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Study on the Effect of Yeast on Certain Growth Traits of Broad Bean Plants

Hana H Hasan[1]*, Souhaib A.ELfaraikh[2]

1,2 Botany Department, Science Faculty, Derna University Libya

*Corresponding author: E-mail addresses: hana.bakkar@omu.edu.ly . S.elfraikh@uod.edu.ly

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ABSTRACT

The experiment was conducted in one of the laboratories of the Plant Science Department, University of Derna, from February 4, 2023, to March 4, 2023, to test the effect of dry yeast solution on the vegetative and root growth of broad bean (Vicia faba). Plants were treated 16 days after planting with a 2% yeast solution through foliar spraying three times, with 4 days between each application. The study results showed a difference in the growth indicators studied and the chlorophyll content of the leaves compared to untreated plants. The highest results for shoot length and root length were 25.5 cm and 15 cm, respectively, with yeast treatment compared to untreated plants. Regarding wet and dry weight, results indicated a positive effect of the yeast solution, showing differences in wet and dry weights of shoots and roots compared to untreated plants, with the highest results being 12.5 cm and 2.76 cm for wet weight of shoots and roots, respectively, and 1.84 cm and 0.95 cm for dry weight of shoots and roots, respectively, compared to untreated plants. Additionally, chlorophyll content in leaves treated with the yeast solution showed the highest result of 3.2 at a wavelength of 663 nm compared to untreated plants. A positive effect of the yeast solution on leaf area was also observed, with results of 8.11 cm^2 per plant compared to 5.27 cm^2 per plant for untreated plants.

1. INTRODUCTION

It is important to highlight that leguminous plants are vital for enhancing soil fertility by fixing atmospheric nitrogen through a symbiotic relationship with *Rhizobium* bacteria. However, challenges such as leaf drop, as well as the premature loss of buds, flowers, and immature pods in broad bean (*Vicia faba*) plants, which result in reduced yields and economic value, have led both researchers and farmers to seek solutions. One of the main approaches to address these issues is the application of growth stimulants, both plant-based and mineral (Wanas, 2002). Recent studies have focused on the use of biostimulants to improve crop yields while minimizing environmental pollution (El-Bassiony et al.,2014).

Baker's yeast (*Saccharomyces cerevisiae*) is considered a natural and biological fertilizer that significantly supports the growth and productivity of various crops (El-Motty et al.,2010). It naturally contains cytokinins that aid in processes such as cell division, differentiation, protein synthesis, and the production of nucleic acids and chlorophyll (Amer , 2004 ; Fathy and Farid, 1996). Yeast can be applied in two primary ways: via foliar spraying or soil addition (El-Ghamriny et al.,1999). Additionally, it provides essential and trace nutrients, growth regulators such as gibberellins and auxins, sugars, and certain vitamins, particularly Vitamin B (El-Yazied and Mady, 2012).

Yeast plays a key role in boosting enzyme activity and improving nutrient uptake, which helps to promote overall plant growth (Abbas, 2013). Furthermore, yeast contributes to increased photosynthetic production by releasing CO2 (Khalil and Ismael, 2010). Recently, yeast solutions have gained attention as a natural, safe alternative to chemical fertilizers, with minimal risk to humans, animals, and the environment (Omran, 2000). The aim of the study is to test the effect of dry yeast solution on the vegetative and root growth of broad bean (Vicia faba), including its impact on shoot and root length, wet and dry weight, chlorophyll content in leaves, and leaf area.

2. METHOD

Study Objective

The economic importance of broad bean and the pursuit of finding the best methods to achieve robust vegetative growth and high yield of broad bean led to this study. The aim of this study was to investigate the effect of dry baker's yeast solution on the vegetative and root growth traits of broad bean, including dry and fresh weight, length of both the vegetative and root systems, leaf area, and chlorophyll content (a and b). Additionally, the study sought to determine the optimal method for using yeast solution through foliar application to achieve the best growth traits studied.

Materials Used

6 pots, Sensitive balance, Petri dishes, Suppression, Medical cotton, Filter paper, Glass cups, Erlenmeyer flask, Distilled water, Sieve, Tweezers, Agricultural soil taken from the Al-Fattayah area

Some of the solutions used

Sterilization solution (90% ethyl alcohol, 30% H_2O_2) Acetone, concentration 85%

Experimental Procedure

The experiment was conducted in the plant laboratory at the University of Derna using 6 pots divided into two groups (control group and yeast group), with three replicates per treatment. Broad bean (Vicia faba) seeds, sourced locally from a herbal shop in the city, were confirmed to be free from any infections. The seeds were sterilized using a sterilization solution composed of ethyl alcohol (90%) and hydrogen peroxide (30%) in a 1:1 (v/v) ratio. The seeds were first washed with distilled water, then surface-sterilized by soaking in the sterilization solution for three minutes, followed by rinsing and washing twice with sterile water to remove residue. The seeds were then placed in Petri dishes and incubated in the dark for 3 days until germinated and ready for planting.

Four seeds were planted 2 cm from the soil surface in each pot. After the seedlings emerged, they were thinned to 3 plants per pot. On the sixteenth day, the first group was treated by spraying with a yeast solution (10 grams of yeast in 500 ml of water) with the addition of 5 grams of sugar to stimulate yeast activity. The second group was left untreated with regard to spraying but received regular watering. A total of 3500 grams of dry soil, which had been sifted and free from impurities, was placed in each pot. The soil was obtained from the Al-Fattayah area east of Derna city. The soil moisture content was adjusted by calculating the field capacity, and each pot was watered with 250 ml of water. The watering was synchronized with the application of the yeast solution.

The initial group was continuously sprayed with the yeast solution three times, with a four-day interval between each application. One month after planting, the plants were harvested, and the root systems were separated from the vegetative parts to prepare for study and analysis.

Growth Parameters

At the end of the experiment, the lengths of the vegetative and root systems were measured, along with the dry and wet weights of both parts. The respective outputs were calculated.

The leaf surface area was determined following the method of Norman and Campbell (1994). This was done by measuring the length and maximum width of the leaf using the following equation:

Leaf surface area = (Length × Width) × K

Where K is a correction factor, estimated to be 0.5 for the broad bean plant.

The dry matter was obtained by drying the vegetative and root systems separately in an oven at 70°C.

Estimation of Photosynthetic Pigments

Photosynthetic pigments were extracted by taking a known weight of fresh leaf material from the plant. The samples, along with a control plant, were placed in an 85% acetone solution. The concentrations of chlorophyll a and b were determined using the spectrophotometric method, as described by Metzner et al. (1965).

The pigment extract was measured against a pure black reference (85% acetone in water) at wavelengths of 644 and 663 nm, considering the dilution factor. The concentrations of the pigments (chlorophyll a and b in mg/ml) were calculated using the following equations:

Chlorophyll a = $10.3 \times E_{663} - 0.918 \times E_{644}$ = mg/ml

Chlorophyll b = $19.9 \times E_{644} - 3.87 \times E_{663}$ = mg/ml

3. ETHIC APPROVAL

For research to be considered ethical, it must receive approval from a scientific research ethics committee located in the same region where the research is being conducted.

4. RESULT

The results from the experiment, as shown in Table 1 Figure 6, highlight the positive effects of the yeast solution on growth parameters (root and shoot length, as well as the fresh and dry weights of roots and shoots). The yeast-treated plants showed an increase in shoot length (21.97 cm) compared to control plants (20.94 cm), representing a 4.91% increase. The root length of yeast-treated plants (10.63 cm) also showed a small increase of 0.94% compared to the control plants (10.53 cm).

In terms of fresh weight, yeast-treated plants showed an increase in the wet weight of shoots (8.79 g) compared to the control plants (8.67 g), representing a 1.38% increase. The wet weight of the root system in yeast-treated plants increased significantly by 29.57%, from 1.42 g in the control to 1.84 g in the yeast-treated plants. Regarding dry weight, the yeast solution enhanced the dry weight of shoots by 38.46%, from 0.39 g in the control to 0.54 g in the yeast-treated plants, and the dry weight of the root system increased by 56.75%, from 0.37 g in the control to 0.58 g in the yeast-treated plants.

The data in Table 2, Figure 7 reveal the effect of the yeast solution on leaf traits. Yeast-treated plants showed a remarkable increase in chlorophyll content, with chlorophyll A rising by 350.88%, from 3.74 mg/ml in control plants to 13.14 mg/ml in yeast-treated plants. Chlorophyll B also increased by 206.03%, from 6.53 mg/ml in the control plants to 13.45 mg/ml in the yeast-treated plants. Furthermore, the leaf surface area of yeast-treated plants increased by 53.73%, from 5.27 cm^2 in control plants to 8.11 cm^2 in yeast-treated plants.

5. DISCUSSION

The findings of this study demonstrate the beneficial effects of yeast solutions on various growth characteristics of plants. The increases in both shoot and root lengths, as well as the fresh and dry weights of these parts in yeast-treated plants, can be linked to the essential mineral nutrients present in the yeast solution, which are vital for plant growth (Yeo EunTaeg et al., 2000). Additionally, yeast produces plant growth regulators like cytokinins and gibberellins, which stimulate physiological processes such as cell division and elongation, promoting enhanced vegetative growth (KAHLEL, 2014). The rise in fresh weight indicates that the yeast solution may have improved the water content in the plants, thereby enhancing their overall growth and vitality.

Moreover, yeast contains the enzyme Trehalose-6-phosphate, essential for synthesizing Trehalose, a compound known to support plant growth under stress conditions (Pawar et al., 1985). This enzymatic activity likely contributes to the improved growth observed in the yeast-treated plants.

The notable increase in leaf area and chlorophyll content in these plants can be attributed to cytokinins, which help delay leaf senescence by reducing chlorophyll degradation. These growth regulators also promote RNA and protein synthesis, resulting in increased leaf growth and chlorophyll production (Yeo EunTaeg et al., 2000). Additionally, the higher chlorophyll levels in yeast-treated plants may stem from biostimulants in the yeast, which enhance the balance between photosynthesis and respiration, thereby boosting photosynthetic efficiency (El-Yazied and Mady, 2012).

The increase in dry matter in the leaves likely results from yeast's stimulatory effects on carbohydrate and protein synthesis, as well as enhanced photosynthesis (Shalaby and El-Nady, 2008). The magnesium and cobalt present in yeast further contribute to the increased chlorophyll content, with cobalt enhancing chlorophyll a and b, as well as carotenoids (Mekki and Ahmed, 2005), and magnesium being a key component necessary for chlorophyll production (Czerpak et al., 1994).

Additionally, yeast application may influence the levels of internal growth regulators like cytokinins and auxins while reducing abscisic acid, a hormone that inhibits growth (Mady, 2009). This shift in hormone balance could account for the observed improvements in plant growth.

These findings align with previous research that highlights the positive effects of dry baker's yeast on vegetative growth and nutritional content in plants. The tryptophan present in yeast, which serves as a precursor for indole acetic acid (IAA) production, has been shown to enhance plant growth (Moor, 1979). Furthermore, yeast treatment has been found to improve growth metrics in various species, including bananas (TC, 1979) and fava beans (Mady, 2009). Similar enhancements were observed in cucumber plants, where the application of yeast solution resulted in increased plant height and other growth parameters (Sarhan et al., 2011). Additionally, in fava bean plants, yeast application has been reported to elevate levels of crude protein, total sugars, and free amino acids (El-Yazied and Mady, 2012).

Figure (1) adjusting the water content and calculating the field capacity of the soil

Figure (2) Filling the soil into the pots and preparing the seeds for germinatio

Figure (3) shows the difference in growth between the two treatments

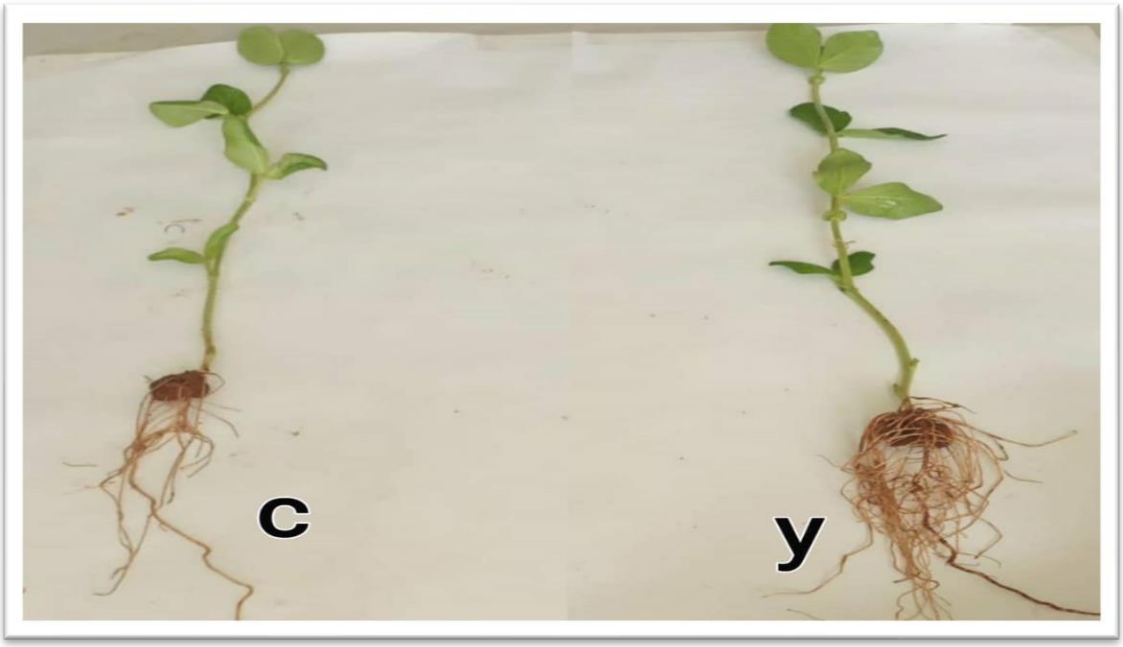

Figure (4) Difference in length between the two treatments

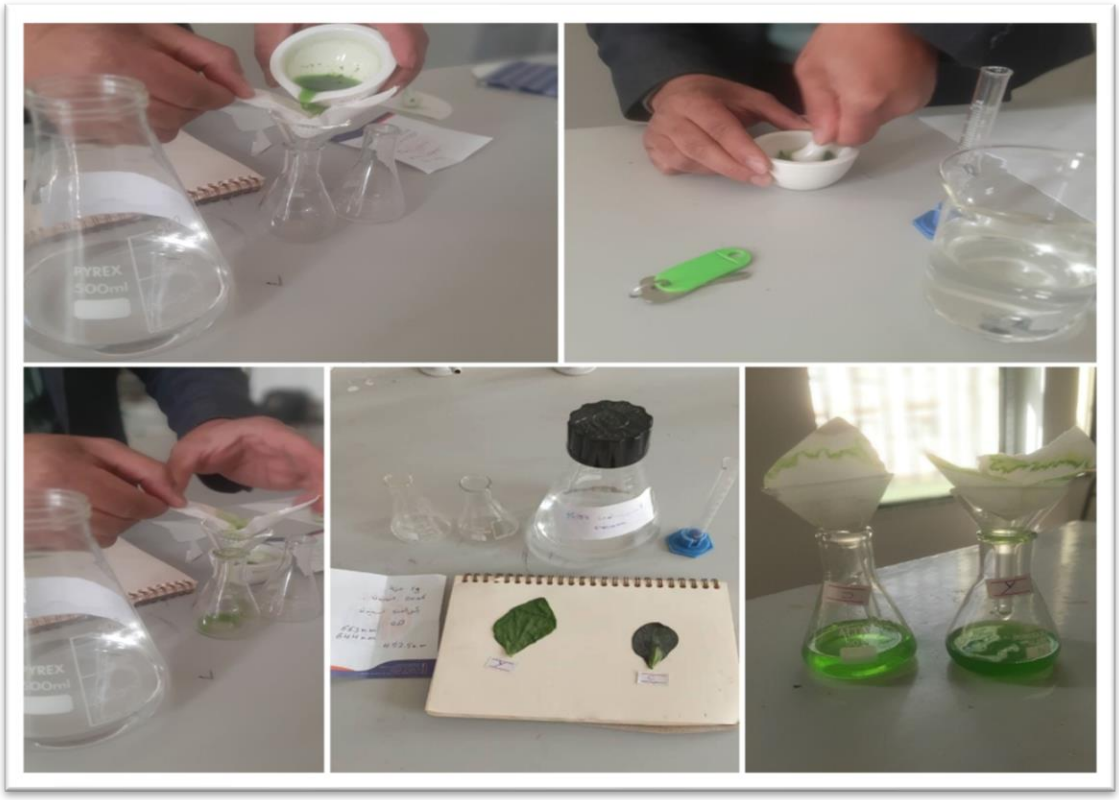

Figure (5): Determination of chlorophyll

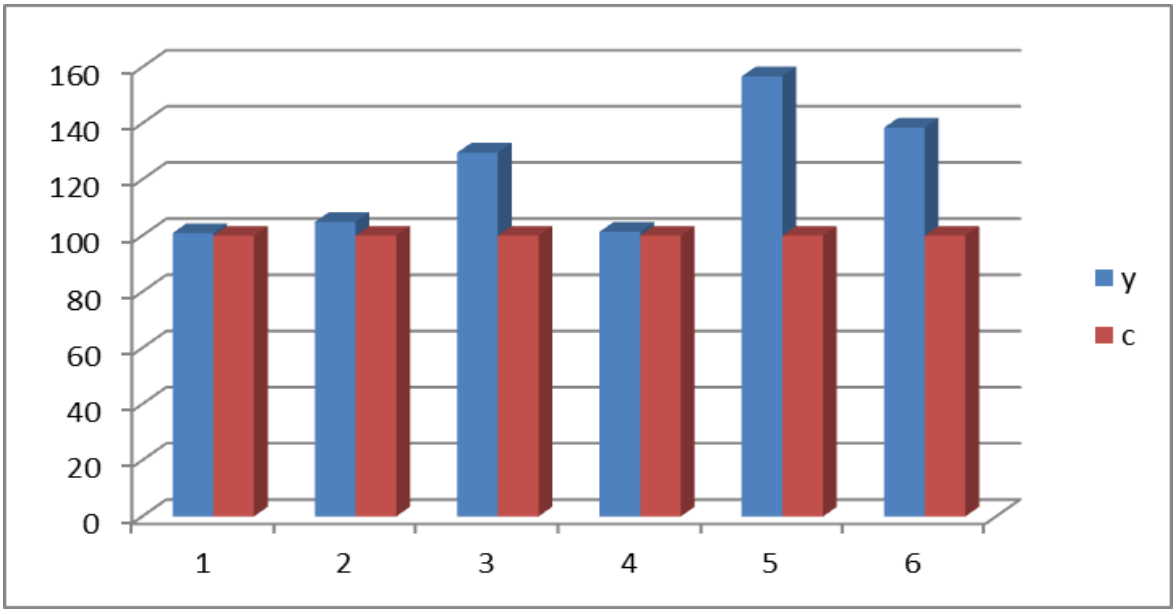

Fig. 6. Effect of Yeast Solution on Growth Parameters of Broad Bean (Vicia faba)

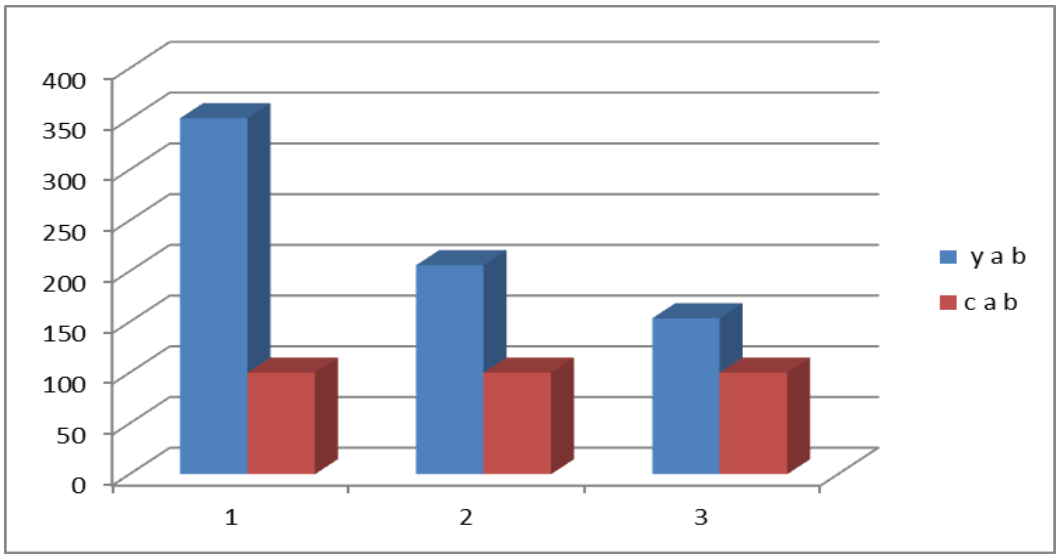

Fig. 7. Effect of Yeast Solution on Chlorophyll Content and Leaf Surface Area of Broad Bean (Vicia faba)

Table.1. Effect of Yeast Solution on Growth Parameters of Broad Bean (Vicia faba)

Transactions	The length of the shoot		The length of the root sum		Wet weight of shoots		Wet weight of root system		Dry weight of shoots		Dry weight of root system	
Percentage and unit of measurement	Cm/pot	1oo%	Cm/pot	100%	g/pot	100%	g/pot	100%	g/pot	100%	g/pot	100%
C	20.94	100	10.53	100	8.67	100	1.42	100	0.39	100	0.37	100
Y	21.97	104.91	10.63	100.94	8.79	101.38	1.84	129.57	0.54	138.46	0.58	156.75

Table.2 Effect of Yeast Solution on Chlorophyll Content and Leaf Surface Area of Broad Bean (Vicia faba)

Transactions	Chlorophyll(A)		Chlorophyll(B)		Surface area of the paper	
Percentage and unit of measurement	mg/ml	%	mg/ml	%	Cm^2/plant	%
C	3.74362	100	6.529	100	5.27	100
Y	13.1359	350.88	13.4518	206.03	8.11	153.73

6. CONCLUSION

The observed findings revealed that December was more prone to seasonal influenza and COVID-19 compared to other months. These findings are in agreement with the many works, who described simultaneous COVID-19 and influenza infections to be severe. It is worth noting that the outbreak of COVID-19 began in December 2019, which corresponds to the influenza season. Therefore, it is important for clinicians to distinguish COVID-19 from other respiratory infections, including influenza.

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