Journal of Geography, Regional Planning and Development
Homepage : https://journal.antispublisher.id/index.php/JGRPD
Email : admin@antispublisher.com

e-ISSN : 3032-131X
JGRPD, Vol. 2, No. 2, February 2025
Page 54-62
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Journal of Geography, Regional Planning and Development

Influence of Dry Baking Yeast Foliar Spray and Eggshell Powder Amendment on Selected Growth Traits of Broccoli

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OPEN ACCESS

DOI : https://doi.org/10.61796/jgrpd.v2i2.1439

Sections Info

Article history:
Submitted: January 23, 2025
Final Revised: January 31, 2025
Accepted: February 15, 2025
Published: February 28, 2025

Keywords:
Broccoli growth
Eggshell powder
Yeast solution
Sustainable agriculture
Plant quality

ABSTRACT

Objective: *An experiment was conducted during the 2020–2021 winter growing season to investigate the effects of eggshell powder and dry yeast solution on the physiological and morphological traits of broccoli.* ***Method:*** *Under carefully regulated under which broccoli seeds were originally planted before being transferred to the field. The study evaluated plant height, total number of leaves, and percentage of dry matter in inflorescences.* ***Results:*** *Plant growth parameters were found to be considerably and favorably effected by both dry yeast and eggshell powder. This combination of 2 g/L dry yeast and 10 g/plant eggshell powder produced the highest dry matter content in the inflorescences (15.78%), the highest plant height (56 cm), and the most leaves (23.06).* ***Novelty:*** *The combination of dry yeast and eggshell powder significantly enhances the physiological and morphological traits of broccoli, demonstrating an effective and practical approach for improving broccoli growth parameters.*

INTRODUCTION

With the growing demand for high-quality horticultural products, improving cultivation techniques is essential to raising output and plant health [1]. Among the effective and sustainable strategies that are becoming more and more well-liked in response are organic additions such as eggshell powder and dry yeast solution, which have shown promise in improving the physiological and morphological traits of plant [2]. By naturally breaking down, eggshells provide a vital supply of calcium for soil enriching [3]. They are thought of as organic biofertilizers and biological catalysts that can increase the yield of different crops [4]. In 2020, the United States is expected to consume over 8,000 million dozen eggs, with 280 eggs ingested per person, up from over 7,951.8 million dozen in 2019. [4] By 2028, consumption is expected to reach 8,917 million dozen, according to USDA predictions. Therefore, using egg waste as a calcium source has two advantages: it reduces waste and enhances soil health.

With its numerous physiological roles, calcium is an important mineral for plant growth as well as growth. It is an essential component of the middle lamella in plant cell walls and performs a crucial role in enhancing cell structure. Calcium is essential for cell division, chromosomal stability, hydrolysis, cell proliferation, and mitochondrial activity. It is also present as calcium pectate [5], [6]. Additionally, during seed formation, it aids in storage processes, the movement of proteins and carbohydrates, and a variety of enzymatic activities [7]. Calcium also improves the plant's ability to absorb CO_2 and helps detoxify oxalic acid by forming calcium oxalate [8].

In agricultural practices, yeast has drawn interest as a possible natural fertilizer due to its rich nutritional profile. Yeast solutions have been investigated for use as foliar fertilizers for a variety of crops. Essential plant nutrients such as iron, calcium, magnesium, potassium, nitrogen, phosphorus, salt, zinc, and silicon are found in yeast, a living organism [9]. Its extract usually contains about 40 mg/g of nitrogen from amino acids, 90 mg/g of total nitrogen, and 82 mg/g of carbohydrates [10]. 38 mg/g of phosphorus, 56 mg/g of sodium, 30 mg/g of potassium, and a variety of ions (1–13 mg/g) are also present. Micronutrient-wise, it contains 0.1 mg/g of calcium, 0.05 mg/g of iron, and 0.05 mg/g of copper

, as well as zinc, 2 mg/g of magnesium, and trace levels of cobalt and manganese (0.005 mg/g each). This varied nutritional profile highlights yeast extract's potential as a useful organic supplement to improve the physiological function of plants. Bread yeast is rich in auxins and gibberellins, two significant classes of natural growth regulators [11]. It has been shown to boost the production of several crops when used as a biological growth enhancer and natural biostimulant. Furthermore, yeast contains naturally occurring cytokinins that stimulate the creation of proteins, amino acids, and chlorophyll while also encouraging cell division and differentiation [12]. Yeast can be applied topically or mixed into the soil to treat plants. Its primary roles are to enhance nutrient intake and stimulate enzymatic activity, both of which promote total vegetative development.

[13] was to evaluate the effects of eggshell powder and yeast extract applied topically, both independently and in combination, on broccoli plant growth and yield. To enhance the morphological and physiological traits of broccoli, this study used two low-cost, environmentally friendly organic amendments: eggshell powder as a calcium source and yeast extract as a natural biostimulant. The research is unique because of this.

RESEARCH METHOD

During the winter growing season of 2020–2021, the Department of Horticulture and Garden Engineering at the Faculty of Agriculture, Al-Qasim Green University, conducted a field experiment to examine the effects of applying eggshell powder and foliar spraying with dry yeast extract on specific growth and quality traits of broccoli plants [14], [15].

Soil samples were taken at a depth of 0 to 30 cm from various points throughout the field before the experiment started. After preparing the root zone layer by air drying, grinding, and sieving through a 2 mm screen, the samples were examined to evaluate important physical and chemical characteristics [16]. Presenting the experimental field soil's physical and chemical properties prior to planting.

in Table 1, two components were used in the design of the experiment: the first was the application of dry yeast solution (B), which came in three levels: B0 (control without spraying), B1 (1 g/L), and B2 (2 g/L) [17], [15]. Adding eggshell powder at three different levels—A0 (control without addition), A1 (5 g/plant), and A2 (10 g/plant)—was the second factor [18].

The experiment was conducted using a Randomized Complete Block Design (RCBD) in a split-plot arrangement, with three main plots and three sub-plots. Each replicate contained nine experimental units, and with three replications, the total number of experimental units reached 27. The first factor (dry yeast solution) was assigned to the main plots, while the second factor (eggshell powder) was assigned to the sub-plots [14], [19]. Seeds were sown on August 22, 2020, in seedling trays filled with peat moss under optimal conditions to promote healthy seedling development. On October 6, 2020, seedlings at the 4–5 true leaf stage were transplanted in the afternoon into the field. Ten seedlings were planted in two rows inside each plot, with 50 cm separating each row and plant. From the day of transplantation to full maturity, observations persisted [19]. Among the attributes that were evaluated were the curds' dry matter %, plant height (cm), and the total number of leaves [15], [16]. This study sought to determine the effects of the applied treatments, both singly and in combination, on the morphological and physiological traits of broccoli plants. The dry baking yeast solution was made by dissolving the dry yeast powder in water to the proper concentration, followed by the addition of sugar.

Put in at a 1:1 ratio. To promote and boost the growth of yeast cells, the mixture was then left to ferment for a full day [20]. The dry baking yeast solution was made by dissolving the dry yeast powder at the appropriate concentration in water, then adding sugar in a 1:1 ratio. After that, the mixture was allowed to stand for a full day in order to activate the yeast cells and promote their growth [20].

Table 1. Some physical and chemical characteristics of the soil of the experiment field before planting.

Capacity	**Standard unit 1990 mm**	**Value**
Degree of soil reaction pH	— — —	7.03
Electrical connection EC	ds m $^{-1}$	3.73
Organic matter	gm.kg^{-1}	1.4
Ready nitrogen	mg. kg $^{-1}$	31.11
Ready phosphorus	mg. kg $^{-1}$	7.6
Ready Potassium	**mg. kg $^{-1}$**	**98**
Sand Ratio	**gm.kg^{-1}**	**335**
Silt percentage	**gm.kg^{-1}**	**334**
Clay	**gm.kg^{-1}**	**331**
Soil texture		Clay mixtures

RESULTS AND DISCUSSION

Height of plant

Table 2 demonstrates that the administration of the dry baking yeast solution. Compared to the control treatment A0, which recorded the lowest stem height at 47.77 cm, the application of eggshell powder significantly enhanced the stem height of broccoli plants, with treatment A2 achieving the highest value of 55.12 cm. This increase may be attributed to the vital role of calcium in promoting cell division and differentiation [5]. This positively influenced the plant's height, aligning with Rashid, who highlighted calcium as a key component of cell walls that significantly contributes to their elongation. These findings are also consistent with the results reported by Abdur et al. [21] in their study on tomato plants. As shown in Table 3, the interaction between the highest levels of eggshell powder (A2) and dry baking yeast solution (B2) had a significant positive effect on the studied traits. This combination resulted in the tallest average broccoli stem height of 56.00 cm, compared to the lowest value of 45.06 cm recorded under the control treatment (A_0B_0).

Table 2. The impact of eggshell powder and dry baking yeast solution on the height (cm) of the broccoli plant.

Eggshell Powder Levels	Dry Bread Yeast Solution Levels			Average
	B			
A	**B0**	**B1**	**B2**	
A0	45.06	49:58	48.68	47.77
A1	46.99	48.45	50.00	48.48
A2	53.60	55.75	56.00	55-12
L.S.D $_{0.05}$	Egg	Yeast	Interference	**L.S.D $_{0.05}$**
	6.38	0.28	4.58	
Average	48-55	51.26	51.56	

Number of total leaves of the plant

In broccoli plants, the application of dry baking yeast solution resulted in a notable increase in the number of leaves, as indicated in Table 3. Under treatment B2, the greatest number of leaves—21.95 per plant—was observed. In contrast to treatment B0, which had the lowest leaf count of 0.25 leaves per plant, treatment B1 performed noticeably better. The cytokinin chemicals produced by the yeast may be responsible for this enhancement since they promote RNA and protein synthesis and slow down the breakdown of chlorophyll.

Thus encouraging improved vegetative growth. In line with Yeo et al.'s findings [22], this could account for the notable rise in leaf growth seen upon application of the

dry baking yeast solution. Another theory, backed by Mady, is that spraying with dry yeast solution may decrease the concentration of abscisic acid in the leaves while increasing the amounts of endogenous growth regulators like auxins and cytokinins.

The data presented in Table 3 indicate that the second factor, eggshell powder, had a significant effect on the number of leaves. Treatment A2 resulted in the highest leaf count, with broccoli plants producing an average of 21.29 leaves per plant, outperforming all other levels. In contrast, the control treatment A0 recorded the lowest value, with an average of 18.66 leaves per plant. This can be attributed to the direct and indirect roles of calcium abundantly found in eggshells in promoting overall plant growth. According to Abu Dahi and Al-Younis, calcium not only enhances the plant's capacity for CO_2 assimilation but also facilitates the translocation of carbohydrates from their production sites in the leaves to their storage sites in the fruits. This, in turn, contributes to improved vegetative growth traits, including an increased number of leaves. As for the interaction between the two study factors, the results in Table 3 highlight the superiority of the A1B2 combination, which recorded the highest number of leaves at 23.06 leaves per plant. In contrast, the A0B0 combination yielded the lowest average of 15.99 leaves per plant for the broccoli crop.

Table 3. Effects of eggshell powder and dry baking yeast solution on the total number of leaves on a broccoli plant.

Eggshell Powder Levels	**Dry Bread Yeast Solution Levels**			**Average**
	B			
A	**B0**	**B1**	**B2**	
A0	15.99	19.00	21.00	18.66
A1	18.85	20.99	23.06	20.97
A2	20.75	21.33	21.78	21.29
L.S.D $_{0.05}$	Egg	Yeast	Interference	
	0.25	0.82	4.76	
Average	18:53	20.44	21.95	

Percentage of dry matter in pink tablets

As shown in Table 4, the first factor—dry baking yeast solution—had a significant influence. Among all treatments, B2 demonstrated the most favorable results, achieving the highest dry matter content in the broccoli heads at 15.40%. Table 4 illustrates that the first factor, the dry baking yeast solution, had a significant influence. Treatment B2 demonstrated the most effective performance, yielding the highest dry matter percentage (15.40%) in the broccoli heads. As shown in the table below, the control treatment B0 recorded the lowest dry matter content at 12.81%. This reduction may be attributed to the

absence of the dry yeast solution, which is rich in essential mineral nutrients vital for vegetative growth and physiological development.

Consequently, this is positively reflected in the increased dry matter content of the plant's pink florets [23]. This enhancement may also be linked to the production of specific plant growth regulators, such as gibberellins and cytokinins, which stimulate physiological processes, promote cell division, and contribute to greater cell expansion and elongation [20].

Based on the data presented in the table below, treatment A2 demonstrated a significant effect of eggshell powder by achieving the highest dry matter percentage at 14.58%, whereas treatment A0 recorded the lowest value at 13.78%. One necessary element that improves the plant's ability to capture CO2 gas is calcium. This is explained by the direct and indirect actions of calcium, which is found in large quantities in eggshells. According to Abu Dahi and Al-Younis's study, this also raises the dry matter percentage of the plant's pink tablets. Consequently, the researched attribute gets better.

Table 4. Effect of eggshell powder and dry baking yeast solution on dry matter proportion in broccoli inflorescences.

Eggshell Powder Levels	**Dry Bread Yeast Solution Levels**			**Average**
	B			
A	**B0**	**B1**	**B2**	
A0	12.67	13.66	15.00	78
A1	12.76	14.20	15.44	14.13
A2	13.00	14.96	15.78	14.58
L.S.D $_{0.05}$	Egg	Yeast	Interference	
	0.32	0.12	1.86	
Average	12.81	14.27	15.40	

CONCLUSION

Fundamental Finding : This investigation elucidates the beneficial effects of dry yeast extract and eggshell-derived calcium powder on the vegetative growth and overall quality of broccoli (Brassica oleracea var. italica). The application of these biologically derived amendments significantly enhanced key agronomic parameters, including plant stature, foliar development, and the proportion of dry biomass within the inflorescences. Notably, the combined treatment of 2 g/L dry yeast solution with 10 g/plant eggshell powder yielded the most pronounced improvements—producing the tallest plants, the greatest number of leaves, and the highest dry matter content. These findings underscore the potential of utilizing such organic supplements to promote robust plant development and optimize crop performance. **Implication :** From an agronomic perspective,

integrating eggshell powder and yeast-based bio-stimulants into broccoli cultivation protocols may offer a sustainable and efficacious strategy for enhancing yield and quality. This suggests that organic inputs derived from agricultural and food waste streams could serve as practical alternatives to conventional fertilizers, aligning with broader goals of sustainable agriculture and resource efficiency. **Limitation :** Although the study demonstrates strong evidence of positive outcomes, the findings are based on specific treatment levels applied to broccoli under controlled conditions. As such, the results may not fully capture the variability in responses that could occur across different soil types, climates, and cultivation practices, which may limit the generalizability of the outcomes to broader agricultural systems. **Future Research :** Future investigations are warranted to assess the long-term impacts of these inputs across diverse broccoli cultivars and other vegetable crops under varying agro-climatic conditions. Additionally, research should aim to determine the ideal application rates suited to different soil compositions and environmental variables. A deeper exploration of their synergistic or antagonistic interactions with other organic and synthetic fertilizers may inform the development of more ecologically responsible and integrated nutrient management systems. Moreover, evaluating the cost-effectiveness and potential ecological consequences of large-scale implementation will be critical in determining the viability of these treatments in commercial agricultural systems.

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