VERTICAL GARDEN SYSTEM FOR RED ONION (*Allium cepa L.*) PRODUCTION USING DRIP IRRIGATION INSIDE A GREENHOUSE

LEGASPI, NIEL MARCO R.
PAJARILLO, ROBERT ROY C.

An Undergraduate Thesis Manuscript Submitted to the Faculty of the Department of Agricultural and Biosystems Engineering, College of Engineering, Central Luzon State University Science City of Munoz, Nueva Ecija, Philippines in Partial Fulfillment of the Requirements for the Degree of

BACHELOR OF SCIENCE IN AGRICULTURAL AND BIOSYSTEMS ENGINEERING
(AB Land and Water Resources Engineering)

JUNE 2023

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDIX TABLES

LIST OF APPENDIX FIGURES

ABSTRACT

LEGASPI, NIEL MARCO R., PAJARILLO, ROBERT ROY C., Department of Agricultural and Biosystems Engineering, Central Luzon State University, Science of Munoz, Nueva Ecija, Philippines. **June 28. VERTICAL GARDEN SYSTEM FOR RED ONION (*Allium cepa* L.) PRODUCTION USING DRIP IRRIGATION INSIDE A GREENHOUSE.**

Adviser: JOHN PAULO C. SACDALAN, Ph.D

This study aimed to construct a vertical garden and install drip irrigation for red onion production in a greenhouse. The research focused on constructing the vertical garden structures, implementing drip irrigation, and evaluating the growth response of onions based on different stacking intervals and rooting depths. Cultural practices, including seedling preparation, weed and pest control, and the irrigation scheme, were followed. The experimental plot was irrigated using a drip irrigation system installed in the field. Six treatments, consisting of three stacking intervals (SI76, SI56, and SI36) and two rooting depths (RD31 and RD16), were replicated three times. Parameters such as number of leaves, leaf length, plant height, bulb diameter, bulb weight, and root length were measured. Data for growth parameters were analyzed using Analysis of Variance to determine significant differences between factors. Two-way ANOVA and Duncan Multiple Range Test (DMRT) were used to compare the data from each vertical structure. Other observations, such as cropstand and occurrence of insect pests and diseases, were also recorded. The results showed a moderately strong relationship between temperature and leaf growth, indicated by an R2 value of 0.67. The analysis of the growth response revealed that stacking interval and rooting depth had a similar effect on the number of leaves (average of 3.91) and leaf growth (weekly average of 1.43 cm). The interaction of

factor A2B2 resulted in the tallest plant height (32.67 cm), while the interaction of A1B1 recorded the highest bulb diameter (average of 4.27 cm) and bulb weight (average of 2.67 g). These growth parameters did not exhibit significant differences. However, the stacking intervals of 0.71 m and 0.56 m had distinct effects on root length, with average lengths of 2.92 and 1.29, respectively.

Keywords: vertical garden; drip irrigation; growth; stacking interval; rooting depth

LITERATURE CITED

Abdisa, T, Chali, A. & Tolesa, K. (2009). Effect of intra row spacing on the yield of three onions (allium cepa L.) varieties at Adami Tulu Agricultural Research Center (mid rift valley of Ethiopia). *Journal of Horticulture and Forestry 2 (1): 7-11.*

Adam, K. (2006). Organic Allium Production. *A Publication of ATTRA – National Sustainable Agriculture Information Service*. https://vdocuments.mx/organic-allium-production-5584a1fdc798b.html?page=1

Arega, M. and Tena, A. (2012). Deficit Irrigation Application Using Center Pivot Sprinkler Irrigation for Onion Production. *International Journal of Basic and Applied Sciences* 1(2): 148-159. Retrieved from https://www.crdeep.org

Bos, M. G., Kselik, R. A. L., Allen, R. G., and Molden, D.J. (2009). Water Requirement for Irrigation and the Environment. *Springer*. https://doi.org/10.1007/978-1-4020-8948-0

Bossie, M., Tilahum, K., & Hordofa, T. (2009). Crop Coeffiecient and evapotranspiration of onion at Awash Melkassa, Central Rift Valley of Ethiopia. Irrigation and Drainage Systems, 23(1), 1–10. https://doi.org/10.1007/s10795-009-9059-9

Brewster, J. L. (2008). Onions and other vegetable Alliums (2nd ed.). CAB International. https://books.google.com/books?hl=en&lr=&id=eW_TiZ1jHCkC&oi=fnd&pg=PR5&dq=Brewster,+J.+L.+(2008).+Onions+and+Other+Vegetable+Alliums+(2nd+Edition).+Wallingford:+CAB+International.&ots=SIHj0z2tb&sig=HNmrQQz7ddNphzxZUZAS4m4pC64

Briggs, W. R. (2001). Photoreceptors in Plant Photomorphogenesis to Date. Five Phytochromes, Two Cryptochromes, One Phototropin, and One Superchrome. PLANT PHYSIOLOGY, 125(1), 85–88. doi:10.1104/pp.125.1.85.

Chatterjee, A., Debnath, S., & Pal, H. (2020). Implication of Urban Agriculture and Vertical Farming for Future Sustainability. *Urban Horticulture - Necessity of the Future*. https://doi.org/10.5772/intechopen.91133.

Department of Agriculture (2022). *The Philippine Onion Industry Roadmap 2021 to 2025*. Retrieved from http://www.pcaf.da.gov.ph/wp-content/uploads/2022/06/Philippine-Onion-Industry-Roadmap-2021-2025.pdf.

Despommier, D. & Ellingsen, E. (2008). The Vertical Farm: The sky-scraper as vehicle for a sustainable urban agriculture. *CTBUH 2008, 8th World Congress - Tall and Green: Typology for a Sustainable Urban Future, Congress Proceedings*. https://www.reserachgate.net/publication/2413325575_The_Vertical_Farm_The_sky_scraper_as_vehicle_for_a_sustainable_urban_agriculture.

Despommier, D. (2010). The Encyclopedia of Earth. Trinity. Retrieved from https://www. eoearth. Org/contributor/Dickson.despommier.

Dirirsa, G., Hordofa, T., and Bekele, D. (2015). Water Requirement and Crop Coefficient of Onion (Red Bombay) in the Central Rift Valley of Ethiopia. *International Journal of Recent Research in Life Sciences* 2(1): 1-6.

Drinkwater, W.O., and Janes, B.E. (1955). Effects of irrigation and soil water on maturity, yield, and storage of two onion hybrids. *Proceedings of the American Society for Horticulture Science*. 66: 267–279.

East-West Seeds Product Catalogue. Technician Information. East – West Seeds Company, Inc., Philippines

Gitaitis, R., & Walcott, R. (2007). The epidemiology and management of seedborne bacterial diseases. Annual Review of Phytopathology, 45(1), 371–397. https://doi.org/10.1146/annurev.phyto.45.0628

Griffiths, G., Trueman, L., Crowther. T., Thomas, B. & Smith, B. (2002). Onions?A global benefit to health. *Phytotherapy research : PTR. 16. 603-15*. doi: 10.1002/ptr.1222.

Gupta, M. K. & Ganapuram, S. (2019). Vertical Farming using Information and Commun ication Technolohies. *Infosys*. Retrieved from https://www.infosys.com/industries /agriculture/insights/ documents/vertical-farming-information-communication.pdf

Hadid, A. (2022). Effect of Shading Level On Shallot Plants Seed Growth and Yield (Allium ascolonicum,L). *AGROLAND: The Agricultural Science Journal. Vol. 9, No. 1 June (2022), 44-51.*

Hayes, A. (2022). *What is cost-benefit analysis, how is it used, what are its pros and cons?*. Investopedia. Retrieved from https://www.investopedia.com/terms/c/cost-benefitanalysis.asp

Hubner Seed. (2016). Water Application Efficiency. *Monsanto Company*. 150315145842 040615CAM. Retrieved from https://www.hubnerseed.com/content/dam/hurber-seed/en-us/agronomy

Kalb T. and Shanmugasundaram S. (2001). Suggested Cultural Practices for Onion. *AVRD C – Training Guide*. Retrieved from https://himalayanblossoms.com/PDF%20Files/Onions/Cultural%20Practices%20of%20Onion.pdf

Karya Kate, Nanbol & Deshi, Kyenpiya & Okechalu, Brains & salamatu, Sirajo & Micheal, Obasi. (2020). The Effect of Growth Environments on the Growth and Yield of Onion (Allium cepa L.) in Jos, Plateau State, Nigeria. Journal of Natural Sciences Research. 8. 67_74.

Kubala, J. (2018). *9 Impressive Health Benefits of Onions*. Healthline. https://www.healthline.com/nutrition/onion-benefits

Jimenez, M., Juan, J., Tarjuelo, J. & Ortega, J. (2010). Effect of irrigation uniformity on evapotranspiration and onion yield. *The Journal of Agricultural Science. 148. 139 - 157.* doi: 10.1017/S002185960999061X.

Kenton, W. (2022). *Variable Cost: What it is and how to calculate it*. Retrieved from https://www.investopedia.com/terms/v/variablecost.asp

Khan, M., Hasan, M., Miah, M., Alam, M., & Masum, A. (2003). Effect of Plant Spacing on the Growth and Yield of Different Varieties of Onion. *Pakistan Journal of Biological Sciences*, *6*(18), 1582–1585. https://doi.org/10.3923/pjbs.2003.1582.1585

Khokhar, K. M. (2008). Effect of temperature and photoperiod on the incidence of bulbing and bolting in seedlings of onion cultivars of diverse origin. The Journal of Horticultural Science and Biotechnology, 83(4), 488–496. https://doi.org/10.1080/14620316.2008.11512412

Khokhar, K. (2019). *Part 1 Onion bulb development*. Chapter 4. Onion Soil and Nutrition. Retrieved from https://www.researchgate.net/publication/335776657_Part_1_Onion_Bukb_development_CHAPTER_4_Soil_and_Nutrition.

Latt, T. (2014). *Bulb Yield and Quality of Onion (Allium Cepa L) as Affected by Sowing Time and Potassium Supply*. Yezin Agricultural University, Nay Pyi Taw, Myanmar. Retrieved from https://meral.edu.mm/record/31/files/theint%20thanda%20latt%20MS%20thesis.pdf

Mallor, C., Balcells, M., Mallor, F., & Sales, E. (2011). *Genetic variation for bulb size, soluble solids content and pungency in the Spanish sweet onion variety Fuentes de Ebro. Response to selection for low pungency*. Plant Breeding, 130(1), 55–59. doi.org/10.1111/j.1439-0523.2009.01737

Markham, D. (2015). *Farm in a Box Produces an Acre's Worth of crops in a Shipping Container*. Retrieved from https://www.infosys.com/agriculture/insights/document/vertical-farming-information-communication.pdf

Matsunaga, W. K., Silva, V. de P. R. da, Amorim, V. P., Sales, E. S. G., Dantas, S. M., & Oliveira, A. B. (2022). Evapotranspiration, crop coefficient and water use efficiency of onion cultivated under different irrigation depths. *Revista Brasileira de Engenharia Agrícola e Ambiental*, *26*(3), 219–225. https://doi.org/10.1590/1807-1929/agriambi.v26n3p219-225.

Mezistrano, J. (2020). *New Trends & Emerging Industries in Drip Irrigation*. DRTS - Manufacturing Solutions for Drip Irrigation, Pipe Extrusion, and Mining. Retrieved from https://drts.com/blog-drip-irrigation-trends-emerging-industries/

National Onion Association (2020). *Onion Health Research*. https://www.onions-usa.org/all-about-onions/onion-health-research/

Navasero, Marcela & Montecalvo, Melissa. (2020). Effect of Entomopathogenic Fungus Metarhizium (Nomuraea) rileyi (Farl.) Samson on the Third Instar Larvae of the Onion Armyworm, Spodoptera exigua Hübner (Lepidoptera: Noctuidae) under Laboratory Conditions. Philippine Agricultural Scientist. 103. 140-145. https://s3.wp.wsu.edu/uploads/sites/2193/2017/08/Onion-PIPE-Diag-Cards.pdf

NETAFIM (n.d.). *Drip Irrigation*. Retrieved from https://www.netafim.asia/Drip-irrigation.

Ortolà, M. P. and Knox, J. W. (2015). Water Relations and Irrigation Requirements of Onion (AlliumCepa L.): A Review of Yield and Quality Impacts. *Experimental Agriculture* 51(2): 210-231. https://doi.org/10.1017/S001447971400234

Pantilu, L. I., Mantiri, F. R., Nio, S. A., & Pandiangan, D. (2012, August 1). Respons Morfologi dan Anatomi Kecambah Kacang Kedelai (Glycine max (L.) Merill) terhadap Intensitas Cahaya yang Berbeda (Morphological and Anatomical Responses of The Soybean (Glycine max (L.) Merill) Sprouts to The Different Light Intensity). *Jurnal Bios Logos*, *4*(2). https://doi.org/10.35799/jbl.2.2.2012.1044

Pascual, M.P., Lorenzo, G.A., Gabriel, A.G. (2018). *Vertical Farming Using Hydroponics System: Toward a Sustainable Onion Production in Nueva Ecija, Philippines*. Open Journal of Ecology, 08(01), 25–41. https://doi.org/10.4236/oje.2018.81003

Pelter, G. Q., Mittelstadt, R., Leib, G., Redulla, B., and Cristoti, A. (2004). Effects of water stress at specific growth stages on onion bulb yield and quality. *Agricultural Water Management*68 (2): 107–115.doi.org/10.1016/j. agwat.2004.03.010

Philippine Statistics Authority. (2015). Special Report - Highlights of the 2012 Census of Agriculture (2012 CA). Retrieved from https://psa.gov.ph/content/special-report-highlights-2012-census-agriculture-2012-ca

Roberts, J. L. (1998). Terminology: A glossary of technical terms on the economics and A glossary of technical terms on the economics and finance of health services. Retrieved from https://www.euro.who.int/_data_assets/pdf_file/0014/102173/E69927.pdf.

Sánchez, E., Ford, T., Kime, L., & Harper, J. K. (2020). Onion Production. Retrieved from https://extension.psu.edu/onion-production

Savva, A.P. & Frenken K. (2002). FAO Irrigation Manual – Localized Irrigation Systems Planning, Design, Operation, and Maintenance. Retrieved from https://www.fao.org/publications/card/ru/c/3adf250c-6c04-51f3-a9a68758f9f342e

Shao, Y., Heath, T. & Zhu, Y. (2016). *Developing an Economic Estimation System for Vertical Farms*. International Journal of Agricultural and Environmental Information Systems (IJAEIS) 7(2). doi: 10.4018/IJAEIS.2016040102.

Shock, C. (2014). *An Introduction to Drip Irrigation*. Oregon State University. Retrieved from https://agsci.oregonstate.edu/mes/irrigation/introduction-drip-irrigation.

Şimşek, M., Tonkaz, T., Kaçıra, M., Çömlekçioğlu, N., & Doğan, Z. (2005, May). The effects of different irrigation regimes on cucumber (Cucumbis sativus L.) yield and yield characteristics under open field conditions. *Agricultural Water Management*, *73*(3), 173–191. https://doi.org/10.1016/j.agwat.2004.10.013

Suleria, H., Butt, M., Khalid, N., Sultan, S., Raza A., Muhammad, A. & Abbas, M. (2015). *Garlic (Allium sativum): Diet based therapy of 21st century-a review*. Asian Pacific Journal of Tropical Disease. 5. 10.1016/S2222-1808(14)60782-9. Retrieved from https://www.researchgate.net/publication/272568343_Garlic_Allium_sativum_Diet_based_therapy_of_21st_century-a_review

Tekle, G. (2015). *Growth, Yield, and Quality of Onion (Allium Cepa L.) as Influenced by Intrarow Spacing and Nitrogen Fertilizer Levels in Central Zone of Tigray, Northern Ethiopia* (Master's Thesis). Harayama University, Harayama. https://cgspace.cgiar.org/bitstream/handle/10568/90462/Tekle.pdf?sequence=1&isAllowed=y.

Thorup-Kristensen, K. (2001). Root Growth and Soil Nitrogen Depletion by Onion Lettuce, Early Cabbage and Carrot. Acta Horticulturae. 563 (563). doi.org/10.17660/ActaHortic.2001.563.25" \t "_blank

Tunnel & Arch Greenhouses. (n.d.). *Greenhouse Emporium*. Retrieved from https://greenhouseemporium.com/collections/greenhouse-kits/tunnel-arch-greenhouse.

Villaroman, C., Espino, A., Lavarias, J., & Taylan, V. (2018). Atmometer – based irrigation irrigation scheduling system for drip – irrigated onion (Allium cepa L.). MATEC Web of Conferences, 192, 03039. doi.org/10.1051/matecconf/201819203039

Ware, G.W. and Mccollum, J.P. (1980). Producing Vegetable Crops. Interstate Press. Danville, IL, USA.

Yuliarti, N. (2010). Household Scale Network Culture. Andi. Yogyakarta.