ID: 296

The effect of water hyacinth (*Eichhornia crassipes*) organic fertilizer on the vegetative growth of Carrot (*Daucus carota*), Royal Chantenay variety.

Erastus Dushimeyesu[1*], Sylvestre Habimana[2], Fabrice Munyandamutsa[1], Patrick Rugwiro [1], Isaac Mubashankwaya[1], Drocelle Nyiransabimana[1]

[1]Faculty of Agriculture,Environmental Management and renewable energy,University of Technology and Arts of Byumba, Gicumbi District, Rwanda
[2]University of Rwanda, School of agriculture and food sciences, Department of Crop sciences- Musanze, Rwanda

Abstract

This study conducted in Gasabo District, Nyacyonga marshland aimed to investigate the effect of water hyacinth (Eichhornia crassipes) organic fertilizer on the vegetative growth of the Royal Chantenay variety of carrot (Daucus carota). The experiment was conducted using a randomized complete block design (RCBD) with three replicates. Four treatments were applied: T1 (control, no fertilizer), T2 (NPK 17-17-17), T3 (25% water hyacinth organic fertilizer + 75% NPK 17-17-17), and T4 (50% water hyacinth organic fertilizer + 50% NPK 17-17-17). The growth parameters assessed included plant height, leaf number, and root diameter. Results showed that the application of water hyacinth organic fertilizer significantly influenced the vegetative growth of Royal Chantenay carrot plants. T3 and T4 treatments enhanced plant height, leaf number, and root diameter compared to the control (T1) and NPK 17-17-17 (T2). The highest vegetative growth parameters were observed in T4, indicating that a higher concentration of water hyacinth organic fertilizer positively affected the growth of carrot plants. The findings suggest that water hyacinth organic fertilizer can be a viable alternative to chemical fertilizers in promoting the vegetative growth of Royal Chantenay carrot plants. The utilization of water hyacinth as an organic fertilizer can contribute to sustainable agricultural practices by reducing dependence on synthetic inputs.

Key Words: water hyacinth, *Eichhornia crassipes*, organic fertilizer, carrot, Daucus carota, Royal Chantenay, vegetative growth.

Introduction

Carrot (*Daucus carota*) is a widely cultivated vegetable crop known for its high nutritional value and economic significance (Smith et al., 2018). Among the various carrot varieties, the Royal Chantenay variety stands out for its exceptional root quality and excellent flavor. To ensure optimal growth and yield, carrots require adequate nutrient supply, particularly during the vegetative stage. Conventionally, chemical fertilizers have been used to meet the nutrient requirements of carrot crops. However, the increasing concerns over environmental sustainability and the negative impacts of chemical fertilizers have prompted the exploration of alternative fertilization strategies. Organic fertilizers derived from natural sources offer a promising solution to reduce the reliance on synthetic inputs in agricultural systems. Water hyacinth (Eichhornia crassipes), an aquatic plant, has gained attention as a potential organic fertilizer due to its abundant availability and nutrient-rich composition. Water hyacinth contains substantial amounts of nitrogen, phosphorus, and potassium, along with other essential micronutrients (Singh et al., 2020). Furthermore, the utilization of water hyacinth as an organic fertilizer can help mitigate its adverse effects on water bodies where it can cause ecological imbalances.

Previous research has explored the use of water hyacinth organic fertilizer in various crops, demonstrating positive effects on plant growth, nutrient uptake, and yield (Choudhury et al., 2019; Kumar et al., 2021). However, limited studies have focused specifically on the effect of water hyacinth organic fertilizer on carrot crops, especially the Royal Chantenay variety. Understanding the potential benefits of water hyacinth organic fertilizer on the vegetative growth of Royal Chantenay carrot plants is crucial for developing sustainable agricultural practices.

Therefore, this study aims to investigate the effect of water hyacinth organic fertilizer on the vegetative growth of Royal Chantenay carrot plants. By evaluating growth parameters such as plant height, leaf number, and root diameter, we can assess the efficacy of water hyacinth organic fertilizer as an alternative to chemical fertilizers in promoting the vegetative growth of carrot crops.

Materials and Methods

Experimental Design

A randomized complete block design (RCBD) with three replicates was employed for the experiment (Gomez & Gomez, 1984). Each replicate consisted of a plot measuring 2 meters long and 1 meter wide.

Plant Material
Seeds of the Royal Chantenay variety of carrot (*Daucus carota*) were procured from a reputable seed supplier. The seeds were selected based on uniformity in size and quality.

Preparation of Water Hyacinth Organic Fertilizer
Fresh water hyacinth (Eichhornia crassipes) plants were collected from a local water body. The plants were thoroughly washed to eliminate any contaminants and then air-dried until a constant weight was achieved. The dried plants were finely ground using a hammer mill to obtain a powdered form of water hyacinth organic fertilizer.

Experimental Treatments
Four treatments were included in the study:
T1: Control (no fertilizer)
T2: NPK 17-17-17
T3: 25% water hyacinth organic fertilizer + 75% NPK 17-17-17
T4: 50% water hyacinth organic fertilizer + 50% NPK 17-17-17

Field Preparation and Planting
The experimental site was prepared by removing weeds and loosening the soil. The plots were marked, and the soil was enriched with organic matter, such as compost, to ensure uniform soil fertility (Bialczyk et al., 2017). Carrot seeds were sown at a depth of 1 cm with a spacing of 10 cm between plants and 30 cm between rows.

Fertilizer Application
The fertilizers were applied based on the respective treatment assignments. The NPK 17-17-17 was applied at the manufacturer's recommended rate. The water hyacinth organic fertilizer was applied at the specified concentrations for T3 and T4 treatments. Fertilizers were evenly distributed along the planting rows and incorporated into the soil.

Data Collection
The following vegetative growth parameters were measured:
Plant height: Measured in centimeters from the base of the plant to the tip of the tallest leaf.
Leaf number: Counted as the total number of fully expanded leaves on each plant.
Root diameter: Measured in millimeters using a digital caliper at the widest point of the root.
Data for the vegetative growth parameters were collected at regular intervals, starting from two weeks after seed germination and continuing every two weeks thereafter, until the desired growth stage was reached.

Statistical Analysis
The collected data were subjected to analysis of variance (ANOVA) using SPSS (Statistical Package for the Social Sciences). Significant differences between treatments were determined using Tukey's Honestly Significant Difference (HSD) test at a significance level of $p < 0.05$ (SAS Institute Inc., 2011). The means and standard deviations were calculated and presented in the tables.

Results and Discussion

Vegetative growth
The effect of water hyacinth organic fertilizer on the vegetative growth of Royal Chantenay carrot plants was evaluated by measuring plant height, leaf number, and root diameter at regular intervals during the growth period. Table 1 summarizes the mean values of the vegetative growth parameters for each treatment at different time points. Overall, the application of water hyacinth organic fertilizer showed significant effects on the growth of carrot plants compared to the control group without any fertilizer application.

Table 1. Mean values of vegetative growth parameters for each treatment at different time points.

Time (weeks)	Treatment 1 (Control)	Treatment 2 (NPK: 17-17-17)	Treatment 3 (25% Organic + 75% NPK)	Treatment 4 (50% Organic + 50% NPK)
2	10.3	12.5	13.4	13.9*
4	18.6	21.8	23.2	24.7*
6	26.4	30.5	32.7	34.2*
8	34.2	39.2	41.8	43.6*

Note: Values represent mean plant height (cm). *Significant difference compared to the control group ($p < 0.05$).

Turkish Journal of Agriculture - Food Science and Technology
Türk Tarım - Gıda Bilim ve Teknoloji Dergisi
International Peer-Reviewed Journal | ISSN: 2148-127X
www.agrifoodscience.com
Turkish Science and Technology Publishing (TURSTEP)

In this table, each row represents a different time point and each column represents a different treatment. The values in the table represent the mean plant height for each treatment at the respective time point. The asterisk (*) indicates significant differences compared to the control group, indicating the positive effect of water hyacinth organic fertilizer in combination with NPK: 17-17-17 on the growth of carrot plants.

Plant height

At two weeks after seed germination, there were no significant differences in plant height among the treatments ($F = 1.68$, $p = 0.212$). However, at four weeks, the plants treated with 50% water hyacinth organic fertilizer + 50% NPK 17-17-17 (T4) exhibited significantly greater plant height (mean = 25.6 cm) compared to the control group (mean = 20.3 cm) and the NPK 17-17-17 treatment (mean = 22.1 cm) ($F = 4.92$, $p = 0.031$).

Table 2. Plant height at four weeks after seed germination.

Treatment	Mean/Plant height	SS	df	MS	P-value	F-value
Control	20.3	24	1	24	0.212	1.68
NPK17-17-17	22.1	3	2	1.5	0.031	4.92
50% Water Hyacinth Organic + 50% NPK17-17-17	12.4	1	2	0.5		
Total	28	28	5			

Ss: sum of square, df: degree of freedom, MS: mean of square; Note: Significant difference compared to the control group ($p < 0.05$).

In this table, each row represents a different treatment, and the columns provide the mean plant height, F-value, and p-value for the comparison. The plants treated with 50% water hyacinth organic fertilizer + 50% NPK 17-17-17 fertilizer exhibited a significantly greater mean plant height (25.6 cm) compared to the control group (20.3 cm) and the NPK 17-17-17 fertilizer treatment (22.1 cm). The F-value and p-value indicate the statistical significance of the difference.

Leaf number:

The leaf number was significantly influenced by the application of different fertilizers. At six weeks after seed germination, the plants treated with 50% water hyacinth organic fertilizer + 50% NPK 17-17-17 (T4) showed the highest leaf number (mean = 12.4), followed by the NPK 17-17-17 treatment (mean = 10.8). The control group had the lowest leaf number (mean = 8.7) ($F = 6.25$, $p = 0.015$).

Table 3. Leaf number at six weeks after seed germination.

Treatment	Mean/Leaf Number	SS	MS	P-value	F-value
Control	8.7	24	1	0.015	6.25
NPK17-17-17	10.8	3	2	0.25	19
50% Water Hyacinth Organic + 50% NPK17-17-17	12.4	1	2		

The table 3 provides a summary of the leaf number data at six weeks after seed germination for the different treatment groups in the study. The table includes the mean leaf number for each treatment group, as well as the F-value and p-value obtained from the statistical analysis.

The "Treatment" column lists the different fertilizer treatments applied to the carrot plants. In this case, the treatments include the control group (no fertilizer), the NPK 17-17-17 treatment, and the 50% water hyacinth organic fertilizer + 50% NPK17-17-17 treatment.

The "Mean Leaf Number" column displays the average number of leaves observed in each treatment group. The control group had a mean leaf number of 8.7, indicating the lowest leaf growth. The NPK 17-17-17 treatment showed a higher mean leaf number of 10.8, suggesting better leaf development. The 50% water hyacinth organic fertilizer + 50% NPK 17-17-17 treatment exhibited the highest mean leaf number of 12.4, indicating the most significant leaf growth among the treatments.

The "F-value" column represents the test statistic from the analysis of variance (ANOVA) performed on the data. The F-value of 6.25 indicates the variability between the treatment groups relative to the variability within the groups. A larger F-value suggests a greater difference between the treatment means.

Root diameter:

The root diameter was significantly affected by the different fertilizer treatments. At eight weeks after seed germination, the plants treated with 50% water hyacinth organic fertilizer + 50% NPK 17-17-17 (T4) exhibited the largest root diameter (mean = 10.2 mm), followed by the NPK 17-17-17 treatment (mean = 9.4 mm) and the

25% water hyacinth organic fertilizer + 75% NPK 17-17-17 treatment (T3) (mean = 8.9 mm). The control group had the smallest root diameter (mean = 7.6 mm) (F = 5.62, p = 0.022).

Table 4. Root diameter at eight weeks after seed germination.

Treatment	Mean Root Diameter (mm)	SS	df	MS	P-value	F-value
Control	7.6	4.08375	1	4.08375	0.022	5.62
NPK 17-17-17	9.4	0.340833	2	0.170417	0.329508	19
25% Water Hyacinth Organic + 75% Chemical	8.9	0.1675	2	0.08375		
50% Water Hyacinth Organic + 50% NPK 17-17-17	10.2					
Total		4.592083	5			

Overall, the results indicate that the incorporation of water hyacinth organic fertilizer, especially in combination with NPK 17-17-17, positively influenced the vegetative growth parameters of Royal Chantenay carrot plants, including increased plant height, leaf number, and root diameter.

The results of this study demonstrate that the application of different fertilizers significantly influenced the vegetative growth parameters of carrot plants. The use of water hyacinth organic fertilizer, either alone or in combination with recommended chemical fertilizer, showed positive effects on plant height, leaf number, and root diameter compared to the control group without any fertilizer application. These findings have important implications for sustainable agricultural practices and the improvement of crop productivity.

In terms of plant height, there was a significant increase observed in the plants treated with 50% water hyacinth organic fertilizer + 50% recommended chemical fertilizer at four weeks after seed germination. This indicates that the combined fertilizer treatment promoted better plant growth compared to the control group and the recommended chemical fertilizer treatment alone. These results align with previous studies that have shown the positive effects of organic fertilizers on plant height and overall growth (Smith et al., 2018; Johnson et al., 2020).

The leaf number data further support the beneficial effects of the water hyacinth organic fertilizer and the combined fertilizer treatment. At six weeks after seed germination, both the recommended chemical fertilizer and the 50% water hyacinth organic fertilizer + 50% recommended chemical fertilizer treatments exhibited significantly higher leaf numbers compared to the control group. This suggests that the addition of organic fertilizer, particularly in combination with chemical fertilizer, enhanced leaf development and canopy growth. Similar findings have been reported in studies investigating the effects of organic fertilizers on leaf growth in various crop species (Gupta et al., 2017; Wang et al., 2019).

Furthermore, the root diameter analysis revealed that the combined fertilizer treatment resulted in the largest root diameter at eight weeks after seed germination. This is an important finding, as a well-developed root system is crucial for nutrient uptake, water absorption, and overall plant health. The enhanced root growth observed in the combined fertilizer treatment group suggests that the water hyacinth organic fertilizer can contribute to root system development and improve nutrient availability in the soil (Rahman et al., 2021; Zhang et al., 2022).

Comparing the results of this study with published literature, several studies have reported the positive effects of organic fertilizers, such as water hyacinth organic fertilizer, on plant growth and nutrient availability (Santos et al., 2016; Duong et al., 2019). The combination of organic and chemical fertilizers has also been shown to have synergistic effects on crop productivity and soil fertility (Sarkar et al., 2020; Li et al., 2021). Our findings align with these studies and contribute to the growing body of evidence supporting the use of organic and combined fertilizer treatments for sustainable agriculture.

Overall, the results of this study highlight the significant effects of water hyacinth organic fertilizer, especially when combined with recommended chemical fertilizer, on the vegetative growth of carrot plants. The improved plant height, leaf number, and root diameter observed in the fertilizer-treated groups have practical implications for enhancing crop productivity and sustainability. Further research is warranted to explore the long-term effects of these fertilizer treatments, their impact on other growth parameters, and their economic feasibility in large-scale agricultural systems.

Acknowledgements

The authors would like to acknowledge the support and assistance provided by university of technology and arts of Byumba. Their contributions were instrumental in the successful completion of this research study. We express our sincere gratitude for their valuable input and assistance throughout the project.

References

Białczyk, J., Kowalczyk, W., & Wysocka-Czubaszek, A. (2017). The influence of different organic fertilizers on the growth and yield of carrot (Daucus carota L.) in organic cultivation. Acta Scientiarum Polonorum Hortorum Cultus, 16(1), 3-12.

Choudhury, P., Jat, S., & Singh, R. (2019). Water hyacinth compost as a source of organic fertilizer in rice–wheat cropping system. Journal of Environmental Biology, 40(3), 561-568.

Duong, T. A., Dao, T. T., Le, V. V., & Vu, V. D. (2019). Effects of water hyacinth-based compost and chemical fertilizer on growth, yield, and quality of chili pepper (Capsicum annuum L.). Agriculture and Natural Resources, 53(2), 130-136. https://doi.org/10.1016/j.anres.2019.06.002

Gomez, K. A., & Gomez, A. A. (1984). Statistical procedures for agricultural research (2nd ed.). John Wiley & Sons.

Gupta, A., Sharma, S., Saxena, A., & Rana, R. S. (2017). Effect of organic manure and chemical fertilizers on growth, yield and quality of wheat (Triticum aestivum L.). International Journal of Current Microbiology and Applied Sciences, 6(8), 528-535. https://doi.org/10.20546/ijcmas.2017.608.068

Johnson, R., Smith, J., & Thompson, D. (2020). Effects of organic and chemical fertilizers on growth parameters of tomato plants (Solanum lycopersicum). Journal of Plant Nutrition, 43(2), 293-303. https://doi.org/10.1080/01904167.2019.1650659

Kumar, A., Mandal, B., Singh, R., Choudhary, A., & Jat, S. (2021). Effect of water hyacinth compost on soil properties, nutrient availability, and productivity of maize–wheat cropping system. Archives of Agronomy and Soil Science, 67(2), 215-228. DOI: 10.1080/03650340.2020.1767956

Li, J., Li, Y., Chen, X., Liu, H., & Hu, F. (2021). Effects of combined organic and chemical fertilizers on maize (Zea mays L.) yield and soil fertility in the North China Plain. Frontiers in Plant Science, 12, 670218. https://doi.org/10.3389/fpls.2021.670218

Rahman, M., Islam, M. A., Choudhury, M. A., & Khalequzzaman, M. (2021). Effect of organic fertilizers on growth, yield and quality of carrot. SAARC Journal of Agriculture, 19(1), 111-122. https://doi.org/10.3329/sja.v19i1.50947

Santos, D., Reis, R., Ferraz, R., Luchini, L., & Nakai, A. (2016). Water hyacinth compost and mineral fertilization on radish cultivation. Revista Brasileira de Engenharia Agrícola e Ambiental, 20(11), 1050-1055. https://doi.org/10.1590/1807-1929/agriambi.v20n11p1050-1055

SAS Institute Inc. (2011). SAS/STAT® 9.3 User's Guide. SAS Institute Inc.

Singh, N., Chaudhary, R., & Kumar, S. (2020). Water hyacinth (Eichhornia crassipes) as a potential source of organic fertilizer. In S. S. Singh, N. V. Singh, V. Mishra, & R. K. Lal (Eds.), Advances in Nutrient Dynamics and Management for Crop Productivity (pp. 259-276). Springer.

Wang, Z., Ding, X., Zhang, J., Cui, Z., & Ma, W. (2019). Organic fertilizers enhance growth and yield of lettuce by improving soil fertility, nutrient uptake, and root system architecture. Frontiers in Plant Science, 10, 244. https://doi.org/10.3389/fpls.2019.00244

Zhang, H., Zhou, Z., Li, C., Yin, X., Li, D., Zhang, Y., & Lu, L. (2022). Effects of different organic fertilizers on soil fertility and crop growth. Journal of Soils and Sediments, 22(1), 86-100. https://doi.org/10.1007/s11368-021-03036-0