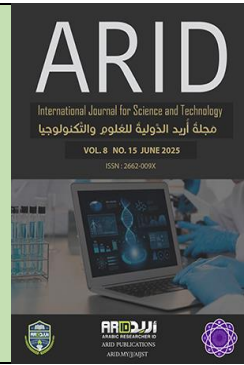




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Effect of spraying with yeast suspension and the nutrient solution Green Soul on vegetative and flowering growth and volatile oil content of seeds of *Mirabilis Jalapa*

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تأثير الرش بمعلق الخميرة والمحلول المغذي Green Soul في النمو الخضري والزهري ومحتوى

البذور من الزيت الطيار لنبات شب الليل. *Mirabilis Jalapa* L.¹ هاجر ستار المزيعة ² رشا كاظم حمزة ¹ دعاء نعمة السامر

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<https://doi.org/10.36772/arid.ajst.2025.8152>**ABSTRACT**

A pot experiment was conducted in Basra city during the 2023-2024 season to evaluate the effect of three levels of yeast suspension at concentrations of (0, 1, 3) g.L⁻¹ and three levels of Green Soul solution at concentrations of (0, 1, 3) ml.L⁻¹, as well as their interactions, on the growth and production of essential oil in the Marvel of Peru. The experiment was designed as a factorial experiment using a completely randomized block design (R.C.B.D) with three replications. The spraying process was carried out on 29/10/2023 in the early morning on both the upper and lower surfaces of the leaves to ensure better nutrient absorption, with a total of three sprays (with a two-week interval between sprays).

The results showed that spraying with yeast suspension at a concentration of 3 g.L⁻¹ and Green Soul solution positively affected plant growth traits and essential oil production. The application of yeast suspension achieved the highest values for plant height (74.88) cm, number of leaves (155) leaves.plant⁻¹, leaf area (1) m².plant⁻¹, and essential oil density (1.55) mg.mL⁻¹ compared to the control treatment, which recorded the lowest values in all traits. Additionally, the interactions of yeast suspension at a concentration of 3 g.L⁻¹ and Green Soul at a concentration of 3 ml.L⁻¹ resulted in positive outcomes for plant height (77.33) cm, number of leaves (167.66) leaves.plant⁻¹, leaf area (1.26) m².plant⁻¹, and essential oil density in seeds (1.65) mg.mL⁻¹ compared to the control treatment, which showed the lowest values.

Furthermore, the interaction of yeast suspension at a concentration of 3 g.L⁻¹ and Green Soul at a concentration of 1 ml.L⁻¹ led to the highest values for the number of branches (7.66) branches.plant⁻¹, dry matter in leaves (21.59) %, number of flowers (106.33) flowers.plant⁻¹, length of the flowering stem (2.56) cm, essential oil production (1.04) g, specific gravity of the oil (1.57), refractive index (1.84), and percentage of essential oil (12.76) % compared to the control treatment, which presented the lowest average.

Keyword Yeast suspension, Green Soul, nutritional solution, Marvel of Peru, Essential Oil.

الملخص

تم إجراء التجربة في أصص في مدينة البصرة خلال 2023-2024 لتقييم تأثير ثلاثة مستويات من معلق الخميرة بتركيز (0، 1، 3) غ.لتر⁻¹ وثلاثة مستويات من محلول Green Soul بتركيز (0، 1، 3) مل.لتر⁻¹، بالإضافة إلى تفاعلاتها على نمو وإنتاج الزيت الطيار لنبات شب الليل. تم تصميم التجربة كتجربة عاملية بتصميم القطاعات العشوائية الكاملة (R.C.B.D) وثلاث تكرارات تمت عملية الرش في 2023/10/29 في الصباح الباكر وعلى كل من السطح العلوي والسفلي للأوراق لضمان امتصاص أفضل للمغذيات و بواقع ثلاث رشات (مع فاصل زمني بين الرشات يبلغ أسبوعين). أظهرت النتائج أن الرش بمعلق الخميرة بتركيز 3 غ.لتر⁻¹ ومحلول Green Soul بتركيز 3 مل.لتر⁻¹ أثر بشكل إيجابي على صفات نمو النباتات وإنتاج الزيت الطيار. حقق تطبيق معلق الخميرة أعلى القيم في ارتفاع النبات (74.88) سم و عدد الأوراق (155) ورقة.نبات⁻¹ و مساحة الورقة (1) م².نبات⁻¹، وكثافة الزيت الطيار (1.55) ملغم.مل⁻¹ مقارنة بمعاملة السيطرة التي سجلت أدنى القيم في جميع الصفات. كما أدت تفاعلات معلق الخميرة بتركيز 3 غ.لتر⁻¹ و Green Soul بتركيز 3 مل.لتر⁻¹ إلى نتائج إيجابية في ارتفاع النبات (77.33) سم و عدد الأوراق (167.66) ورقة.نبات⁻¹ و مساحة الورقة (1.26) م².نبات⁻¹، وكثافة الزيت الطيار في البذور (1.65) ملغم.مل⁻¹ مقارنة بمعاملة السيطرة التي أظهرت أدنى القيم. كما أدى تفاعل معلق الخميرة بتركيز 3 غ.لتر⁻¹ و Green Soul بتركيز 1 مل.لتر⁻¹ إلى أعلى القيم في عدد الفروع (7.66) فرع.نبات⁻¹ و المادة الجافة في الأوراق (21.59) % و عدد الأزهار (106.33) زهرة.نبات⁻¹ و طول الساق الزهري (2.56) سم و إنتاج الزيت الطيار (1.04) غم و الوزن النوعي للزيت (1.57) و معامل الانكسار (1.84) ونسبة الزيت الطيار (12.76) % مقارنة بمعاملة السيطرة التي قدمت أدنى متوسط.

الكلمات المفتاحية: معلق الخميرة , Green Soul , المحلول المغذي , شب الليل , الزيت الطيار.

I. Introduction:

Mirabilis jalapa L., commonly known as the Marvel of Peru, is a perennial plant belonging to the Nyctaginaceae family, native to the Americas. It is characterized by its flowers that bloom after “four o’clock” during the summer, earning it the name "Four O'clock Flower." The plant can grow to over half a meter in height and bears small, trumpet-shaped flowers with a fragrant aroma, ranging in color from white to yellow to purple. It is tolerant of high temperatures and drought, and is easy to propagate and care for [1].

Phytochemical compounds such as triterpenes and flavonoids have been reported in the aerial parts of the plant. The roots contain carbohydrates, resins, and alkaloids (such as trigonelline). The seeds contain beta-sitosterol, beta-amyrin, and beta-sitosterol-D-glucoside. Compounds such as tricosan-12-one, n-hexacosanal, beta-sitosterol, and tetracosanoic acid have been isolated from the leaves. Numerous modern pharmaceutical studies have documented the efficacy of the leaves, flowers, and seeds as analgesics, antispasmodics, and antibacterial agents [2].

In recent years, many studies have investigated the effectiveness of foliar solution and their direct impact on improving crop growth and productivity. Many of these studies have shown that foliar solution is a necessary and effective supplement to fertilizers for increasing production. It has been demonstrated that 85% of a plant's nutrient needs can be met by solution absorbed through the leaves, while roots fulfil essential element requirements up to 15% [3]. There is growing interest among flower and ornamental plant producers in using foliar solution containing macro and micronutrients, as they are characterized by rapid absorption and movement within plant tissues when sprayed on leaves. These solutions are preferred because they quickly and safely address nutrient deficiencies in plants due to their low concentration of elements [4].

[5] found that spraying African marigold with the nutrient solution Magic Grow Tonic at a concentration of 7 ml/L⁻¹ resulted in a significant increase in plant height (25.91) cm, number

of leaves (14.41) leaves. Plant⁻¹, stem diameter (6.91) mm, flower stalk length (3.17) cm, flower diameter (5.68) cm, and dry matter in flowers (15.83) %.

Additionally, [6] reported that spraying zucchini plants of the Marriott Zalik F1 variety with the nutrient solution Green Grow at concentrations of (1, 2, 3, 4, 5) ml/L⁻¹ significantly outperformed in all studied traits, including plant height (63.79) cm, number of leaves (32.37) leaves. plant⁻¹, number of branches (2.21) branche. Plant⁻¹, and number of female flowers (14.11) flower. Plant⁻¹.

Research has also shown that spraying certain suspensions on plants, such as dry yeast suspension, improves vegetative and floral growth indicators due to the presence of numerous essential elements and compounds for plant growth. A study indicated that spraying coriander plants with a yeast suspension at a concentration of 12 g/L⁻¹ led to a significant increase in the number of flowers and the percentage of essential oil [7].

Another study [8] showed that spraying Chinese clove with yeast suspension at a concentration of 2 ml/L⁻¹ and the nutrient solution "Algidex" at concentrations of 2 and 4 ml/L⁻¹ resulted in clear superiority in all studied indicators, including plant height, number of leaves, fresh weight of the vegetative mass, and fresh and dry weight of the roots. Furthermore, the interaction between the yeast suspension and the nutrient solution led to a significant improvement in most studied traits.

Results from another study [9] indicate that spraying zucchini plants with yeast suspension at a concentration of 8 g.L⁻¹ resulted in significant superiority in all studied indicators. The highest recorded values were (43.3) cm for plant height, (34) leaves plant⁻¹, (12,152) cm² for leaf area, (3.27) m² per plant for leaf area index, 25.1 fruits per plant, and a yield of 3,194 grams per plant. These results highlight the effectiveness of using yeast suspension in enhancing both the growth and yield of zucchini plants.

Objective of the Study:

The research aims to study the effects of yeast suspension and Green Soul solution on the growth and productivity of *Mirabilis jalapa L.*, focusing on improving vegetative and floral traits and essential oil production in its seeds. It seeks to develop strategies for enhancing agricultural productivity using natural extracts as safe alternatives to chemical fertilizers, supporting sustainable agriculture and reducing environmental impacts. Additionally, the research aims to provide scientific data on yeast use to boost productivity, contributing to food security amid environmental and economic challenges.

II. MATERIALS AND METHODS:

This study was conducted in the city of Basra during the 2023-2024 growing season at a private nursery in Basra Governorate, aiming to evaluate the effect of spraying yeast solution and Green Soul on the Marvel of Peru plants, focusing on measuring their impact on vegetative growth, floral production, and essential oil production in the seeds.

Seeds of the Marvel of Peru were planted on 12/9/2023 in pots with a diameter of 25 cm and a height of 30 cm. The soil used was rich in clay, with low sand content and a small proportion of organic matter. The soil also contained low levels of macronutrients such as nitrogen and phosphorus, which may affect plant growth, justifying the use of the proposed treatments to improve productivity.

The experiment was designed as a factorial experiment with two main factors: yeast solution at three concentration levels (0, 1, 3 g/L⁻¹) and Green Soul nutrient solution at three concentration levels (0, 1, 3 ml/L⁻¹). The interaction between these two factors was studied in three replicates.

For the yeast solution, Chinese-made yeast produced by Star Maya was used, which mainly consists of fungal cells of the species *Saccharomyces cerevisiae*. The yeast is in a dry state until activated with water and contains simple sugars as an energy source, along with a solution containing vitamins (especially vitamin B) and minerals. The yeast solution was prepared by dissolving (1, 3) g of baker's yeast in a small amount of warm distilled water at 35°C, with the

addition of sugar at a concentration of 0.5 g/L^{-1} . The mixture was left for 12 hours, then the volume was completed with distilled water according to the method described in [10].

As for the Green Soul nutrient solution, it is a high-purity fertilizer suitable for vegetative growth stages. It contains compound nitrogen along with iron, which is essential for completing the photosynthesis process. Additionally, it contains humic acid, which enhances soil fertility and helps to chelate nutrients and break down heavy soils. The nutrient solution was prepared by dissolving (1 and 3) mL of the solution in one liter of distilled water.

Aqueous solutions of both the yeast suspension and the Green Soul solution were prepared at the required concentrations, with a few drops of the spreading agent Tween 20 added to improve the solution's distribution on the leaves. Spraying was carried out on 29/10/2023 in the early morning until the leaves were thoroughly wet. The process was repeated three times at two-week intervals. The treatments were applied according to the experimental design to study their effects on plant growth and essential oil production.

The means of the results were statistically analyzed using the Genstat program to compare the Least Significant Differences (L.S.D.) test at a significance level of 0.05 [11].

Table (1): physical and chemical properties of the soil

Greene %	Clay %	Sand %	Organic matter	K (Mg.Kg)	P (Mg.Kg)	N (Mg.Kg)	soil pH	Degree of electrical conductivity	Qualities
11.23	80.42	8.35	0.10	6.10	0.13	0.35	7.3	6.00	

Examined traits:

All measurements for the studied traits were taken when the plants reached the flowering stage from three plants for each experimental unit, then the rate was calculated and included the following:

- 1- Plant height (cm):** the height was measured with a metric ruler from the surface of the soil till top of the plant .
- 2- Number of leaves (leaves. plant⁻¹):** leaves were counted in the main stem of the plant after harvest.
- 3- number of branches (branch. plant⁻¹):** The number of branches of the plant was calculated according to the rate.

4- Leaf area (cm².plant⁻¹) : The leaf area was calculated by cutting some leaves from each plant and then tracing their shapes with a pencil on paper. Each leaf was then cut out and weighed precisely. The area of each leaf was determined to be 2×2 cm and weighed accurately on a sensitive balance. Subsequently, the leaf area per plant can be found using the method of proportions [12] .

5- Leaves dry matter (%) : a specific weight of chopped leaves was placed in an electric oven at 70 for 72 hours till dry weight reached stabilized, leaves dry matter percent was calculated according to the following equation:

$$(\text{Dry matter}) \% = \frac{\text{leaves dry weight}}{\text{Leaves fresh weight}} \times 100$$

6- number of flowers (flower. plant⁻¹): The number of flowers was calculated according to the rate.

7- Stalk of flowers (cm): measure the length of the pink holder using the Vernier caliper.

8- Essential Oil Yield (g.plant): I conducted an oil extraction process from seeds according to the method described by [13] . I took 100 grams of ground seeds and placed them in the extraction flask of a Soxhlet apparatus connected to a 500 ml receiving flask. I used 300 ml of the solvent Petroleum Spirit (distillation range 40-60°C) to separate the oil over a period of 48 hours. Then, I performed the solvent evaporation from the oil using a rotary evaporator at a temperature of 60°C until the solvent was completely evaporated. The yield of volatile oil in the seeds for each treatment was estimated as described by [14] applying the following:

$$\text{Essential Oil Yield (g.plant)} = \text{Flower Yield (g.plant)} \times \text{Percentage of Essential Oil.}$$

9- Density of Essential Oil (mg. µL⁻¹) : The density of the essential oil was measured by weighing 100 µL of the oil at a temperature of 25°C and dividing it by its volume at the same temperature, as mentioned by [14].

$$\text{Density of Essential Oil (mg. µL}^{-1}\text{)} = \frac{\text{Weight of 100 µL of Essential Oil}}{\text{Volume of 100 µL of Essential Oil}}$$

10- Specific Gravity: The specific gravity of oil samples was estimated by taking a volume of 100 microliters of essential oil in a precise volumetric pipette. The weight of this volume was recorded using a Mettler toledo balance. The specific gravity values were calculated at a temperature of 20°C based on three measurements from each sample by dividing the weight of that volume of oil by the weight of the same volume of distilled water at the same temperature [14] .

11- Refractive Index: The refractive index of each oil sample from each treatment was measured using an Abbe Refract meter, specifically the Abbe Type Universal Refract meter, of German origin, at a temperature of 20°C.

12- Percentage of Essential Oil :The percentage of essential oil was calculated according to the equation by [14] which is:

$$\text{Percentage of Essential Oil (\%)} = \frac{\text{Weight of the suspension oil (mg)}}{\text{Weight of the sample taken (mg)}} \times 100$$

III. Results and Discussion:

The results in Tables 2 and 3 showed that spraying with yeast suspension at a concentration of 3 g.L⁻¹ gave the highest values for all studied traits compared to the treatment with Green Soul solution and the control treatment.

Meanwhile, the dual interaction between yeast suspension at a concentration of 3 g.L⁻¹ and 3 ml.L⁻¹ of Green Soul solution gave the highest values in plant height (77.33) cm, number of leaves (167.66) leaves.plant⁻¹, leaf area (1.26) m².plant⁻¹, and oil density in seeds (1.65) mg. ml⁻¹ compared to the untreated control, which gave the lowest average in plant height (49.33) cm , number of leaves (93.66) leaves.plant⁻¹, leaf area (0.66) m². plant⁻¹, and oil density (0.78) mg. ml⁻¹ .

On the other hand, the interaction between yeast suspension at a concentration of 3 g.L⁻¹ and Green Soul solution at a concentration of 1 ml.L⁻¹ gave the highest values in the number of branches (7.66) branches.plant⁻¹, dry matter in leaves (21.59) %, number of flowers (106.33) flowers.plant⁻¹, length of the flowering stalk (2.56) cm, oil yield (1.04) g, specific weight of oil

(1.57), refractive index (1.84), and percentage of oil (12.76)% compared to the untreated control, which gave the lowest average in the number of branches (2.66) branches.plant⁻¹, dry matter in leaves (10.20) %, number of flowers (52.33) flowers.plant⁻¹, length of the flowering stalk (1.86) cm, oil yield (0.20) g, specific weight (0.20), refractive index (1.16), and percentage of oil (1.67)%.

This may be attributed to the presence of active yeast suspension, which contains amino acids, proteins, and mineral elements that contribute to the structure of organic bases, leading to the formation of nucleic acids (RNA and DNA) and the synthesis of growth hormones such as cytokines, which promote growth [7] .

The reason may be attributed to the presence of vitamins B1 and B2 in yeast, which are involved in the construction of enzymatic cofactors that play various roles in oxidation and reduction processes occurring during numerous metabolic activities in plants. [15]. This finding is consistent with what, [16] noted significant effects on *Lawsonia inermis* plants.

The superiority of spraying with Green Soul suspension can be attributed to its content of nitrogen, phosphorus, and potassium. Potassium is considered an enzymatic catalyst, while magnesium is important in the ribosomes where protein synthesis occurs and is an essential component of the chlorophyll molecule. It also encourages photosynthesis and respiration processes, regulates plant hormone activity, and enhances cell division.

Table (2): The effects of spraying yeast suspension and the nutrient solution Green Soul on vegetative and flowering growth of *Mirabilis Jalapa* L.

Traits Treatments	Height plant (cm)	Number of leaves (leaf plant ⁻¹)	Number of branches	Leaf area (cm ² .plant ¹)	Dry matter of leaf %	Number of Flower (flower plant ⁻¹)	Stalk of flowers (cm)
yeast suspension (g. L ⁻¹)							
0	52.66	116.00	3.44	0.71	10.93	53.66	2.07
1	72.55	123.88	5.88	0.73	17.15	81.88	2.67
3	74.88	155.00	7.33	1.00	19.28	101.11	2.73
Green Soul (ml. L ⁻¹)							

0		63.66	117.08	5.44	0.72	16.15	77.00	2.44
1		67.22	130.00	5.77	0.79	14.50	79.77	2.47
3		69.22	147.00	5.44	0.93	16.71	79.88	2.56
Levels of overlap between yeast suspension (g. L ⁻¹) and Green Soul (ml. L ⁻¹)								
0	0	49.33	93.66	2.66	0.66	10.20	52.33	1.86
	1	52.00	117.00	4.00	0.69	11.19	54.00	2.10
	3	56.66	147.00	3.66	0.77	11.40	54.66	2.03
1	0	69.33	121.33	6.33	0.76	15.67	86.33	2.23
	1	72.33	114.33	5.66	0.78	15.83	80.66	2.20
	3	76.00	117.00	5.66	0.76	19.95	87.66	2.20
3	0	75.00	140.00	7.33	0.95	17.47	99.33	2.43
	1	75.00	151.66	7.66	0.98	21.59	106.33	2.56
	3	77.33	167.66	7.00	1.26	18.79	97.66	2.46
P < (0.05)L.S.d		10.64	37.10	1.15	0.14	3.17	13.8	0.17

Table (3): The effects of spraying yeast suspension and the nutrient solution Green Soul on essential oil characteristics in seeds of *Mirabilis Jalapa* L.

Traits Treatments	essential oil Yield		Density of Essential Oil (mg.ml ⁻¹)	Specific Gravity	Refractive Index	percentage of oil
yeast suspension (g. L ⁻¹)						
0	0.19		0.71	0.21	0.95	3.02
1	0.55		1.07	1.32	1.39	8.85
3	0.79		1.55	1.56	1.28	11.81
Green Soul (ml. L ⁻¹)						
0	0.40		1.13	1.03	1.17	7.93
1	0.46		1.14	1.04	1.35	7.57
3	0.69		1.16	1.03	1.41	8.08
Levels of overlap between yeast suspension (g. L ⁻¹) and Green Soul (ml. L ⁻¹)						
0	0	0.20	0.78	0.20	1.16	1.67
	1	0.20	0.84	0.21	1.31	4.18
	3	0.20	0.83	0.23	1.32	3.20
1	0	0.46	1.09	1.32	1.25	9.35
	1	0.48	1.10	1.35	1.44	7.95
	3	0.54	1.01	1.29	1.48	9.23
3	0	0.41	1.51	1.50	1.26	10.58
	1	1.04	1.48	1.57	1.84	12.76
	3	0.71	1.65	1.55	1.48	12.10
P < (0.05)L.S.d		0.28	0.75	0.31	0.11	2.20

IV. Conclusions and Recommendations

The study showed that spraying yeast suspension at a concentration of 3 g/L⁻¹ and Green Soul solution at a concentration of 3 ml/L⁻¹ improved the growth and essential oil production in *Mirabilis jalapa* L., with their interaction achieving the best results in all studied traits. Accordingly, the study recommends using these concentrations, conducting further research on different concentrations, raising farmers' awareness of the importance of organic fertilizers, and promoting their use to achieve better agricultural outcomes.

Abbreviations:

Abbreviation	Meaning
R.C.B.D	Randomized Complete Block Design
L.S.D	Least Significant Difference
g.L ⁻¹	grams per liter
ml.L ⁻¹	milliliters per liter
mg.mL ⁻¹	milligrams per milliliter
N	Nitrogen
P	Phosphorus
K	Potassium
DNA	Deoxyribonucleic Acid
RNA	Ribonucleic Acid

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