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Fermented Coffee Pulp Juice as Fertilizer in Cabbage Plug Transplants Production

Judelyn Ocbus[1*] **Manolo Valdez**[1]

[1]*Nueva Vizcaya State University, College of Agriculture, Bayombong, Nueva Vizcaya*

*__Correspondence:__ judetomin@gmail.com

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Abstract

This study aimed to evaluate the effects of the different concentrations of Fermented Coffee Pulp Juice (FCPJ) as well as its appropriate mode of application in enhancing cabbage plug transplants production. The experiment was laid out following the Factorial Completely Randomized Design (FCRD) with three replications. Factor 1 comprised the different modes of application that is drenching and foliar spraying while factor 2 consisted the different FCPJ concentrations, which included, 'Pure Water only, '15 ml FCPJ/L water, 30 ml FCPJ/L water and 45 ml FCPJ/L water.

Results revealed that drenching significantly produced cabbage plug transplants with bigger stems and leaves with higher chlorophyll content. Application of 45ml/L water significantly increased the total leaf chlorophyll content, shoot fresh weight and stem diameter of plug transplants. Results also showed that the different concentrations did not affect the number of leaves and seedling height, however, significant differences were observed compared to the untreated seedlings.

Key words

Cabbage plug transplant production, fermented coffee pulp juice, drenching, foliar spray

Introduction

Producing high-quality vegetable seedlings is critical in maximizing the growth and yield of crops. High quality seedlings can enhance the initial growth of crops, improve the quality, consistency, and yield of the final harvest, and reduce the time required for production. (Park *et al.*, 2022). Balanced fertilization combined with the provision of favorable plant environment is essential in the production of good quality seedlings. The need for fertilizer efficiency has grown as a result of rising fertilizer costs and environmental concerns. To improve fertilizer use efficiency, organic fertilizer sources have been used in conjunction with inorganic fertilizers. (Baghdadi *et al.*, 2018).

A growing number of farmers are adopting environmentally friendly techniques, such as employing organic liquid fertilizer—such as fermented fruit and plant juices—instead of synthetic ones, as a means of contributing to a sustainable environment. Traditionally, the production of Fermented Plant Juice is only limited to plant shoots and fruits such as sweet potato tops, banana pseudo stem, papaya and banana fruits among others. Agricultural by-products and wastes such as coffee pulp are seldom utilized.

Being the major by-product of coffee wet processing, coffee pulp offers potential opportunities to be used as fertilizers. However, due to its high C:N ratio, coffee pulp cannot be used directly as fertilizer. Hence, this study focuses on the fermentation of coffee pulp in order to produce foliar fertilizers applied to cabbage seedlings. Combined inorganic and organic fertilizer application through the supplementation of fermented coffee pulp juice may be evaluated to enhance the production of quality cabbage seedlings.

Materials and Methods

A two-factor experiment arranged in Completely Randomized Design (CRD) with three replications was used in the study. There were twenty-four (24) experimental trays with 128 seedlings each. Following farmers' practice, cells were filled with vermicompost and coco coir dust as growing media with a ratio of 1:1. The trays were then watered, allowing the media to absorb enough moisture. Two seeds per cell were sown and covered with the media. After seven days, thinning was done allowing only one seedling per cell. 'Scorpio' variety was used as recommended for dry season cultivation and is mostly planted by farmers in the locality. After sowing, the seedling trays were randomly arranged inside the plastic tunnels. Weeding and pesticide application were done to control pests and diseases. Surface irrigation was also employed to facilitate the water requirements of the crops.

Treatment application was done upon the appearance of true leaves. One-part fresh coffee pulps were mixed with 1 part molasses and were fermented for seven days. After which, the juice was extracted from the pulp by squeezing. The extracts were diluted with water with the concentrations, 15, 30 and 45 ml L^{-1} water. The resulting solutions were then applied onto the seedlings at 2- true leaf stage by drenching and foliar spraying. Application was done once a week (every seven days) and ended one week before transplanting. At the end of the experiment, ten (10) sample seedlings were randomly selected per experimental tray for the measurement of the different parameters namely; number of leaves and its chlorophyll content, seedling height and stem diameter, and the fresh biomass of the seedlings. The study was terminated when the seedlings were ready to be transplanted as indicated by the emergence of 3-4 true leaves.

The data gathered were consolidated and tabulated using the analysis of variance (ANOVA) for Completely Randomized Design. The means were separated using Duncan's Multiple Range Test (DMRT) to determine the significant differences among treatment means at 0.05 level of probability.

Results and Discussion

Leaf Characters of Cabbage Seedlings

Table 1 presents the number of leaves and chlorophyll content of cabbage seedlings applied with fermented coffee pulp juice. Results showed that drenching produced seedlings with higher chlorophyll content over those that were sprayed. Miller et al. (2013) stated that fermented plant juice solutions can both be watered onto plants or into the soil, or it can be applied as a foliar spray. However, Coolong & McAvoy (n.d.) emphasized that the waxy cuticle of many leafy vegetables like cabbage, collard and kale inhibits the nutrient absorption of many nutrients including nitrogen, phosphorous and potassium. Thus, the application of these elements as foliar spray is not recommended.

Table 1. Leaf characteristics of cabbage plug transplants applied with fermented coffee pulp juice

Treatments	Number of Leaves	Chlorophyll Content Index (CCI)
Factor A		
A_1 – Drenching	3.75	7.47^a
A_2 – Foliar Spray	3.75	6.68^b
Factor B		
B_1 – Pure water	3.33^b	6.77^b
B_2 - 15 ml L^{-1} water	4.00^a	6.68^b
B_3 – 30 ml L^{-1} water	3.67^a	7.17^{ab}
B_4 – 45 ml L^{-1} water	4.00^a	7.69^a
A x B		
A_1B_1	3.33	6.75
A_1B_2	4.00	7.18
A_1B_3	3.67	7.43
A_1B_4	4.00	8.50
A_2B_1	3.33	6.78
A_2B_2	4.00	6.18
A_2B_3	3.67	6.90
A_2B_4	4.00	6.87
C.V. (%)	9.5	8.7

Means followed by a common letter superscript are not significantly different at 5% level by DMRT.

In terms of the different concentrations of FCPJ, cabbage plug transplants applied with a concentration of 45ml L-1 water produced leaves with higher chlorophyll content. This could be attributed to the higher manganese and iron content of FCPJ. Nitrogen, magnesium, iron and manganese are essential nutrients needed for the production of chlorophyll. Chlorophyll molecules are needed for the transformation of light energy to chemical bonds in plants. Reduced chlorophyll concentrations may limit the photosynthetic processes and further decrease in the primary production of chlorophylls. Plant chlorophyll concentration plays a major role as a visual indicator of mineral nutrient deficiencies, often expressed in leaf color changes from dark green to light green or yellow (Veazie et al., 2020). In addition, Zinc, which is present in the FCPJ at 11.18 ppm, also plays a role in chlorophyll

formation. In a study done by Patel et al. (2021), maximum chlorophyll a, chlorophyll b and total chlorophyll were found with the foliar application of micronutrients Zinc, Boron and Molybdenum. They further stated that the minimum a, b and total chlorophyll (mg/g) were observed in no application of these micronutrient treatments. In addition, treatments B2, B3 and B4 produced an average of 4 leaves per plant at transplanting and was not comparable to control group (pure water only) having an average of 3 leaves per plant. The number of leaves in plants influences yields because it is the major organ for photosynthesis and also produces the bulk of plant biomass.

Stem Characters

Table 2 shows the effects of Fermented Coffee Pulp Juice (FCPJ) application in terms of seedling height and stem diameter of cabbage plug transplants. Drenching significantly produced cabbage seedlings with bigger stems, however, seedling height was not significantly affected. Hence, it can be inferred that drenching is efficient over foliar spraying as it produced plug transplants with bigger stems. Smethurst (2004) mentioned that nutrients in their ionic forms are absorbed by the roots from soil solution and its uptake rate is dependent on its concentration in the immediate soil solution around the roots. In relation to drenching, the nutrients present in FCPJ were easily absorbed by the plant roots because it is applied in solution form. Since drenching of nutrients is a form of fertigation, Dixon and Guodong (2022) emphasized its several benefits in crop production. Fertigation synchronizes the supply of nutrients with the crop nutrient requirement by enhancing water-use and nutrient-use efficiency resulting to higher yield. It also reduces the loss of important crop nutrients by minimizing leaching, ammonia volatilization and denitrification process.

Plug transplants with bigger stem diameter found in those applied with 45 ml FCPJ /L water could be attributed to the better leaf growth characteristics found in table 1 wherein plug transplants had higher chlorophyll content. Increased photosynthetic performance due to higher chlorophyll content of plug transplants applied with 45ml FCPJ/ L caused the production of more photosynthates. According to Zhu et al. (2010), 2–4% of the absorbed radiation in the leaves is used for the growth of the plants (Zhu et al., 2010) and 50–80% of the photo assimilates from a single mature leaf are translocated into the phloem tissues (Ainsworth and Bush, 2011).

Table 2. Stem characteristics of cabbage seedlings applied with fermented coffee pulp juice

Treatments	Seedling Height (cm)	Stem Diameter (mm)
Factor A		
A_1 – Drenching	7.74	1.80[a]
A_2 – Foliar Spray	7.69	1.68[b]
Factor B		
B_1 – Pure water	6.95[b]	1.65[b]
B_2 -15 ml L^{-1} water	7.79[a]	1.72[b]
B_3 – 30 ml L^{-1} water	8.03[a]	1.72[b]
B_4 – 45 ml L^{-1} water	8.10[a]	1.88[a]
A x B		
A_1B_1	6.75	1.69
A_1B_2	7.71	1.75
A_1B_3	8.18	1.74
A_1B_4	8.32	2.02
A_2B_1	7.15	1.60
A_2B_2	7.86	1.69
A_2B_3	7.88	1.69
A_2B_4	7.88	1.73
C.V. (%)	5.9	5.1

Means followed by a common letter superscript are not significantly different at 5% level by DMRT.

Fresh Biomass

Table 3 shows the fresh biomass of cabbage plug transplants applied with FCPJ. Results revealed that the mode of application of FCPJ did not show significant differences on the fresh root and shoot weight of the plug transplants. Among the different concentrations of FCPJ used in the study, 45 ml L^{-1} water significantly produced cabbage plug transplants with heavier shoot over root. This shows that at 45ml L^{-1} concentration of FCPJ, shoot production is favored over root production in cabbage seedlings.

Maskova and Herben (2018) mentioned that the root-to-shoot ratio measures the quantity of plant tissues having supportive functions (roots) compared to the quantity of plant tissue with growth function (shoots). Plants with a greater amount of roots can outcompete others for soil nutrients, whereas, plants with more shoots can capture more light energy and grow bigger. In agreement with this, the higher fresh biomass shoot weight over root weight in this study is indicative of plants that are able to collect more light energy and hence have better photosynthetic

functions.

The authors also added that one of the mechanisms in which plants deal with limited resources in the environment is through biomass partitioning, which can impact plant growth rate. In environments with abundant nutrients, plants allocate more biomass to their leaves and stems due to intense competition for light above ground. Conversely, in nutrient-poor environments where below-ground competition is dominant, they allocate a larger proportion of biomass to their roots. With these concepts, it could be concluded that the application of 45 ml FCPJ/L water promotes a nutrient-rich environment as indicated by higher shoot weight over root weight as found in the present study.

Table 3. Fresh biomass of cabbage plug transplants applied with fermented coffee pulp juice.

Treatments	FRESH	
	Shoot weight (g)	Root Weight (g)
Factor		
A_1 – Drenching	4.36	3.25
A_2 – Foliar Spray	4.48	3.10
Factor B		
B_1 - Control (Pure water)	4.01^b	2.84^b
B_2 -15 ml L^{-1} water	4.23^b	2.89^b
B_3- 30 ml L^{-1} water	4.38^b	3.24^b
B_4 -45 ml L^{-1} water	5.06^a	3.73^a
A x B		
A_1B_1	3.97	2.86
A_1B_2	4.19	2.88
A_1B_3	4.33	3.40
A_1B_4	4.95	3.84
A_2B_1	4.05	2.81
A_2B_2	4.26	2.90
A_2B_3	4.43	3.08
A_2B_4	5.16	3.62
C.V. (%)	6.8	12.0

Means followed by a common letter superscript are not significantly different at 5% level by DMRT.

Conclusions

The results of the study indicated that the application of fermented coffee pulp juice exhibited a significant impact in the production of cabbage plug transplants. The concentration of 45ml FCPJ/L water significantly produced cabbage plug transplants with bigger stems, higher chlorophyll content and higher fresh plant biomass. Meanwhile, cabbage seedlings applied with FCPJ, regardless of the concentrations, significantly produced taller plug transplants with more leaves over those that were not applied. In terms of the mode of application, drenching significantly produced plug transplants with bigger stems and more leaves having higher chlorophyll content than those applied through foliar spraying.

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Author Contributions

Ocbus, J. designed the study, performed the experiments, analyzed the data, and worked on the manuscript. Valdez M. supervised the conduct and findings of this work and contributed to the final version of the manuscript. Both authors provided critical feedback and helped shape the research, analysis, and manuscript.

Conflict of Interests

Authors declare that there is no conflict of interests.

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