads, green pods, mushrooms and truffles; 2021.
Available:https://doi.org/10.1007/978-3-030-66969-0

5. Ibrahim AM, Kayat F, Mohammed A. Spring onion (*Allium fistulosum* L.) breeding strategies. In: Al-Khayri, J.M., Jain, S.M., Johnson, D.V. (eds). Advances in Plant Breeding Strategies: Vegetable Crops. Springer, Cham.978- 3-030-66969-0_4; 2021.
DOI: 10.1007/978-3-030-66969-0
6. Zhou Y, Dhillon A, Xiao V. Effect of water pH on spring onion growth; 2021.
Available:https://ojs.library.ubc.ca/index.php/expedition/article/view/196142
7. Singh H, Dahiphale A, Singh RK. Environmental factors affecting growth and productivity of crops. Conference: International Conference on "Climate Change and Its Implications on Crop Production and Food Security."; 2016.
DOI:10.13140/RG.2.2.16576.58882
8. Sharma D. Effect of environmental factors on vegetable production. Journal of Pharmacognosy and Phytochemistry. 2020;9(4):610–612.
9. Deshi K, Nanbol K, Obasi M, Okechalu B, Sirajo S. The effect of growth environments on the growth and yield of onion (*Allium cepa* L.) in Jos, Plateau State, Nigeria; 2018.
10. Meena MK, Suman M. Evaluation of Okra varieties under sub-humid plains of South-East Rajasthan for morphological and phenological traits. Asian Res. J. Agric. [Internet]. 2024;17(1):49-55.
[Cited 2024 Jun. 4]
Available:https://journalarja.com/index.php/ARJA/article/view/409
11. Vaniya R, Mahatma L. Green molecules in plant health management. J. Exp. Agric. Int. [Internet]. 2023;45(10):122-9.
[Cited 2024 Jun. 4]
Available:https://journaljeai.com/index.php/JEAI/article/view/2206
12. Wakchaure GC, Minhas PS, Meena KK, Singh NP, Hegade PM, Sorty AM. Growth, bulb yield, water productivity and quality of onion (*Allium cepa* L.) as affected by deficit irrigation regimes and exogenous application of plant bio–regulators. Agricultural Water Management. 2018;199:1-0.
13. Lysenko EA, Kozuleva MA, Klaus AA, Pshybytko NL, Kusnetsov VV. Lower air humidity reduced both the plant growth and activities of photosystems I and II under prolonged heat stress. Plant Physiology and Biochemistry. 2023;194:246-62.
14. Chia SY, Lim MW. A critical review on the influence of humidity for plant growth forecasting. IOP Conference Series. Materials Science and Engineering. 2022; 1257(1):012001.
15. Han W, Yang Z, Huang L, Sun C, Yu X, Zhao M. Fuzzy comprehensive evaluation of the effects of relative air humidity on the morpho-physiological traits of Pakchoi (*Brassica Chinensis* L.) under high temperature. Sci. Hortic. 2019;246: 971–978.
DOI: 10.1016/j.scienta.2018.11.079.
16. Amani M, Foroushani S, Sultan M, Bahrami M. Comprehensive review on dehumidification strategies for agricultural greenhouse applications. Appl. Therm. Eng. 2020;181:115979.
DOI:10.1016/j.applthermaleng.2020.115979
DOI:10.1016/j.applthermaleng.2020.115979
17. Hsie B, Mendes K, Antunes W, Endres L, Campos M, Souza F, Ssntos N, Singh B, Arruda E, Pompelli M. Jatropha curcas L. (Euphorbiaceae) modulates stomatal traits in response to leaf-to-air vapor pressure deficit. Biomass and Bioenergy. 2015;81:273–281.
DOI: 10.1016/j.biombioe.2015.07.014
18. Abidin I, Faridah SN, Sapsal MT, Samsuar S, Mubarak H. Automation of humidity in the greenhouses for plant cultivation. Department of Agricultural Technology, Faculty of Agriculture, Hasanuddin University, 90245, Makassar, Indonesia. 2024;96.
DOI: 10.1051/bioconf/20249604004
19. Thazin T, Aung ZL, Win TT. 1 IoT based hydroponic temperature and humidity control system using fuzzy logic. Department of Computer Engineering and Information Technology Yangon Technological University, Yangon, Myanmar; 2019.
20. Grange RI, Hand DW, Grange RI, Hand DW. A review of the effects of atmospheric humidity on the growth of horticultural crops. Journal of Horticultural Science. 1987;62:2:125-134.
DOI: 10.1080/14620316.1987.11515760
21. Gulandaz MA, Kabir S, Kabir SN, Ali M, Reza N, Haque A, Jang GH, Chung SO. Layout of suspension-type small-sized dehumidifiers affects humidity variability and energy consumption in greenhouses.

Controlled Environment Horticulture: Latest Advances and Future Prospects). 2024; 10(1).
DOI: 10.3390/horticulturae10010063

22. Mañas F, Hägglund T, Guzman JL, Rodriguez F, Berenguel M. A practical solution for multivariable control of temperature and humidity in greenhouses. European Journal of Control. 2024;77:100967.
DOI:10.1016/j.ejcon.2024.100967

23. Boughamsa M, Hamza A, Ramdani M. Multiscale fuzzy model-based short term predictive control of greenhouse microclimate. 2015 IEEE 13th International Conference on Industrial Informatics (INDIN), Cambridge, UK. 2015;1348-1353.

24. Hadidi A, Youcef S, Saba D. Intelligent multiagent system for agricultural management processes (Case Study: Greenhouse). The Digital Agricultural Revolution. 2022;143–170.
DOI: 10.1002/9781119823469.ch6

25. Zheng Y, Yang Z, Xu C, Wang L, Huang H, Yang S. The interactive effects of daytime high temperature and humidity on growth and endogenous hormone concentration of tomato seedlings. HortScience Horts. 2020;55(10):1575-1583. Retrieved May 21, 2024.
DOI: 10.21273/HORTSCI15145-20

26. Lind KR, Lee N, Sizmur T, Siemianowski O, Van Bruggen S, Ganapathy Subramaniam B, et al. Plant growth environments with programmable relative humidity and homogeneous nutrient availability. PLoS ONE. 2016; 11(6):e0155960.
DOI: 10.1371/journal.pone.0155960

27. Mourik S, Ooster B, Vellekoop M. Plant performance in precision horticulture: Optimal climate control under stochastic dynamics; 2023.

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