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DAFTAR PUSTAKA

Abbas, S., Amna, Javed, M. T., Ali, Q., Azeem, M., & Ali, S. (2021). Nutrient Deficiency Stress and Relation with Plant Growth and Development. In *Engineering Tolerance in Crop Plants Against Abiotic Stress* (pp. 239–262). CRC Press. https://doi.org/10.1201/9781003160717-12

Abdelaal, K., Alkahtani, M., Attia, K., Hafez, Y., Király, L., & Künstler, A. (2021). The role of plant growth-promoting bacteria in alleviating the adverse effects of drought on plants. In *Biology* (Vol. 10, Issue 6). MDPI AG. https://doi.org/10.3390/biology10060520

Abiodun, O. I., Jantan, A., Omolara, A. E., Dada, K. V., Umar, A. M., Linus, O. U., Arshad, H., Kazaure, A. A., Gana, U., & Kiru, M. U. (2019). Comprehensive Review of Artificial Neural Network Applications to Pattern Recognition. In *IEEE Access* (Vol. 7, pp. 158820–158846). Institute of Electrical and Electronics Engineers Inc. https://doi.org/10.1109/ACCESS.2019.2945545

Ahanger, M. A., Morad-Talab, N., Abd-Allah, E. F., Ahmad, P., & Hajiboland, R. (2016). Plant growth under drought stress: Significance of mineral nutrients. In *Water Stress and Crop Plants: A Sustainable Approach* (Vols. 2–2, pp. 649–668). wiley. https://doi.org/10.1002/9781119054450.ch37

Almendro-Candel, M. B., Lucas, I. G., Navarro-Pedreño, J., & Zorpas, A. A. (2018). Physical Properties of Soils Affected by the Use of Agricultural Waste. In *Agricultural Waste and Residues*. InTech. https://doi.org/10.5772/intechopen.77993

Angeles-Fadchar, N., & Cruz, J. C. D. (2018, November). *Hybrid Irrigation System Model for Coffee Propagation Tunnel*. https://doi.org/10.1109/HNICEM.2018.8666267

Arifin, Z., Aisyawati, L., Anggraeni, L., Krismawati, A., & Trijaya, D. S. (2024). Effectiveness of NPK (11-11-28) fertilizer on the growth and yield of shallot. *IOP Conference Series: Earth and Environmental Science*, *1312*(1). https://doi.org/10.1088/1755-1315/1312/1/012045

UNIVERSITAS GADJAH MADA
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Universitas Gadjah Mada, 2025 | Diunduh dari http://etd.repository.ugm.ac.id/

Avianto, Y., Noviyanto, A., Jaya, G. I., Handru, A., Ferhat, A., Hartanto, E. S., Sidiq, M. F., Saputra, B. F., Ramadhani, J. N., & Shofry, M. A. (2024). Integrating Automated Drip Irrigation and Organic Matter to Improve Enzymatic Performance and Yield of Water Efficient Chilli in Karst Region. *Journal of Ecological Engineering*, *25*(11), 175–187. https://doi.org/10.12911/22998993/192820

Badan Pusat Statistik. (2024). *Statistik Daerah Kabupaten Gunungkidul 2024*.

Badr, M. A., Abou-Hussein, S. D., & El-Tohamy, W. A. (2016). Tomato yield, nitrogen uptake and water use efficiency as affected by planting geometry and level of nitrogen in an arid region. *Agricultural Water Management*, *169*, 90–97. https://doi.org/10.1016/j.agwat.2016.02.012

Bae, H., Ji, H., Lim, Y. J., Ryu, Y., Kim, M. H., & Kim, B. J. (2019). Characteristics of drought propagation in South Korea: relationship between meteorological, agricultural, and hydrological droughts. *Natural Hazards*, *99*(1), 1–16. https://doi.org/10.1007/s11069-019-03676-3

Bansal, G., Mahajan, A., Verma, A., & Bandhu Singh, D. (2021). A review on materialistic approach to drip irrigation system. *Materials Today: Proceedings*, *46*, 10712–10717. https://doi.org/10.1016/j.matpr.2021.01.546

Barker, L. J., Hannaford, J., Chiverton, A., & Svensson, C. (2016). From meteorological to hydrological drought using standardised indicators. *Hydrology and Earth System Sciences*, *20(6)*, 2483–2505. https://doi.org/10.5194/hessd-12-12827-2015

Beyene, A., Cornelis, W., Verhoest, N. E. C., Tilahun, S., Alamirew, T., Adgo, E., De Pue, J., & Nyssen, J. (2018). Estimating the actual evapotranspiration and deep percolation in irrigated soils of a tropical floodplain, northwest Ethiopia. *Agricultural Water Management*, *202*, 42–56. https://doi.org/10.1016/j.agwat.2018.01.022

Blatchford, M. L., Karimi, P., Bastiaanssen, W. G. M., & Nouri, H. (2018). From global goals to local gains—a framework for crop water productivity. *ISPRS International Journal of Geo-Information*, *7*(11). https://doi.org/10.3390/ijgi7110414

UNIVERSITAS GADJAH MADA
**Mitigasi Kekeringan Agronomis pada Pertanian Bawang Merah (Allium ascalonicum L.) di Lahan Lempung:
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Universitas Gadjah Mada, 2025 | Diunduh dari http://etd.repository.ugm.ac.id/

Blatchford, M. L., Mannaerts, C. M., Zeng, Y., Nouri, H., & Karimi, P. (2019). Status of accuracy in remotely sensed and in-situ agricultural water productivity estimates: A review. In *Remote Sensing of Environment* (Vol. 234). Elsevier Inc. https://doi.org/10.1016/j.rse.2019.111413

Bulle, M., Kishorekumar, R., Pathak, P. K., Wany, A., & Gupta, K. J. (2020). Measurement of Nitrate Reductase Activity in Tomato (Solanum lycopersicum L.) Leaves Under Different Conditions. In *Methods in Molecular Biology* (Vol. 2057, pp. 27–35). Humana Press Inc. https://doi.org/10.1007/978-1-4939-9790-9_3

Bwambale, E., Abagale, F. K., & Anornu, G. K. (2022). Smart irrigation monitoring and control strategies for improving water use efficiency in precision agriculture: A review. In *Agricultural Water Management* (Vol. 260). Elsevier B.V. https://doi.org/10.1016/j.agwat.2021.107324

Carranca, C., Brunetto, G., & Tagliavini, M. (2018). Nitrogen nutrition of fruit trees to reconcile productivity and environmental concerns. *Plants*, *7*(1). https://doi.org/10.3390/plants7010004

Çetin, Ö., & Akalp, E. (2019). Efficient Use of Water and Fertilizers in Irrigated Agriculture: Drip Irrigation and Fertigation. *Acta Horticulturae et Regiotecturae*, *22*(2), 97–102. https://doi.org/10.2478/ahr-2019-0019

Chen, H., Li, D., Xiao, K., & Wang, K. (2018). Soil microbial processes and resource limitation in karst and non-karst forests. *Functional Ecology*, *32*(5), 1400–1409. https://doi.org/10.1111/1365-2435.13069

Ćirić, V., Prekop, N., Šeremešić, S., Vojnov, B., Pejić, B., Radovanović, D., & Marinković, D. (2023). THE IMPLICATION OF CATION EXCHANGE CAPACITY (CEC) ASSESSMENT FOR SOIL QUALITY MANAGEMENT AND IMPROVEMENT. *Agriculture and Forestry*, *69*(4), 113–134. https://doi.org/10.17707/AgricultForest.69.4.08

Darko, R. O., Shouqi, Y., Junping, L., Haofang, Y., & Xingye, Z. (2017). Overview of advances in improving uniformity and water use efficiency of sprinkler irrigation. *International Journal of Agricultural and Biological Engineering*, *10*(2), 1–15. https://doi.org/10.3965/j.ijabe.20171002.1817

UNIVERSITAS GADJAH MADA
**Mitigasi Kekeringan Agronomis pada Pertanian Bawang Merah (Allium ascalonicum L.) di Lahan Lempung:
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Universitas Gadjah Mada, 2025 | Diunduh dari http://etd.repository.ugm.ac.id/

Dasipah, E., Sukmawaty, D., Ria, E. R., & Safa, Z. N. (2023). Increasing the productivity of shallot planting and its impact on the agricultural market, West Java. *Brazilian Journal of Biology*, *83*. https://doi.org/10.1590/1519-6984.277745

de Mello Prado, R. (2021). *Mineral nutrition of tropical plants* (Vol. 1). Switzerland Springer. https://www.researchgate.net/publication/353411467

de Salis, H. H. C., da Costa, A. M., Vianna, J. H. M., Schuler, M. A., Künne, A., Fernandes, L. F. S., & Pacheco, F. A. L. (2019). Hydrologic modeling for sustainable water resources management in urbanized karst areas. *International Journal of Environmental Research and Public Health*, *16*(14). https://doi.org/10.3390/ijerph16142542

Desalegn, T., Abera, D., Indris, S., Tolcha, W., & Hordofa, T. (2019). *Results of Natural Resources Management Research*. http://www.eiar.gov.et

Dlapa, P., Hriník, D., Hrabovský, A., Šimkovic, I., Žarnovican, H., Sekucia, F., & Kollár, J. (2020). The impact of land-use on the hierarchical pore size distribution and water retention properties in loamy soils. *Water (Switzerland)*, *12*(2). https://doi.org/10.3390/w12020339

Duc, K. N., Ancev, T., & Randall, A. (2019). Evidence of climatic change in Vietnam: Some implications for agricultural production. *Journal of Environmental Management*, *231*, 524–545. https://doi.org/10.1016/j.jenvman.2018.10.011

Eslamian, S., Ostad-Ali-Askari, K., Singh, V. P., Dalezios, N. R., Ghane, M., Yihdego, Y., & Matouq, M. (2017). A Review of Drought Indices. *International Journal of Constructive Research in Civil Engineering*, *3*(4). https://doi.org/10.20431/2454-8693.0304005

Fadhilah, M. L., Fariyanti, A., & Asmarantaka, R. W. (2023). Price Stability and Shallot Market Integration in Central Java. *Agrisocionomics: Jurnal Sosial Ekonomi Pertanian*, *7*(1), 114–125. http://ejournal2.undip.ac.id/index.php/

Fan, J., Lu, X., Gu, S., & Guo, X. (2020). Improving nutrient and water use efficiencies using water-drip irrigation and fertilization technology in

UNIVERSITAS GADJAH MADA
**Mitigasi Kekeringan Agronomis pada Pertanian Bawang Merah (Allium ascalonicum L.) di Lahan Lempung:
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Universitas Gadjah Mada, 2025 | Diunduh dari http://etd.repository.ugm.ac.id/

Northeast China. *Agricultural Water Management*, *241*. https://doi.org/10.1016/j.agwat.2020.106352

Fan, M., Qin, Y., Jiang, X., Cui, N., Wang, Y., Zhang, Y., Zhao, L., & Jiang, S. (2022). Proper Deficit Nitrogen Application and Irrigation of Tomato Can Obtain a Higher Fruit Quality and Improve Cultivation Profit. *Agronomy*, *12*(10). https://doi.org/10.3390/agronomy12102578

Farnham, C., Oishi, M., & Terai, H. (2023). Evaluation of an intermittent mist spray cooling system for improving greenhouse eggplant cultivation. *E3S Web of Conferences*, *396*. https://doi.org/10.1051/e3sconf/202339603026

Farooq, M., Hussain, M., Ul-Allah, S., & Siddique, K. H. M. (2019). Physiological and agronomic approaches for improving water-use efficiency in crop plants. In *Agricultural Water Management* (Vol. 219, pp. 95–108). Elsevier B.V. https://doi.org/10.1016/j.agwat.2019.04.010

Fathi, A. (2022). *Role of nitrogen (N) in plant growth, photosynthesis pigments, and N use efficiency: A review*. https://doi.org/10.5281/zenodo.7143588

Ferrante, A., & Mariani, L. (2018). Agronomic management for enhancing plant tolerance to abiotic stresses: High and low values of temperature, light intensity, and relative humidity. In *Horticulturae* (Vol. 4, Issue 3). MDPI Multidisciplinary Digital Publishing Institute. https://doi.org/10.3390/horticulturae4030021

Gessler, A., Schaub, M., & McDowell, N. G. (2017). The role of nutrients in drought-induced tree mortality and recovery. In *New Phytologist* (Vol. 214, Issue 2, pp. 513–520). Blackwell Publishing Ltd. https://doi.org/10.1111/nph.14340

Ginting, T. H. U., Ginting, J., & Damanik, R. I. M. (2024). Morfologi Bawang Merah (Allium ascalonicum L.) Pada Cekaman Kekeringan Terhadap Aplikasi Asam Salisilat. *JURNAL BUDIDAYA PERTANIAN*, *20*(1), 90–98. https://doi.org/10.30598/jbdp/2024.20.1.90

Gondal, A. H., Hussain, I., Bakar Ijaz, A., Zafar, A., Ch, B. I., Zafar, H., Danish Sohail, M., Niazi, H., Touseef, M., Khan, A. A., Tariq, M., Yousuf, H., & Usama, M. (2021). Influence of Soil Ph and Microbes on Mineral Solubility

UNIVERSITAS GADJAH MADA
**Mitigasi Kekeringan Agronomis pada Pertanian Bawang Merah (Allium ascalonicum L.) di Lahan Lempung:
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Universitas Gadjah Mada, 2025 | Diunduh dari http://etd.repository.ugm.ac.id/

and Plant Nutrition: A Review. *International Journal of Agriculture and Biological Sciences-ISSN*.

Govindasamy, P., Muthusamy, S. K., Bagavathiannan, M., Mowrer, J., Jagannadham, P. T. K., Maity, A., Halli, H. M., G. K, S., Vadivel, R., T. K, D., Raj, R., Pooniya, V., Babu, S., Rathore, S. S., L, M., & Tiwari, G. (2023). Nitrogen use efficiency—a key to enhance crop productivity under a changing climate. In *Frontiers in Plant Science* (Vol. 14). Frontiers Media S.A. https://doi.org/10.3389/fpls.2023.1121073

Gummadi, S., Rao, K. P. C., Seid, J., Legesse, G., Kadiyala, M. D. M., Takele, R., Amede, T., & Whitbread, A. (2018). Spatio-temporal variability and trends of precipitation and extreme rainfall events in Ethiopia in 1980–2010. *Theoretical and Applied Climatology*, *134*(3–4), 1315–1328. https://doi.org/10.1007/s00704-017-2340-1

Gupta, A., Rico-Medina, A., & Caño-Delgado, A. I. (2020). The physiology of plant responses to drought. *Science*, *368(6488)*, 266–269. https://www.science.org

Hapsoh, I. R. D., Rifa'i, M., & Husaini, M. F. (2023). Effect of Combination of Various Dosages of NPK Fertilizer with Organic Fertilizer on the Growth and Production of Shallots. *Crop Production: Grains, Legumes, Fruits, Vegetables, Flowers, Cotton: Crop Nutrition, Irrigation*, *54*(9), 34. http://creativecommons.org/licenses/by/4.0

Hara, P., Piekutowska, M., & Niedbała, G. (2021). Selection of independent variables for crop yield prediction using artificial neural network models with remote sensing data. *Land*, *10*(6). https://doi.org/10.3390/land10060609

Harahap, A. S., Luta, D. A., Sri, D., & Sitepu, M. B. (2022). KARAKTERISTIK AGRONOMI BEBERAPA VARIETAS BAWANG MERAH (Allium ascalonicum L.) DATARAN RENDAH. *Seminar Nasional UNIBA Surakarta*, 287–296.

Hasan, M. M., Hasan, M. M., Teixeira da Silva, J. A., & Li, X. (2016). Regulation of phosphorus uptake and utilization: Transitioning from current knowledge to practical strategies. In *Cellular and Molecular Biology Letters* (Vol. 21, Issue 1). BioMed Central Ltd. https://doi.org/10.1186/s11658-016-0008-y

UNIVERSITAS GADJAH MADA
**Mitigasi Kekeringan Agronomis pada Pertanian Bawang Merah (Allium ascalonicum L.) di Lahan Lempung:
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Universitas Gadjah Mada, 2025 | Diunduh dari http://etd.repository.ugm.ac.id/

Hasanuzzaman, M., Bhuyan, M. H. M. B., Nahar, K., Hossain, M. S., Al Mahmud, J., Hossen, M. S., Masud, A. A. C., Moumita, & Fujita, M. (2018). Potassium: A vital regulator of plant responses and tolerance to abiotic stresses. In *Agronomy* (Vol. 8, Issue 3). MDPI AG. https://doi.org/10.3390/agronomy8030031

Hatfield, J. L., & Dold, C. (2019). Water-use efficiency: Advances and challenges in a changing climate. In *Frontiers in Plant Science* (Vol. 10). Frontiers Media S.A. https://doi.org/10.3389/fpls.2019.00103

Irmak, S., Djaman, K., & Rudnick, D. R. (2016). Effect of full and limited irrigation amount and frequency on subsurface drip-irrigated maize evapotranspiration, yield, water use efficiency and yield response factors. *Irrigation Science*, *34*(4), 271–286. https://doi.org/10.1007/s00271-016-0502-z

Issaka, Z., Li, H., Yue, J., Tang, P., & Darko, R. O. (2018). Water-smart sprinkler irrigation, prerequisite to climate change adaptation: A review. In *Journal of Water and Climate Change* (Vol. 9, Issue 2, pp. 383–398). IWA Publishing. https://doi.org/10.2166/wcc.2018.017

Jadhav, Mr. M. A. (2024). THE DRIP IRRIGATION SYSTEM. *International Journal of Scientific Research in Engineering and Management*, *08*(04), 1–5. https://doi.org/10.55041/IJSREM31457

Jarwar, A. H., Wang, X., Wang, L., Zhanshuai, L., Zhaoyang, Q., Mangi, N., Pengjia, B., Jinjin, W., Ma, Q., & Shuli, F. (2019). Performance and evaluation of drip irrigation system, and its future advantages. *Journal of Biology, Agriculture and Healthcare*, *9*(9). https://www.researchgate.net/publication/340777951

Kaarthikeyan, G. M., & Suresh, A. (2019). A Study on Understanding the Adoption of Water Saving Technology: A Case Study of Drip Irrigation. In *International Journal of Recent Technology and Engineering (IJRTE)* (Issue 7). https://www.researchgate.net/publication/333163896

Karthika, K. S., Rashmi, I., & Parvathi, M. S. (2018). Biological functions, uptake and transport of essential nutrients in relation to plant growth. In *Plant*

UNIVERSITAS GADJAH MADA
**Mitigasi Kekeringan Agronomis pada Pertanian Bawang Merah (Allium ascalonicum L.) di Lahan Lempung:
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Universitas Gadjah Mada, 2025 | Diunduh dari http://etd.repository.ugm.ac.id/

Nutrients and Abiotic Stress Tolerance (pp. 1–49). Springer Singapore. https://doi.org/10.1007/978-981-10-9044-8_1

Kaur, S., Kaur, R., & Chauhan, B. S. (2018). Understanding crop-weed-fertilizer-water interactions and their implications for weed management in agricultural systems. In *Crop Protection* (Vol. 103, pp. 65–72). Elsevier Ltd. https://doi.org/10.1016/j.cropro.2017.09.011

Khadim, M. D., Wesal, A. B., & Peezhand, A. W. (2024). Overview of the Impact of Compost on Bulk Density, Aggregate Consistency and Cation Exchange Capacity of Soils and its Consequential Effect on Crop Productivity. *Cognizance Journal of Multidisciplinary Studies*, *4*(6), 344–359. https://doi.org/10.47760/cognizance.2024.v04i06.021

Khan, F., Siddique, A. B., Shabala, S., Zhou, M., & Zhao, C. (2023). Phosphorus Plays Key Roles in Regulating Plants' Physiological Responses to Abiotic Stresses. In *Plants* (Vol. 12, Issue 15). Multidisciplinary Digital Publishing Institute (MDPI). https://doi.org/10.3390/plants12152861

Khotimah, K., Randi, M. J., Juwanda, M., & Laela, T. N. (2024). Responses of the five shallot cultivars to salicylic acid treatment under stress drought conditions. *Ilmu Pertanian (Agricultural Science)*, *9*(3), 164. https://doi.org/10.22146/ipas.102184

Kim, H. M., Kim, H. M., Jeong, H. W., Lee, H. R., Jeong, B. R., Kang, N. J., & Hwang, S. J. (2018). Growth and Rooting Rate of 'Maehyang' Strawberry as Affected by Irrigation Method on Cutting Propagation in Summer Season. *Protected Horticulture and Plant Factory*, *27*(2), 103–110. https://doi.org/10.12791/ksbec.2018.27.2.103

Kodrat, K. F. (2024). The Effect of Climate Change on the Shallot Supply Chain: Impact and Risk Management Strategy. *Pakistan Journal of Life and Social Sciences*, *22*(2), 4772–4783. https://doi.org/10.57239/PJLSS-2024-22.2.00353

Kucserka, T., Németh, G. I., Pálfi, I., Kiss, Z. L., Tombácz, E., & Galambos, I. (2023). Adsorption-Based Pretreatment of Irrigation Water to Prevent Water

UNIVERSITAS GADJAH MADA
**Mitigasi Kekeringan Agronomis pada Pertanian Bawang Merah (Allium ascalonicum L.) di Lahan Lempung:
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Universitas Gadjah Mada, 2025 | Diunduh dari http://etd.repository.ugm.ac.id/

Quality Issues. In *Separations* (Vol. 10, Issue 9). Multidisciplinary Digital Publishing Institute (MDPI). https://doi.org/10.3390/separations10090468

Kumari, V. V., Banerjee, P., Verma, V. C., Sukumaran, S., Chandran, M. A. S., Gopinath, K. A., Venkatesh, G., Yadav, S. K., Singh, V. K., & Awasthi, N. K. (2022). Plant Nutrition: An Effective Way to Alleviate Abiotic Stress in Agricultural Crops. In *International Journal of Molecular Sciences* (Vol. 23, Issue 15). MDPI. https://doi.org/10.3390/ijms23158519

Łabędzki, L., & Bąk, B. (2017). Impact of meteorological drought on crop water deficit and crop yield reduction in Polish agriculture. *Journal of Water and Land Development*, *34*(1), 181–190. https://doi.org/10.1515/jwld-2017-0052

Lawson, T., & Vialet-Chabrand, S. (2019). Speedy stomata, photosynthesis and plant water use efficiency. In *New Phytologist* (Vol. 221, Issue 1, pp. 93–98). Blackwell Publishing Ltd. https://doi.org/10.1111/nph.15330

Lee, Y. Y., Yuan, C. S., Yen, P. H., Mutuku, J. K., Huang, C. E., Wu, C. C., & Huang, P. J. (2022). Suppression Efficiency for Dust from an Iron Ore Pile Using a Conventional Sprinkler and a Water Mist Generator. *Aerosol and Air Quality Research*, *22*(2). https://doi.org/10.4209/AAQR.210320

Li, F., Yuan, C., Lao, D., Yao, B., Hu, X., You, Y., Wang, L., Sun, S., & Liang, X. (2020). Drip irrigation with organic fertilizer application improved soil quality and fruit yield. *Agronomy Journal*, *112*(1), 608–623. https://doi.org/10.1002/agj2.20052

Li, J. (2018). Increasing Crop Productivity in an Eco-Friendly Manner by Improving Sprinkler and Micro-Irrigation Design and Management: A Review of 20 Years' Research at the IWHR, China. *Irrigation and Drainage*, *67*(1), 97–112. https://doi.org/10.1002/ird.2139

Li, Y., Sun, Y., Liao, S., Zou, G., Zhao, T., Chen, Y., Yang, J., & Zhang, L. (2017). Effects of two slow-release nitrogen fertilizers and irrigation on yield, quality, and water-fertilizer productivity of greenhouse tomato. *Agricultural Water Management*, *186*, 139–146. https://doi.org/10.1016/j.agwat.2017.02.006

Li, Y., Wang, S., Peng, T., Zhao, G., & Dai, B. (2023). Hydrological characteristics and available water storage of typical karst soil in SW China under different

UNIVERSITAS GADJAH MADA
**Mitigasi Kekeringan Agronomis pada Pertanian Bawang Merah (Allium ascalonicum L.) di Lahan Lempung:
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Universitas Gadjah Mada, 2025 | Diunduh dari http://etd.repository.ugm.ac.id/

soil–rock structures. *Geoderma*, *438*. https://doi.org/10.1016/j.geoderma.2023.116633

Liu, Z., Li, K., Xiong, K., Li, Y., Wang, J., Sun, J., & Cai, L. (2021). Effects of Zanthoxylum bungeanum planting on soil hydraulic properties and soil moisture in a karst area. *Agricultural Water Management*, *257*. https://doi.org/10.1016/j.agwat.2021.107125

Lu, Z. X., Wang, P., Ou, H. B., Wei, S. X., Wu, L. C., Jiang, Y., Wang, R. J., Liu, X. S., Wang, Z. H., Chen, L. J., & Liu, Z. M. (2022). Effects of different vegetation restoration on soil nutrients, enzyme activities, and microbial communities in degraded karst landscapes in southwest China. *Forest Ecology and Management*, *508*. https://doi.org/10.1016/j.foreco.2021.120002

Maghfiratika, M., Suriyanti, S., & Haris, A. (2023). PERTUMBUHAN DAN PRODUKSI BAWANG MERAH (Allium ascalonicum. L) VARIETAS TAJUK PADA BERBAGAI DOSIS PUPUK KANDANG AYAM DAN DOSIS KNO 3. *Jurnal AGrotekMAS*, *4*(3), 309–316. https://jurnal.fp.umi.ac.id/index.php/agrotekmas

Maharajan, T., Ceasar, S. A., Ajeesh krishna, T. P., Ramakrishnan, M., Duraipandiyan, V., Naif Abdulla, A. D., & Ignacimuthu, S. (2018). Utilization of molecular markers for improving the phosphorus efficiency in crop plants. In *Plant Breeding* (Vol. 137, Issue 1, pp. 10–26). Blackwell Publishing Ltd. https://doi.org/10.1111/pbr.12537

Mahendran, P. P., & Yuvaraj, M. (2020). Advantage and Disadvantage of Drip Irrigation System. *Research Today*, *2(7)*, 535–537.

Mahiwal, S., & Pandey, G. K. (2022). Potassium: a vital nutrient mediating stress tolerance in plants. In *Journal of Plant Biochemistry and Biotechnology* (Vol. 31, Issue 4, pp. 705–719). Springer. https://doi.org/10.1007/s13562-022-00775-4

Maina, M. M., & Luqman, Z. A. (2022). DESIGN AND EVALUATION OF MICRO-SPRINKLER IRRIGATION SYSTEM USING ONION FOR SUSTAINABLE DRYLAND AGRICULTURE. *Nigerian Journal of Engineering Science and Technology Research*, *8*(2), 1–13.

UNIVERSITAS GADJAH MADA
**Mitigasi Kekeringan Agronomis pada Pertanian Bawang Merah (Allium ascalonicum L.) di Lahan Lempung:
Integrasi Irigasi Mikro dan ManajemenÂ Pemupukan**
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Universitas Gadjah Mada, 2025 | Diunduh dari http://etd.repository.ugm.ac.id/

Malhotra, H., Vandana, Sharma, S., & Pandey, R. (2018). Phosphorus nutrition: Plant growth in response to deficiency and excess. In *Plant Nutrients and Abiotic Stress Tolerance* (pp. 171–190). Springer Singapore. https://doi.org/10.1007/978-981-10-9044-8_7

Mallareddy, M., Thirumalaikumar, R., Balasubramanian, P., Naseeruddin, R., Nithya, N., Mariadoss, A., Eazhilkrishna, N., Choudhary, A. K., Deiveegan, M., Subramanian, E., Padmaja, B., & Vijayakumar, S. (2023). Maximizing Water Use Efficiency in Rice Farming: A Comprehensive Review of Innovative Irrigation Management Technologies. In *Water (Switzerland)* (Vol. 15, Issue 10). MDPI. https://doi.org/10.3390/w15101802

Manik, T. K., Timotiwu, P. B., & Mua'ddin. (2023). Shallot growth and yield supported by irrigation and nitrogen application in utilizing dry land area in Mesuji, Lampung Province, Indonesia. *Sains Tanah*, *20*(1), 100–113. https://doi.org/10.20961/stjssa.v20i1.70711

Marcos-Garcia, P., Lopez-Nicolas, A., & Pulido-Velazquez, M. (2017). Combined use of relative drought indices to analyze climate change impact on meteorological and hydrological droughts in a Mediterranean basin. *Journal of Hydrology*, *554*, 292–305. https://doi.org/10.1016/j.jhydrol.2017.09.028

Marpaung, A. E., & Rosliani, R. (2019). Adaptability of Growth and Yield on 5 varieties of Shallot (Allium ascalonicum L) in Wet Highland. *Journal of Tropical Horticulture*, *2*(1), 1. https://doi.org/10.33089/jthort.v2i1.12

Messerschmid, C., Lange, J., & Sauter, M. (2020). Field-based estimation and modelling of distributed groundwater recharge in a Mediterranean karst catchment, Wadi Natuf, West Bank. *Hydrology and Earth System Sciences*, *24(2)*, 887–917.

Messina, C. D., Technow, F., Tang, T., Totir, R., Gho, C., & Cooper, M. (2018). Leveraging biological insight and environmental variation to improve phenotypic prediction: Integrating crop growth models (CGM) with whole genome prediction (WGP). *European Journal of Agronomy*, *100*, 151–162. https://doi.org/10.1016/j.eja.2018.01.007

UNIVERSITAS GADJAH MADA
**Mitigasi Kekeringan Agronomis pada Pertanian Bawang Merah (Allium ascalonicum L.) di Lahan Lempung:
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Universitas Gadjah Mada, 2025 | Diunduh dari http://etd.repository.ugm.ac.id/

Mitran, T., Meena, R. S., Lal, R., Layek, J., Kumar, S., & Datta, R. (2018). Role of Soil Phosphorus on Legume Production. In *Legumes for Soil Health and Sustainable Management* (pp. 487–510). Springer Singapore. https://doi.org/10.1007/978-981-13-0253-4_15

Mohammed, A. T., & Irmak, S. (2022). Maize response to irrigation and nitrogen under center pivot, subsurface drip and furrow irrigation: Water productivity, basal evapotranspiration and yield response factors. *Agricultural Water Management*, *271*. https://doi.org/10.1016/j.agwat.2022.107795

Mukherjee, S., Mishra, A., & Trenberth, K. E. (2018). Climate Change and Drought: a Perspective on Drought Indices. In *Current Climate Change Reports* (Vol. 4, Issue 2, pp. 145–163). Springer. https://doi.org/10.1007/s40641-018-0098-x

Nasar, J., Khan, W., Khan, M. Z., Gitari, H. I., Gbolayori, J. F., Moussa, A. A., Mandozai, A., Rizwan, N., Anwari, G., & Maroof, S. M. (2021). Photosynthetic Activities and Photosynthetic Nitrogen Use Efficiency of Maize Crop Under Different Planting Patterns and Nitrogen Fertilization. *Journal of Soil Science and Plant Nutrition*, *21*(3), 2274–2284. https://doi.org/10.1007/s42729-021-00520-1

Neupane, J., & Guo, W. (2019). Agronomic basis and strategies for precision water management: A review. In *Agronomy* (Vol. 9, Issue 2). MDPI AG. https://doi.org/10.3390/agronomy9020087

Nur, S., Suwarto, S., Saparso, S., & Djatmiko, H. A. (2020). Morfo-Physiological Response of Three Shallot Varieties on Water Surface Variation Level. *International Journal of Applied Science*, *3*(2), p1. https://doi.org/10.30560/ijas.v3n2p1

Pan, R., Martinez, A., Brito, T., & Seidel, E. (2018). Processes of Soil Infiltration and Water Retention and Strategies to Increase Their Capacity. *Journal of Experimental Agriculture International*, *20*(2), 1–14. https://doi.org/10.9734/jeai/2018/39132

Patricia Amankwah-Yeboah, Yeboah, S., Osei, G., Waaley, L., Kyerematen, P., Agyeman, K., Aruna, F. A., Adomako, J., Owusu Danquah, E., & Ampong, A.

UNIVERSITAS GADJAH MADA
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Universitas Gadjah Mada, 2025 | Diunduh dari http://etd.repository.ugm.ac.id/

N. (2023). Critical attributes and considerations for selecting irrigation systems for wastewater. *Journal of the Ghana Institution of Engineering (JGhIE)*, *23*(2), 64–75. https://doi.org/10.56049/jghie.v23i2.56

Peng, X., Dai, Q., Ding, G., Shi, D., & Li, C. (2019). The role of soil water retention functions of near-surface fissures with different vegetation types in a rocky desertification area. *Plant and Soil*, *441*(1–2), 587–599. https://doi.org/10.1007/s11104-019-04147-1

Peng, X., Li, C., Dai, Q., Xu, S., & Zang, J. (2024). Morphological development of drying shrinkage cracks at the rock–soil interface in a karst rocky desertification area. *Journal of Hydrology: Regional Studies*, *54*. https://doi.org/10.1016/j.ejrh.2024.101894

Permana, D. F. W., Mustofa, A. H., Nuryani, L., Kristiaputra, P. S., & Alamudin, Y. (2021). Budidaya bawang merah di Kabupaten Brebes. *Jurnal Bina Desa*, *3(2)*, 125–132.

Polakitan, A., Salamba, H. N., & Manoppo, C. N. (2022). The Effect of Watering Techniques for Increasing the Yield of Shallots (Allium cepa L) in Dry Land. *E3S Web of Conferences*, *361*. https://doi.org/10.1051/e3sconf/202236104021

Priyanto, Faisal, M., & Imamudin, M. (2025). Artificial Neural Network-Based Forecasting of Rice Yield Using Environmental and Agricultural Data. *Advance Sustainable Science, Engineering and Technology (ASSET)*, *7*(3). https://doi.org/10.26877/asset.v7i3.2019

Qi, D., Wieneke, X., Tao, J., Zhou, X., & Desilva, U. (2018). Soil pH is the primary factor correlating with soil microbiome in karst rocky desertification regions in the Wushan County, Chongqing, China. *Frontiers in Microbiology*, *9*(MAY). https://doi.org/10.3389/fmicb.2018.01027

Querejeta, J. I., Ren, W., & Prieto, I. (2021). Vertical decoupling of soil nutrients and water under climate warming reduces plant cumulative nutrient uptake, water-use efficiency and productivity. *New Phytologist*, *230*(4), 1378–1393. https://doi.org/10.1111/nph.17258

Rahayu, Y. S., Yuliani, & Dewi, S. K. (2022). *PENYAKIT TANAMAN AKIBAT DEFISIENSI UNSUR HARA*. Unesa University Press.

UNIVERSITAS GADJAH MADA
**Mitigasi Kekeringan Agronomis pada Pertanian Bawang Merah (Allium ascalonicum L.) di Lahan Lempung:
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Universitas Gadjah Mada, 2025 | Diunduh dari http://etd.repository.ugm.ac.id/

Rashmi, I., Shirale, A., Kartikha, K. S., Shinogi, K. C., Meena, B. P., & Kala, S. (2017). *Leaching of plant nutrients from agricultural lands. Essential plant nutrients: uptake, use efficiency, and management*. https://www.researchgate.net/publication/319718333

Rawat, J., Sanwal, P., & Saxena, J. (2016). Potassium and its role in sustainable agriculture. In *Potassium Solubilizing Microorganisms for Sustainable Agriculture* (pp. 235–253). Springer India. https://doi.org/10.1007/978-81-322-2776-2_17

Rawat, P., Das, S., Shankhdhar, D., & Shankhdhar, S. C. (2021). *Phosphate-Solubilizing Microorganisms: Mechanism and Their Role in Phosphate Solubilization and Uptake*. https://doi.org/10.1007/s42729-020-00342-7/Published

Reinsch, S., Robinson, D. A., van Soest, M. A. J., Keith, A. M., Parry, S., & Tye, A. M. (2024). Temperate Soils Exposed to Drought—Key Processes, Impacts, Indicators, and Unknowns. In *Land* (Vol. 13, Issue 11). Multidisciplinary Digital Publishing Institute (MDPI). https://doi.org/10.3390/land13111759

Riaz, M. U., Ayub, M. A., Khalid, H., Ul Haq, M. A., Rasul, A., Ur Rehman, M. Z., & Ali, S. (2020). Fate of Micronutrients in Alkaline Soils. In *Fate of Micronutrients in Alkaline Soils* (pp. 577–613). Springer Singapore. https://doi.org/10.1007/978-981-15-6953-1_16

Riyanto, D., Widodo, S., & Sukristiyonubowo Sukristiyonubowo. (2018). *Biochar dan Pupuk Hayati Dalam Meningkatkan Kualitas Lahan Sawah Tadah Hujan Serta Produktivitas Padi di Gunungkidul, Aplikasi*. 206–215.

Saha, A., Sekharan, S., & Manna, U. (2020). Superabsorbent hydrogel (SAH) as a soil amendment for drought management: A review. In *Soil and Tillage Research* (Vol. 204). Elsevier B.V. https://doi.org/10.1016/j.still.2020.104736

Saidah, Syafruddin, Suwitra, I. K., Wahyuni, A. N., Wardani, N., Meilin, A., Tandi, O. G., Purwaningsih, H., Rahayu, H. S. P., Amin, M., & Asnawi. (2024). The effect of inorganic fertilizer combination in the growth and yield of Palasa Shallot (Allium ascalonicum L.) local variety of Central Sulawesi. *IOP*

UNIVERSITAS GADJAH MADA
**Mitigasi Kekeringan Agronomis pada Pertanian Bawang Merah (Allium ascalonicum L.) di Lahan Lempung:
Integrasi Irigasi Mikro dan ManajemenÂ Pemupukan**
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Universitas Gadjah Mada, 2025 | Diunduh dari http://etd.repository.ugm.ac.id/

Conference Series: Earth and Environmental Science, *1417*(1). https://doi.org/10.1088/1755-1315/1417/1/012011

Sankar, J., & Rajakumar, R. (2016). *Hydrogel: Novel Soil Conditioner and Safer Delivery Vehicle for Fertilizers and Agrochemicals-A Review*. https://www.researchgate.net/publication/311641165

Sardans, J., & Peñuelas, J. (2021). Potassium control of plant functions: Ecological and agricultural implications. *Plants*, *10*(2), 1–31. https://doi.org/10.3390/plants10020419

Scharwies, J. D., & Dinneny, J. R. (2019). Water transport, perception, and response in plants. *Journal of Plant Research*, *132*(3), 311–324. https://doi.org/10.1007/s10265-019-01089-8

Sein, Z. M. M., Zhi, X., Ogou, F. K., Nooni, I. K., Lim Kam Sian, K. T. C., & Gnitou, G. T. (2021). Spatio-temporal analysis of drought variability in myanmar based on the standardized precipitation evapotranspiration index (Spei) and its impact on crop production. *Agronomy*, *11*(9). https://doi.org/10.3390/agronomy11091691

Seleiman, M. F., Al-Suhaibani, N., Ali, N., Akmal, M., Alotaibi, M., Refay, Y., Dindaroglu, T., Haleem Abdul-Wajid, H., & Leonardo Battaglia, M. (2021). Drought Stress Impacts on Plants and Different Approaches to Alleviate Its Adverse Effects. *Plants*, *10(2)*, 259. https://doi.org/10.3390/plants

Sharma, V., & Bhambota, S. (2022). Strategies to Improve Crop-Water Productivity. In *Food, Energy, and Water Nexus: A Consideration for the 21st Century* (pp. 149–172). Springer International Publishing. https://doi.org/10.1007/978-3-030-85728-8_8

Si, D., Lin, Y., Xu, Q., & Zhang, S. (2025). Effects of biochar on rainwater redistribution, soil water evaporation and desiccation cracking: A case study of limestone soil in karst areas of southwest China. *Science of the Total Environment*, *965*. https://doi.org/10.1016/j.scitotenv.2025.178692

Singh, V. K., Malhi, G. S., Kaur, M., Singh, G., & Jatav, H. S. (2022). *Use of organic soil amendments for improving soil ecosystem health and crop productivity*.

UNIVERSITAS GADJAH MADA
**Mitigasi Kekeringan Agronomis pada Pertanian Bawang Merah (Allium ascalonicum L.) di Lahan Lempung:
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Universitas Gadjah Mada, 2025 | Diunduh dari http://etd.repository.ugm.ac.id/

Slamini, M., Sbaa, M., Arabi, M., & Darmous, A. (2022). Review on Partial Root-zone Drying irrigation: Impact on crop yield, soil and water pollution. In *Agricultural Water Management* (Vol. 271). Elsevier B.V. https://doi.org/10.1016/j.agwat.2022.107807

Smithers, E. T., Luo, J., & Dyson, R. J. (2019). Mathematical principles and models of plant growth mechanics: From cell wall dynamics to tissue morphogenesis. In *Journal of Experimental Botany* (Vol. 70, Issue 14, pp. 3587–3599). Oxford University Press. https://doi.org/10.1093/jxb/erz253

Srivastava, A. K., Shankar, A., Chandran, A. K. N., Sharma, M., Jung, K. H., Suprasanna, P., & Pandey, G. K. (2020). Emerging concepts of potassium homeostasis in plants. In *Journal of Experimental Botany* (Vol. 71, Issue 2, pp. 608–619). Oxford University Press. https://doi.org/10.1093/jxb/erz458

Stevens, G., Motavalli, P., Scharf, P., Nathan, M., & Dunn, D. (2018). *Crop nutrient deficiencies & toxicities*. http://muextension.missouri.edu/xplor/agguides/

Sun, Y., Wang, M., Mur, L. A. J., Shen, Q., & Guo, S. (2020). Unravelling the roles of nitrogen nutrition in plant disease defences. In *International Journal of Molecular Sciences* (Vol. 21, Issue 2). MDPI AG. https://doi.org/10.3390/ijms21020572

Susila, E., Maulina, F., Anwar, A., Syarif, A., & Agustian, A. (2023). The Effect of Indigenous AMF Applications on The Morpho-Physiological Characteristics of Two Varieties of Shallots on Drought Stress Conditions. *Journal of Applied Agricultural Science and Technology*, *7*(2), 186–196. https://doi.org/10.55043/jaast.v7i2.80

Tai, C., Sawada, Y., Masuda, J., Daimon, H., & Fukao, Y. (2020). Cultivation of spinach in hot seasons using a micro-mist-based temperature-control system. *Scientia Horticulturae*, *273*. https://doi.org/10.1016/j.scienta.2020.109603

Thorup-Kristensen, K., & Kirkegaard, J. (2016). Root system-based limits to agricultural productivity and efficiency: The farming systems context. In *Annals of Botany* (Vol. 118, Issue 4, pp. 573–592). Oxford University Press. https://doi.org/10.1093/aob/mcw122

UNIVERSITAS GADJAH MADA
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Universitas Gadjah Mada, 2025 | Diunduh dari http://etd.repository.ugm.ac.id/

Tian, Y., Qian, F., Chen, Y., Liu, K., Li, X., Wang, J., He, Q., uz Zaman, Q., Sultan, K., Fahad, S., Deng, G., & Chen, S. (2025). Foliar-Applied Seaweed Extract as a Biostimulant for Enhancing Drought Tolerance in Tobacco. *Journal of Plant Growth Regulation*. https://doi.org/10.1007/s00344-025-11653-3

Tirivarombo, S., Osupile, D., & Eliasson, P. (2018). Drought monitoring and analysis: Standardised Precipitation Evapotranspiration Index (SPEI) and Standardised Precipitation Index (SPI). *Physics and Chemistry of the Earth*, *106*, 1–10. https://doi.org/10.1016/j.pce.2018.07.001

Trovato, M., Funck, D., Forlani, G., Okumoto, S., & Amir, R. (2021). Editorial: Amino Acids in Plants: Regulation and Functions in Development and Stress Defense. In *Frontiers in Plant Science* (Vol. 12). Frontiers Media S.A. https://doi.org/10.3389/fpls.2021.772810

Wakchaure, G. C., Minhas, P. S., Meena, K. K., Singh, N. P., Hegade, P. M., & Sorty, A. M. (2018). 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*, *199*, 1–10. https://doi.org/10.1016/j.agwat.2017.11.026

Wang, J., Du, G., Tian, J., Zhang, Y., Jiang, C., & Zhang, W. (2020). Effect of irrigation methods on root growth, root-shoot ratio and yield components of cotton by regulating the growth redundancy of root and shoot. *Agricultural Water Management*, *234*. https://doi.org/10.1016/j.agwat.2020.106120

Wang, Y., Chen, Y. F., & Wu, W. H. (2021). Potassium and phosphorus transport and signaling in plants. In *Journal of Integrative Plant Biology* (Vol. 63, Issue 1, pp. 34–52). Blackwell Publishing Ltd. https://doi.org/10.1111/jipb.13053

Waseem, M., Khurshid, T., Abbas, A., Ahmad, I., & Javed, Z. (2022). Impact of meteorological drought on agriculture production at different scales in Punjab, Pakistan. *Journal of Water and Climate Change*, *13*(1), 113–124. https://doi.org/10.2166/wcc.2021.244

World Meteorological Organization dan Global Water Partnership. (2016). *Handbook of Drought Indicators and Indices (WMO-No.1173)*. www.droughtmanagement.info

UNIVERSITAS GADJAH MADA
**Mitigasi Kekeringan Agronomis pada Pertanian Bawang Merah (Allium ascalonicum L.) di Lahan Lempung:
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Universitas Gadjah Mada, 2025 | Diunduh dari http://etd.repository.ugm.ac.id/

Wu, J., Wang, J., Hui, W., Zhao, F., Wang, P., Su, C., & Gong, W. (2022). Physiology of Plant Responses to Water Stress and Related Genes: A Review. In *Forests* (Vol. 13, Issue 2). MDPI. https://doi.org/10.3390/f13020324

Xue, R., Zhang, C., Yan, H., Li, J., Ren, J., Akhlaq, M., Hameed, M. U., & Disasa, K. N. (2023). Physiological Response of Tomato and Cucumber Plants to Micro-Spray in High-Temperature Environment: A Scientific and Effective Means of Alleviating Crop Heat Stress. *Agronomy*, *13*(11). https://doi.org/10.3390/agronomy13112798

Yadav, M. R., Kumar, R., Parihar, C. M., Yadav, R. K., Jat, S. L., Ram, H., Meena, R. K., Singh, M., . B., Verma, A. P., Ghoshand, A., & Jat, M. L. (2017). Strategies for improving nitrogen use efficiency: A review. *Agricultural Reviews*, *OF*. https://doi.org/10.18805/ag.v0iof.7306

Yahaya, S. M., Mahmud, A. A., Abdullahi, M., & Haruna, A. (2023). Recent advances in the chemistry of nitrogen, phosphorus and potassium as fertilizers in soil: A review. *Pedosphere*, *33*(3), 385–406. https://doi.org/10.1016/j.pedsph.2022.07.012

Yan, J., Bogie, N. A., & Ghezzehei, T. A. (2020). Root uptake under mismatched distributions of water and nutrients in the root zone. *Biogeosciences*, *17*(24), 6377–6392. https://doi.org/10.5194/bg-17-6377-2020

Yang, J., Chen, H., Nie, Y., & Wang, K. (2019). Dynamic variations in profile soil water on karst hillslopes in Southwest China. *Catena*, *172*, 655–663. https://doi.org/10.1016/j.catena.2018.09.032

Yang, J., Nie, Y., Chen, H., Wang, S., & Wang, K. (2016). Hydraulic properties of karst fractures filled with soils and regolith materials: Implication for their ecohydrological functions. *Geoderma*, *276*, 93–101. https://doi.org/10.1016/j.geoderma.2016.04.024

Yao, N., Li, Y., Liu, Q., Zhang, S., Chen, X., Ji, Y., Liu, F., Pulatov, A., & Feng, P. (2022). Response of wheat and maize growth-yields to meteorological and agricultural droughts based on standardized precipitation evapotranspiration indexes and soil moisture deficit indexes. *Agricultural Water Management*, *266*. https://doi.org/10.1016/j.agwat.2022.107566

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Universitas Gadjah Mada, 2025 | Diunduh dari http://etd.repository.ugm.ac.id/

Yousefvand, P., Sohrabi, Y., Mastinu, A., Heidari, G., & Weisany, W. (2024). Salicylic acid altered the fatty acids compositions and nutrient status of shallot (Allium hirtifolium) grown under drought stress. *Journal of Agriculture and Food Research*, *18*. https://doi.org/10.1016/j.jafr.2024.101502

Zargar, S. M., Gupta, N., Nazir, M., Mahajan, R., Malik, F. A., Sofi, N. R., Shikari, A. B., & Salgotra, R. K. (2017). Impact of drought on photosynthesis: Molecular perspective. *Plant Gene*, *11*, 154–159. https://doi.org/10.1016/j.plgene.2017.04.003

Zerga, B. (2024). Karst topography: Formation, processes, characteristics, landforms, degradation and restoration: A systematic review. In *Watershed Ecology and the Environment* (Vol. 6, pp. 252–269). KeAi Communications Co. https://doi.org/10.1016/j.wsee.2024.10.003

Zhang, C., Zhang, W., Yan, H., Ni, Y., Akhlaq, M., Zhou, J., & Xue, R. (2022). Effect of micro–spray on plant growth and chlorophyll fluorescence parameter of tomato under high temperature condition in a greenhouse. *Scientia Horticulturae*, *306*. https://doi.org/10.1016/j.scienta.2022.111441

Zhang, H., Khan, A., Tan, D. K. Y., & Luo, H. (2017). Rational water and nitrogen management improves root growth, increases yield and maintains water use efficiency of cotton under mulch drip irrigation. *Frontiers in Plant Science*, *8*. https://doi.org/10.3389/fpls.2017.00912

Zhao, H., Xu, Z., Zhao, J., & Huang, W. (2017). A drought rarity and evapotranspiration-based index as a suitable agricultural drought indicator. *Ecological Indicators*, *82*, 530–538. https://doi.org/10.1016/j.ecolind.2017.07.024

Zhao, L. S., Li, K., Wang, Q. M., Song, X. Y., Su, H. N., Xie, B. Bin, Zhang, X. Y., Huang, F., Chen, X. L., Zhou, B. C., & Zhang, Y. Z. (2017). Nitrogen Starvation Impacts the Photosynthetic Performance of Porphyridium cruentum as Revealed by Chlorophyll a Fluorescence. *Scientific Reports*, *7*(1). https://doi.org/10.1038/s41598-017-08428-6

Zhao, Z., & Shen, Y. (2022). Rain-induced weathering dissolution of limestone and implications for the soil sinking-rock outcrops emergence mechanism at the

UNIVERSITAS
GADJAH MADA
**Mitigasi Kekeringan Agronomis pada Pertanian Bawang Merah (Allium ascalonicum L.) di Lahan Lempung:
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Universitas Gadjah Mada, 2025 | Diunduh dari http://etd.repository.ugm.ac.id/

karst surface: a case study in southwestern China. *Carbonates and Evaporites*, *37*(4). https://doi.org/10.1007/s13146-022-00813-1

Zhou, H., Niu, X., Yan, H., Zhao, N., Zhang, F., Wu, L., Yin, D., & Kjelgren, R. (2019). Interactive effects of water and fertilizer on yield, soil water and nitrate dynamics of young apple tree in semiarid region of northwest China. *Agronomy*, *9*(7). https://doi.org/10.3390/agronomy9070360

Zinkernagel, J., Maestre-Valero, J. F., Seresti, S. Y., & Intrigliolo, D. S. (2020). New technologies and practical approaches to improve irrigation management of open field vegetable crops. In *Agricultural Water Management* (Vol. 242). Elsevier B.V. https://doi.org/10.1016/j.agwat.2020.106404

Abiodun, O. I., Jantan, A., Omolara, A. E., Dada, K. V., Mohamed, N. A., & Arshad, H. (2018). State-of-the-art in artificial neural network applications: A survey. *Heliyon*, *4*(11).

Aderele, M. O., Srivastava, A. K., Butterbach-Bahl, K., & Rahimi, J. (2025). Integrating machine learning with agroecosystem modelling: Current state and future challenges. *European Journal of Agronomy*, *168*, 127610.

Allen, R. G., Pereira, L. S., Raes, D., & Smith, M. (1998). Crop evapotranspiration-Guidelines for computing crop water requirements-FAO Irrigation and drainage paper 56. *Fao, Rome*, *300*(9), D05109.

Balai Penelitian Tanah. (2012). *Petunjuk Teknis Evaluasi Kesuburan Tanah* (Edisi Revisi). Bogor: Balai Penelitian Tanah, Badan Penelitian dan Pengembangan Pertanian, Kementerian Pertanian.

Behzadian, M., Otaghsara, S. K., Yazdani, M., & Ignatius, J. (2012). A state-of the-art survey of TOPSIS applications. *Expert Systems with Applications, 39*(17), 13051–13069.

Boniecki, P., Sujak, A., Niedbała, G., Piekarska-Boniecka, H., Wawrzyniak, A., & Przybylak, A. (2023). Neural modelling from the perspective of selected statistical methods on examples of agricultural applications. *Agriculture*, *13*(4), 762.

UNIVERSITAS
GADJAH MADA
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Universitas Gadjah Mada, 2025 | Diunduh dari http://etd.repository.ugm.ac.id/

Castillo-Girones, S., Munera, S., Martínez-Sober, M., Blasco, J., Cubero, S., & Gómez-Sanchis, J. (2025). Artificial Neural Networks in Agriculture, the core of artificial intelligence: What, When, and Why. *Computers and Electronics in Agriculture*, *230*, 109938.

Cheng, R., Wang, L., & Li, Y. (2020). Nonlinear exponential models for plant growth dynamics. *Ecological Modelling, 427*, 109061.

FAO (Food and Agriculture Organization of the United Nations, Italy). 2018. FAO soils portal (online).

Hameed, I. A., Bochtis, D., Sørensen, C. G., dkk. (2019). A decision support system for crop management using TOPSIS method. *Computers and Electronics in Agriculture, 156*, 460–471.

Hayat, N., Al Mamun, A., Nasir, N. A. M., Selvachandran, G., Nawi, N. B. C., & Gai, Q. S. (2020). Predicting sustainable farm performance—using hybrid structural equation modelling with an artificial neural network approach. *Land*, *9*(9), 289.

Hossain, M. A., Karim, R., & Islam, M. (2023). Comparative analysis of TOPSIS and VIKOR methods in irrigation decision-making. *Agricultural Water Management, 278*, 108149.

Hossain, M. A., Karim, R., & Islam, M. (2023). Comparative performance of polynomial and exponential models in predicting crop growth. *Computers and Electronics in Agriculture, 205*, 107612.

Jing, F., Shi, S., Kang, W., Guan, J., Lu, B., Wu, B., & Wang, W. (2024). The physiological basis of alfalfa plant height establishment. *Plants*, *13*(5), 679.

Kim, B., Kim, H., Kim, K., Kim, S., & Kim, J. (2019). Learning not to learn: Training deep neural networks with biased data. In *Proceedings of the IEEE/CVF conference on computer vision and pattern recognition* (pp. 9012-9020).

Lambers, H., Oliveira, R. S., & Pons, T. L. (2019). Growth and allocation. In *Plant physiological ecology* (pp. 385-449). Cham: Springer International Publishing.

UNIVERSITAS GADJAH MADA
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Universitas Gadjah Mada, 2025 | Diunduh dari http://etd.repository.ugm.ac.id/

Lewis, C. D. (1982). *Industrial and Business Forecasting Methods: A Practical Guide to Exponential Smoothing and Curve Fitting*. London: Butterworths.

Liliane, T. N., & Charles, M. S. (2020). Factors affecting yield of crops. *Agronomy-climate change & food security*, *9*, 9-24.

López-Cruz, M., Crossa, J., & de los Campos, G. (2022). Modeling plant growth trajectories using exponential quadratic functions. *Theoretical and Applied Genetics, 135*, 3735–3749.

Luo, S., Zhang, H., & Li, Y. (2022). Application of TOPSIS for multi-criteria decision analysis in sustainable crop production. *Sustainability, 14*(3), 1245.

Madhiarasan, M., & Louzazni, M. (2022). Analysis of artificial neural network: architecture, types, and forecasting applications. *Journal of Electrical and Computer Engineering*, *2022*(1), 5416722.

Mathan, J., Bhattacharya, J., & Ranjan, A. (2016). Enhancing crop yield by optimizing plant developmental features. *Development*, *143*(18), 3283-3294.

Nguyen, H. T., Pham, D. H., & Tran, M. Q. (2024). Soil permeability of sandy loam and clay loam soil in the paddy fields in An Giang Province in Vietnam. *Soil and Tillage Research*, 241, 105984. https://doi.org/10.1016/j.still.2024.105984

Oduro, S., Antwi, E., & Gyasi, R. M. (2020). Multi-criteria decision-making in agricultural land use planning using TOPSIS. *Land Use Policy, 95*, 104617.

Rani, P., Mishra, A. R., & Mardani, A. (2020). Multi-criteria decision-making for sustainable agriculture: A review of methods and applications. *Sustainability, 12*(11), 4655.

Suryaningtyas, D., Hidayat, F., Nugraha, M., & Prasetyo, B. (2023). Improving digital soil mapping in Bogor, Indonesia using parent material information. *Geoderma Regional*, 33, e00741. https://doi.org/10.1016/j.geodrs.2023.e00741

UCLA Stats OARC. (n.d.). *How do I interpret the sign of the quadratic term in a polynomial regression?* UCLA: Institute for Digital Research and Education. Retrieved August 24, 2025, from

UNIVERSITAS GADJAH MADA
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https://stats.oarc.ucla.edu/other/mult-pkg/faq/general/faqhow-do-i-interpret-the-sign-of-the-quadratic-term-in-a-polynomial-regression/

Unterthiner, T., Keysers, D., Gelly, S., Bousquet, O., & Tolstikhin, I. (2020). Predicting neural network accuracy from weights. *arXiv preprint arXiv:2002.11448*.

Vázquez-Veloso, J. A., Peña-Gallardo, C., Rodríguez-Hernández, A., & García, J. M. (2023). Improving plant growth prediction models: Challenges in integrating nutrient and water dynamics. Computers and Electronics in Agriculture, 214, 108379. https://doi.org/10.1016/j.compag.2023.108379

Wang, X., Li, J., Zhao, Y., & Xu, L. (2025). Modeling crop growth and development: Challenges and opportunities under changing environmental conditions. Agricultural Systems, 213, 103851. https://doi.org/10.1016/j.agsy.2025.103851

Yin, X., Struik, P. C., & Tang, J. (2021). Exponential models in crop growth analysis: concepts, uses, and future prospects. *Journal of Experimental Botany, 72*(16), 5820–5834.

Zhang, L., Zhang, F., Wang, H., & Tang, C. (2016). Mechanical properties of clays and clay minerals. *Applied Clay Science*, 123, 1-9. https://doi.org/10.1016/j.clay.2016.01.004

Zhang, Y., Wang, J., & Xu, C. (2019). Application of exponential quadratic models in horticultural crop growth prediction. *Scientia Horticulturae, 256*, 108612.

Zhang, Y., Wang, J., & Xu, C. (2021). Multi-criteria decision analysis of rice variety selection using TOPSIS. *Journal of Integrative Agriculture, 20*(4), 1029–1042.