International Journal of Engineering, Science, and Environmental Research (IJESER)

Federal Polytechnic Wannune

Volume-1, Issue-2, pp-162-167

ISSN: 3121-8180

Research Paper **Peer-Reviewed/Open Access/ www.ijeser.com**

Enhancing Growth and Yield of Heading Cabbage (Brassica Oleracea l.) through Ethrel Priming in Southern Guinea Savanna

[a]Bar-Anyam, M. N., [*b]Ugoo, T. R., [b]Okpokwu, E. B. & [c]Ama, G. S.

[a]Department of Agronomy, Federal University Lafia, Nigeria

[b]Department of Crop Production, College of Agronomy, Joseph Sarwuan Tarka University PMB 2373, Makurdi, Nigeria

[c]Department of Crop Production Technology/Agricultural Technology, Federal Polytechnic, Wanunne, Nigeria;

*Corresponding authors' email: Richard.ugoo@uam.edu.ng; ORCID: 0000-0002-1572-3485

Abstract

A field experiment was conducted between October 2023 and February 2024 at the Crop Section of the Teaching and Research Farm, Joseph Sarwuan Tarka University PMB 2373 Makurdi, Nigeria, to evaluate the growth, yield, and head formation of cabbage as influenced by ethrel priming in Makurdi. The experimental treatments consisted of cabbage seeds (Gloria var) grown under four ethrel priming concentrations: 0 ml, 10 ml, 20 ml, and 30 ml per litre of water, laid out in a completely randomized design (CRD) replicated three times in a shade house. Data were subjected to analysis of variance (ANOVA) using GENSTAT statistical software (v17.1DE, 2015), and significant means were separated using Fisher's least significant difference (F-LSD) at 5% probability. Results of the study revealed that cabbage seed primed with ethrel at 20 ml/L produced significantly higher plant height, number of leaves, head diameter, yield, and harvest index compared to 10 ml and 30 ml/L, while 0 ml/L recorded the lowest values. Increasing ethrel beyond 20 ml/L reduced performance. Therefore, seed priming with 20 ml/L ethrel is recommended for optimal cabbage (Gloria var) growth and yield in Makurdi. The cultivation of cabbage (Gloria var) under controlled environments such as shade house is recommended for cabbage farmers in Makurdi with high temperature and solar radiation effects.

Keywords: Cabbage, Yield, Heading, Ethrel, Priming

1.0 Introduction

Cabbage (*Brassica oleracea* L. var. capitata) is a biennial plant belonging to the family Brassicaceae (formerly Cruciferae) and is widely used in salads and traditional dishes (Singh *et al.,* 2021; Gelaye, & Tadele, 2022). It is a cool-season crop that is popular with commercial producers (Lounsbury et al., 2020). However, it can be cultivated anywhere in the world for use in fresh and processed forms (Kapusta-Duch & Kusznierewicz, 2021). Additionally, cabbage is a known vegetable crop worldwide because of its adaptability to a wide range of climate and soil conditions (Gelaye, & Tadele, 2022). However, cabbage production in the lowland tropics faces challenges such as a lack of adaptable cultivars, pest and disease pressure, and environmental limitations like high temperatures and intense solar radiation, which favour leaf growth over head formation (Červenski *et al.,* 2022).

Despite its global importance, research on cabbage production in Nigeria remains limited (Madina *et al.,* 2023). Seed priming, a pre-sowing hydration and dehydration process, has emerged as a low-cost, effective method to enhance seed germination, seedling vigour, and crop yield (McDonald, 2000). Rahman *et al.* (2022), observed that seed priming enhances antioxidant enzyme activity, reduces oxidative stress, and improves water uptake efficiency, which helps crops recover faster after stress. Several other authors have reported the beneficial roles of seed priming on crops as seed priming interacts with soil properties and temperature conditions, influencing germination speed and seedling vigor (Harris *et al.,* 2019; Salleh *et al.,* 2020; Srivastava *et al.,* 2021; Kumar *et al.,* 2023). Moreover, priming increases the production of protective compounds such as antioxidants and heat-shock proteins, which help reduce oxidative stress during the early stages of seedling growth (Jisha *et al.,* 2013).

Although widely applied to cereals and legumes, its application to cabbage remains underexplored. Investigating ethrel priming, a plant growth regulator-based method, could contribute to optimizing cabbage productivity in challenging tropical environments like Makurdi.

2.0 Literature Review

2.1 Seed Priming

Seed priming involves controlled hydration to trigger metabolic activities before germination, followed by re-drying to original moisture content (Kamithi *et al.,* 2016). This process enhances germination rate, seedling emergence, and stress tolerance under adverse conditions (Farooq *et al.,* 2010; Marthandan *et al.,* 2020). Primed seeds often exhibit improved enzyme activity, nutrient mobilization, and antioxidant responses (Paparella *et al.,* 2015; Wojtyla *et al.,* 2018).

2.2 Mechanisms of Seed Priming

Seed priming progresses through three physiological phases; imbibition, activation, and germination onset. It activates key enzymes (e.g., α-amylase), promotes ATP synthesis, DNA repair, and antioxidant enzyme production, resulting in faster and more uniform germination (Ibrahim, 2016; Hussain *et al.,* 2016).

2.3 Ethrel Priming

Ethrel (ethephon) releases ethylene, a hormone that influences plant growth, flowering, and senescence (Lee *et al.,* 2021). Studies show that plant growth regulators such as ethrel primed on vegetable crops enhances growth and yield (Mohkami *et al.,* 2024; Singh *et al.,* 2024; Ghiyal *et al.,* 2025). Aryanpooya & Davarynejad (2010) and Mehdi *et al.* (2012) observed increased fruit size and vitamin content in ethrel-treated cucumber and sour cherry fruits, while Barba-Espín *et al.* (2020) and Bhadoria *et al.* (2018) reported improved stress tolerance. However, excessive concentrations can reduce plant performance, necessitating optimization for local conditions (Igbal *et al.,* 2017; Kumar *et al.,* 2024).

3.0 Materials and Methods

3.1 Experimental Location

A field experiment was conducted at the Teaching and Research Farm of Joseph Sarwuan Tarka University, Makurdi (latitude 7°47′N, longitude 8°36′E) within the southern Guinea savannah zone of Nigeria between October, 2023 and February, 2024

3.2 Planting Materials and Nursery

Cabbage (*Brassica oleracea* Gloria Var) seeds were obtained from Pioneer Seed Company, Makurdi. Seedlings were raised in seed trays at the nursery section of the University Research farms in early October 2023 and transplanted after 30 days.

The experimental soil was well drained sandy loam. 10kg of the soil was placed in black polythene pots measuring 32cm in diameter and 30cm depth. After potting, fertilizer at the equivalence of 40kgN/ha, 20kg P_2O_5/ha 22 kgK_20/ha mixed into the soil.

3.3 Experimental Treatments and Design

Seeds were dipped for 60 seconds in ethrel solutions (0, 10, 20, and 30 ml/L water) containing 0.025% Tween 20 as a surfactant (ISPP, 2000). Untreated seeds (0ml/L) served as control. The study experiment was laid out in a completely randomized design (CRD) and replicated three times. Each replicate contained ten pots, thus giving a total of forty pots.

3.4 Transplanting and Crop Management

Seedlings were transplanted one per pot. Shade was provided for two weeks post-transplanting. Cypermethrin was applied at 2, 4, and 6 weeks after transplanting to control pests, and weeding was carried out as needed.

3.5 Data Collection

Data were collected on plant height, number of leaves, head diameter, head yield, and harvest index following standard procedures at 120 DAT.

The harvest index (HI) was expressed as the percentage ratio between the economic yield and the total biological yield and was calculated using the formula:

HI = (Economic yield)/(Total biological yield)×100/1 --- (1)

3.6 Statistical Analysis

Data were analyzed using ANOVA in GENSTAT (v17.1DE, 2015), and means were separated using Fisher's LSD at a 5% significance level.

4.0 Results

Ethrel priming significantly increased plant height, number of leaves, and head diameter compared to control (Table 1). The highest values were recorded with 20 ml/L ethrel while the least value was recorded with the control treatment. Plant height and head diameter did not differ significantly between seeds primed with ethrel at 20ml/L to 30ml/L. However, the number of leaves of cabbage significantly improved as ethrel priming concentrations increased from 10 to 30ml/L (Table 1).

Table 1: Effect of ethrel priming concentrations on plant height (cm), number of leaves and head diameter per cabbage plant at final harvest (120 DAT)

Treatment (Ethrel/L water)	Plant Height (cm)	Number of Leaves	Head Diameter (cm)
Control	11.7	9.0	6.9
10ml	13.4	11.0	10.4
20ml	15.6	13.9	12.1
30ml	15.0	12.8	11.5
F-LSD (0.05)	**0.72**	**0.81**	**0.79**

F-LSD = Fisher's least significance difference at 5% level of significance; DAT – Days after transplant

Table 2 revealed that head yield and harvest index were significantly improved by ethrel priming, with 20 ml/L giving the highest yield and index. Similarly, the control treatments recorded the lowest head yield and harvest index. Although harvest index did not differ significantly between seed primed with ethrel at 20ml/L and 30ml/L as well as between 10ml/L and 30ml/L of water.

Table 2: Effect of ethrel priming concentrations on the yield (g/plant) and harvest index (%) per cabbage plant at final harvest

Treatment (Ethrel/L water)	Head Yield (g/plant)	Harvest Index (%)
Control	260.0	52
10ml	305.9	60
20ml	431.2	65
30ml	422.0	63
F-LSD (0.05)	**3.25**	**4.11**

F-LSD = Fisher's least significance difference at 5% level of significance

5.0 Discussion

Ethrel priming significantly improved all measured growth and yield parameters relative to control. The enhancement aligns with reports by Zhang *et al.* (2025), Barsoom & Attala, (2020) and Liu *et al.* (2016), indicating that seed priming influences plant vigour and productivity. More-so, this study clearly showed that cabbage seed priming had effect on growth and this in agreement with Ekeruo *et al.,* 2024). However, yields in Makurdi (431.2 g/plant) were lower than those in cooler environments such as Jos (850 g–1.7 kg/plant), suggesting that high temperatures hinder head formation (Zhang *et al.,* 2022). Future studies should focus on developing or selecting heat-tolerant cabbage cultivars for tropical conditions (Zhang *et al.,* 2022).

6.0 Conclusion

From the study, it can be concluded that cabbage seed (Gloria var) primed with ethrel at 20 ml/L significantly improved cabbage growth, yield, and head formation compared to unprimed seeds. However, overall yields were limited by Makurdi's hot climatic conditions. Improved environmental management and cultivar selection are required for optimal performance. Therefore, the study recommends that for cabbage farmers in this study location, seeds should be primed with ethrel at 20ml/L of water and the adoption and evaluation of heat-tolerant cabbage varieties adaptable to tropical climates.

References

Aryanpooya, Z., & Davarynejad, G. H. (2010). Pre-Harvest Ethrel Spraying Effects on Post-Harvest Quality of Sour Cherry Fruits. In VI International Postharvest Symposium 877 (pp. 269-274).

Barba-Espín, G., Chen, S. T., Agnolet, S., Hegelund, J. N., Stanstrup, J., Christensen, J. H., ... & Lütken, H. (2020). Ethephon-induced changes in antioxidants and phenolic compounds in anthocyanin-producing black carrot hairy root cultures. *Journal of Experimental Botany*, 71(22), 7030-7045.

Barsoom, A., & Attala, M. (2020). Effect of ethrel and gibberelic Acid on growth, flowering, sex ratio and yield to Luffa plant. *Middle East Journal of Agriculture Research*, 9(4), 984-993.

Bhadoria, P., Nagar, M., Bharihoke, V., & Bhadoria, A. S. (2018). Ethephon, an organophosphorous, a fruit and vegetable ripener: has potential hepatotoxic effects?. *Journal of family medicine and primary care*, *7*(1), 179-183.

Červenski, J., Vlajić, S., Ignjatov, M., Tamindžić, G., & Zec, S. (2022). Agroclimatic conditions for cabbage production. *Ratarstvo i povrtarstvo*, *59*(2), 43-50.

Ekeruo, G., Iyorkaa, N., Kortse, P., Dughdugh, P., Ugbaa, M., & Okoh, J. O. (2024). Effects of Osmo-priming Duration on Rice (*Oryza sativa* L.) Seed Germination and Seedling Parameters. *Journal of Experimental and Molecular Biology*, 25(1), 51-58.

Farooq, M., Basra, S. M., Wahid, A., & Ahmad, N. (2010). Changes in nutrient-homeostasis and reserves metabolism during rice seed priming: consequences for seedling emergence and growth. *Agricultural Sciences in China*, 9(2), 191-198.

Gelaye, Y., & Tadele, E. (2022). Agronomic productivity and organic fertilizer rates on growth and yield performance of cabbage (*Brassica oleracea* var. capitata L.) in northwestern Ethiopia. *The Scientific World Journal*, 2022(1), 2108401.

GENSTAT (2015). GENSTAT 17.0 Release 17.1DE, Discovery Edition 4, Lawes Agricultural Trust, Rothamsted Experimental Station.

Ghiyal, V., Kumar, K., Kumar, S., Kumar, V., & Singh, D. (2025). Plant growth regulators: A key to enhancing vegetable crop productivity. *International Journal of Agricultural Invention*, 10(1), 35-42.

Harris, D., Tripathi, R. S., and Joshi, A. (2019). Seed priming for enhancing germination and crop yield in rice: A review. *Agronomy for Sustainable Development*, 39(3), 45–60. https://doi.org/10.1007/s13593-019-0567-2

Hussain, S., Khan, F., Hussain, H. A., & Nie, L. (2016). Physiological and biochemical mechanisms of seed priming-induced chilling tolerance in rice cultivars. *Frontiers in plant science*, 7, 116.

Ibrahim, E. A. (2016). Seed priming to alleviate salinity stress in germinating seeds. *Journal of plant physiology*, 192, 38-46.

Iqbal, N., Khan, N. A., Ferrante, A., Trivellini, A., Francini, A., & Khan, M. I. R. (2017). Ethylene role in plant growth, development and senescence: interaction with other phytohormones. *Frontiers in plant science*, 8, 475.

ISPP (2000). Vegetable seed priming descriptions for Brassica and Raphanus 2000. Indian Society of Plant Physiology (ISPP) pp. 51. IARI New Delhi.

Jisha, K. C., Vijayakumari, K., and Puthur, J. T. (2013). Seed priming for abiotic stress tolerance: An overview. *Acta Physiologiae Plantarum*, 35(5), 1381–1396. https://doi.org/10.1007/s11738-012-1186-5.

Kamithi, K. D., Wachira, F., & Kibe, A. M. (2016). Effects of different priming methods and priming durations on enzyme activities in germinating chickpea (*Cicer arietinum* L.). *American Journal of Natural and Applied Sciences*, 1(1), 1-9.

Kapusta-Duch, J., & Kusznierewicz, B. (2021). Young shoots of white and red headed cabbages like novel sources of glucosinolates as well as antioxidative substances. *Antioxidants,* 10(8), 1277.

Kumar, S., Seem, K., and Mohapatra, T. (2023). Biochemical and epigenetic modulations under drought: Remembering the stress tolerance mechanism in rice. *Life,* 13(5), 1156. https://doi.org/10.3390/life13051156.

Lee, B.-R., Zaman, R., La, V. H., Park, S.-H., & Kim, T.-H. (2021). Ethephon-Induced Ethylene Enhances Protein Degradation in Source Leaves, but Its High Endogenous Level Inhibits the Development of Regenerative Organs in Brassica napus. *Plants,* 10(10), 1993. https://doi.org/10.3390/plants10101993.

Liu, J., Tang, X., Wang, Y., Zang, Y., & Zhou, B. (2016). A Zostera marina manganese superoxide dismutase gene involved in the responses to temperature stress. *Gene*, 575(2), 718-724.

Lounsbury, N. P., Warren, N. D., Wolfe, S. D., & Smith, R. G. (2020). Investigating tarps to facilitate organic no-till cabbage production with high-residue cover crops. *Renewable Agriculture and Food Systems,* 35(3), 227-233.

Madina, P., Michael, O. A. & Iyough, D. D. (2023). Productivity of cabbage (*Brassica oleracea* L.) as affected by organic manure and varieties grown in Jos Plateau State. Nigeria. *Journal of Agricultural Science and Food Technology* Vol. 9 (1):1-5. https://doi.org/10.36630/jasft_22001

Marthandan, V., Geetha, R., Kumutha, K., Renganathan, V. G., Karthikeyan, A., & Ramalingam, J. (2020). Seed priming: a feasible strategy to enhance drought tolerance in crop plants. *International journal of molecular sciences*, 21(21), 8258.

McDonald, M. B. (2000). Seed priming. Seed technology and its biological basis. Sheffield Academic Press, Sheffield, 287-325.

Mehdi, M., Ahmed, N., Jabeen, N., Khan, S. H., & Baseerat Afroza, B. A. (2012). Effect of ethrel on hybrid seed production of cucumber (Cucumis sativus L.) under open and protected conditions. 556-560. cabidigitallibrary.org

Mohkami, Z., Kheiry, A., Sanikhani, M., Razavi, F., Tavakolizadeh, M., & Ghorbanpour, M. (2024). Enhancing the medicinal properties and phytochemical content of bitter melon (*Momordica charantia* L.) through elicitation with brassinosteroid, ethrel, and carrageenan. *BMC Plant Biology*, 24(1), 967.

Paparella, S., Araújo, S. D. S., Rossi, G., Wijayasinghe, M. A. L. A. K. A., Carbonera, D., & Balestrazzi, A. (2015). Seed priming: state of the art and new perspectives. *Plant cell reports,* 34(8), 1281-1293.

Rahman, M. S., Imran, S., Rauf, F., Khatun, M., Baskin, C. C., Murata, Y. and Hasanuzzaman, M. (2020). Seed priming with phytohormones: An effective approach for the mitigation of abiotic stress. *Plants,* 10(1), 37. https://doi.org/10.3390/plants10010037

Salleh, M. S., Nordin, M. S., and Puteh, A. B. (2020). Germination performance and biochemical changes under drought stress of primed rice seeds. *Seed Science and Technology*, 48(3), 333–343. https://doi.org/10.15258/sst.2020.48.3.02

Singh, R. K., Topno, S. E., & Bahadur, V. (2024). Effect of GA3, NAA and Ethrel on plant growth, yield and quality of broccoli (*Brassica oleracea* var. italica). *International Journal of Advanced Biochemistry Research*; SP-8(10): 488-492. https://doi.org/10.33545/26174693.2024.v8.i10Sf.2524

Singh, S., Bhatia, R., Kumar, R., Das, A., Ghemeray, H., Behera, T. K., & Dey, S. S. (2021). Characterization and genetic analysis of OguCMS and doubled haploid based large genetic arsenal of Indian cauliflowers (*Brassica oleracea* var. botrytis L.) for morphological, reproductive and seed yield traits revealed their breeding potential. *Genetic Resources and Crop Evolution*, 68(4), 1603-1623.

Srivastava, A. K., Kumar, J. S. and Suprasanna, P. (2021). Seed "primeomics": Plants memorize their germination under stress. *Biological Reviews*, 96(5), 1723–1743. https://doi.org/10.1111/brv.12722

Wojtyla, Ł., Lechowska, K., Kubala, S., & Garnczarska, M. (2016). Molecular processes induced in primed seeds—increasing the potential to stabilize crop yields under drought conditions. *Journal of plant physiology*, 203, 116-126.

Zhang, L., Dai, Y., Yue, L., Chen, G., Yuan, L., Zhang, S. & Wang, C. (2022). Heat stress response in Chinese cabbage (*Brassica rapa* L.) revealed by transcriptome and physiological analysis. *PeerJ,* 10, e13427.

Zhang, W., Li, C., Li, Z., Hu, N., Cao, G., Huang, J. & Zhang, H. (2025). Effects of Different Plant Growth Regulators on Growth Physiology and Photosynthetic Characteristics of Pinus koraiensis Seedlings. *Plants,* 14(23), 3671.

How to cite this Article: *Bar-Anyam, M. N., Ugoo, T. R., Okpokwu, E. B., & Ama, G. S. (2026). Enhancing growth and yield of heading cabbage (Brassica oleracea L.) through Ethrel priming in Southern Guinea Savanna. International Journal of Engineering, Science, and Environmental Research (IJESER), 1(2), 162–167.*