Effect of spraying with dry yeast (*Saccharomyces cerevisiae*) and boron on the growth and production of the strawberries plant cultivated under the conditions of protected agriculture

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ABSTRACT

This study was conducted in one of the greenhouses belonging to the nursery of the Horticulture and Forestry Division in the Department of Plant Production, Directorate of Agriculture, Najaf province for the season 2016-2017 to study the effect of spraying with dry yeast (Saccharomyces cerevisiae) and boron and their interaction on the growth and production of the strawberries plant. The study included 9 treatments: spraying the plants with two concentrations of dry yeast (1, 2 $g.L^{-1}$) in addition to distilled water only with three concentrations of boron (0, 2, 4 $g.L^{-1}$). The experiment was conducted as a factorial experiment according to the design of the Randomized Complete Block Design (RCBD), with three replicate. The results showed that spraying the plants with dry yeast led to a significant increase in the plant height and the number of leaves at the concentration of (1 $g.L^{-1}$), while the spraying treatment with concentration (2 $g.L^{-1}$) gave a significant increase in the dry weight of the total vegetative, the leaves content of chlorophyll and the fruits content of Total sugars, The average production of one plant and the average production of the greenhouse. The spraying with boron showed a significant increase in the traits of vegetative growth and the of the yield traits at a concentration of (2 $g.L^{-1}$). Interactions of the study factors had a significant effect on all studied traits.

Keywords: strawberry, dry yeast, boron, yield.

تأثير الرش بالخميرة الجافة و البورون في نمو و انتاج نبات الشليك المزروع تحت ظروف الزراعة المحمية

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الخلاصة :

نفذ هذا البحث في احد البيوت البلاستيكية التابعة لمشتل شعبة البستنة و الغابات في قسم الانتاج النباتي / مديرية الزراعة / محافظة النجف الاشرف للموسم 2016 – 2017 ، لدراسة تأثير الرش بالخميرة الجافة و البورون و تداخلاتهما في نمو وانتاج نبات الشليك . و تضمنت الدراسة 9 معاملات هي رش النباتات بتركيزين من الخميرة الجافة هي(1 ، 2) غم.لتر$^{-1}$ بالأضافة إلى الماء المقطر فقط مع تركيزين من البورون مع عدم الاضافة هي (0 ، 2 ، 4) غم.لتر$^{-1}$. نفذت كتجربة عاملية على وفق تصميم القطاعات المعشاة و بثلاث مكررات . أظهرت النتائج أن رش النباتات بالخميرة الجافة إلى زيادة معنوية في ارتفاع النبات و عدد الأوراق عند التركيز 1غم.لتر$^{-1}$ ، في حين أعطت المعاملة 2غم.لتر$^{-1}$ زيادة معنوية في الوزن الجاف للمجموع الخضري و محتوى الأوراق من الكلوروفيل و محتوى الثمار من السكريات الكلية و معدل انتاج النبات الواحد و معدل انتاج البيت البلاستيكي . و ادى الرش بالبورون إلى زيادة معنوية في صفات النمو الخضري و صفات الحاصل عند التركيز 2 غم.لتر$^{-1}$. و كان لتداخلات عاملي الدراسة تأثير معنوياً في جميع الصفات المدروسة .

الكلمات المفتاحية : الفراولة ، الخميرة الجافة ، البورون ، الحاصل .

1. INTRODUCTION

Strawberry (*Fragaria ananassa Duch*) belongs to Rosacea (21). It is the fourth most consumed fruit after apples, oranges, and bananas (19). It is also one of the richest sources of natural antioxidants among fruits, in addition to the usual nutrients, such as vitamins and minerals. Many researchers indicated the importance of the fertilization process for the plant because of its role in increasing production, which at the same time lead to increase environmental pollution resulting from the use of chemical fertilizers harmful to human health and increase the cost of production, so the search for new sources may be alternative In blocking the need of the plants for nutrients, to minimize the damage caused by chemical fertilizers. which at the same time lead to increase environmental pollution resulting from the use of chemical fertilizers harmful to human health and increase the cost of production, Therefore, the search for new sources may be alternative in filling the need of plants of nutrients, to reduce the damage caused by chemical fertilizers. Several studies have indicated the importance of bio-fertilizers in subsequent years. Lateifa, (10) reported that bio-fertilizers have a similar effect for organic fertilizers in reducing harmful environmental pollution. EL-Ghamring (6) indicated that dry yeast (Saccharomyces cerevisiae) is considered one of the types of bio-fertilizers used in soil fertilization and foliar nutrition for various crops, because they contain various amino acids, proteins and a number of elements that play an important role in plant growth (5), as well as their production of plant-like growth regulators such as Auxins, Gibberellins, and cytokines (16). Urech (17) indicated that the dry yeast has the ability to store surplus phosphorus in the chains form, consisting of 20 - 200 units of phosphate in the gaps inside the cell. It was noted from field studies that the addition of dry yeast with some fertilizers gave good results (7). As for boron, it has been shown to play a role in many biological and physiological processes within the plant, such as carbohydrate transfer, differentiation, cytotoxicity, nitrogen metabolism, nucleic acid formation, regulation of plant hormones, lipid metabolism, phosphorus, photosynthesis, Active and inducing the formation of phenolic compounds and their role in fertilization (15). Therefore, the study aims to determine the effect of spraying with yeast and boron on the growth and production of the strawberries and some of its qualitative traits.

2. MATERIALS AND METHODS

This study was conducted in one of the greenhouses belonging to the nursery of the Horticulture and Forestry Division in the Department of Plant Production, Directorate of Agriculture, Najaf province for the period from 1/7/2016 to 1/7/2017. The seedlings of the Portola cultivar were brought from the nursery of Horticulture department in Abu Ghraib belonging to the Ministry of Agriculture. The soil of the greenhouse was prepared through the process of removing the thickets, plowing, smoothing and leveling, the thermal sterilization. The pesticides were used to prevent insect and fungal diseases. The plastic house soil was then divided into six plots along with the greenhouse, with a width of 0.8 m and a length of 56 m and a height of 0.30 m. and left a distance of 1 m at the beginning and end of the house without cultivation, and then 1 m was cultivated with the strawberries plants at the beginning and end of each the polt as Guarding plants. The side plots were left cultivating with the same plants as Guarding plants. The seedlings were cultivated on 1/10/2016 inside the greenhouse dedicated to the double row beds system so that the distance between the double lines 0.20 m and the distance between the plant and another within the line 0.30 m, The distance between the center of the plot and another 1.40 m. The service operations were conducted such as weeding and irrigation, where the drip irrigation system was applied at a rate of 3.5 to 4.5 L per hour, as needed, as well as fertilization operations which conducted uniformly for all treatments according to the recommended fertilizer program in most of the strawberries farms (11). The treatments of the experiment included studying the effect of the spraying with dry yeast at three concentrations of (0, 1, 2 $g.L^{-1}$), which symbolized by (S0, S1, S2), respectively, spraying with boron; where a BO_3 used at three concentrations of (0, 2, 4 $g.L^{-1}$), which symbolized by (Bz, B2, B4), respectively. The treatments were conducted after two weeks from cultivating the seedlings, with three sprayings, and the period between one spraying and another was two weeks. A factorial experiment (3x3) was conducted according to The Randomized Complete Block Design (RCBD), with three replicates, 30 plants per experimental unit. The averages of treatments were compared with the Duncan Multiple Range Test at a 5% probability level. The Discovery Virgon 3Genstat was used in statistical analysis.

Preparation of dry bread yeast suspension

A dry yeast suspension was prepared by dissolving 1 and 2 g of supplied yeast from local markets in a liter of warm distilled water at a temperature of 32 °C and add 2 g sucrose to activate the yeast. It was then placed in an incubator at 25 °C for 2 hours. Table (1) shows yeast components.

Table 1: shows the contents of bread yeast (Saccharomyces cerevisiae) for some nutrient elements ($mg.L^{-1}$).

Material	Value
Carbohydrates	82
Total nitrogen	90
Chlorides	1 – 13
phosphate	38
potassium	30
Calcium	0.1
iron	0.01
Magnesium	2
Copper	0.05

The studied traits

1- **Plant height (cm):** It was measured from the soil surface to the top of the plant.
2- **The number of leaves ($leaf.Plants^{-1}$):** The number of leaves on the stem and lateral branches and for all plants in each unit was calculated and the average of leaves per plant was then calculated.
3- **The dry weight of the total vegetative ($g.plant^{-1}$):** The vegetative parts were placed in perforated paper bags and dried in an electric oven at a temperature of 70 C until the weight was confirmed and weighed by a sensitive balance and for each treatment.
4- **The leaves content of the chlorophyll (mg. 100 g^{-1} fresh weight):** The total chlorophyll pigment was estimated in the leaves by taking a sample of leaves from each treatment and it's weight 0.5 g, placed in the ceramic mortar and adding to it a 10 ml of acetone (80%) and then mashed, which was then filtered to separate the dye solution from the paper tissue using the filter paper (Whatman N 0.1).

The process was repeated again to extract the remaining pigments with 5 ml of acetone until whitening the tissue and the resulted leachate was then collected from the filtration processes and complete the volume to 15 ml using acetone. The values were read using a spectrophotometer and the spectrophotometer readings were taken on two wavelengths of 645 and 663 nm. The amount of total chlorophyll (mg. 100 g-1 fresh weight) was calculated using the following equation:

$$\text{Total chlorophyll} = 20.2 \times D645 + 8.02 \times D663 \left(\frac{V}{W} \times 100\right) \times 100$$

5- **Fruit content of total sugars (g.100 g^{-1} L fresh weight):** It was measured by a digital refractometer model DR201-95 manufactured by the German company (Kruss) (12).

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6- **Plant yield (g.plant^{-1}):** It was calculated By dividing the total cumulative number of plants on their number.

7- **The total yield for the one greenhouse (kg. greenhouse^{-1}):** The result was calculated according to the following equation:

The average yield of the greenhouse = The average yield of the plant × the number of plants in the greenhouse / 1000

Plant height (cm):

Table (2) shows the excelling of the spraying treatment with dry yeast in plant height, especially in treatment S1, which gave the highest average of plant height amounted to (11.11 cm) followed by the treatment S2, with a significant difference, which gave 10.98 cm, while the treatment S0 recorded the lowest average of plant height amounted to 9.35 cm. As for the effect of boron, it was observed that its addition led to a significant increase in plant height, especially treatment B4, which gave the highest average of plant height amounted to 12.04 cm followed by the B2treatment, with a significant difference, which gave a height amounted to 9.72 cm, while the lowest plants height was at B0 treatment which amounted to (9.68 cm). The interaction between yeast and boron was affected in the plant height. The treatment B4S2 gave the highest average amounted to 12.50 cm. While the B0S0 treatment showed the lowest average of plant height amounted to 7.50 cm.

Table 2: Effect of spraying with dry yeast and boron and the interaction between them in the plant height (cm) for the season 2016 - 2017.

Levels of dry yeast suspension (S) g.L^{-1}	Levels of boron (B) g.L^{-1}			Effect of dry yeast suspension
	B0	**B2**	**B3**	
S0	7.50 e	8.42 de	12.14 a	9.35 b
S1	11.33 b	10.50 c	11.50 b	11.11 a
S2	10.21 c	10.25 c	12.50 a	10.98 ab
Effect of boron	9.68 c	9.72 bc	12.04 a	

Number of leaves (leaf.plant^{-1})

Table (3) shows that the dry yeast led to a significant increase in the number of leaves, where the treatment S1 gave the highest number of leaves which amounted to (11.10 leaf.plant^{-1}), which significantly excelled on the S2 treatment, which gave (10.98 leaf.plant^{-1}), while the S0 treatment gave the lowest number of leaves amounted to (9.52 leaf.plant^{-1}). The results of the same table showed that B4 was significantly excelled on the B0 treatment, which recorded (12.07 leaf.plant^{-1}), While the B0 treatment gave (9.84 leaf.plant^{-1}). After the B2 treatment gave the lowest number of leaves amounted to (9.69 leaf.plant^{-1}). The interaction between dry yeast and boron had a clear effect on this trait. The results indicate that the highest number of leaves resulted in the B4S2 treatment, which amounted to (12.50 leaf.plant^{-1}), with a significant increase from the control treatment, which gave the lowest number of leaves amounted to (8.22 leaf.plant^{-1}).

The dry weight of the total vegetative (g.plant^{-1})

Table (4) indicates that there is an effect for the spraying treatment with dry yeast on the total vegetative from the plant, The S2 treatment was significantly excelled in increase the dry weight for the total vegetative amounted to (10.37 g.plant^{-1}), followed by a significant difference from the S1 treatment, which gave (9.34 g.plant^{-1}). While the S0 treatment showed the lowest dry weight of the total vegetative amounted to (8.62 g.plant^{-1}). As for the effect of boron, It is noted from the table itself that there are significant differences in this trait due to treating with boron, The B4 treatment was excelled by giving it the highest dry weight of

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the total vegetative amounted to 11.87 g, compared to the control treatment, which recorded the lowest dry weight of the total vegetative amounted to 9.84 g. The interaction has a significant effect in this trait, The B4S2 treatment was characterized by giving it the highest dry weight amounted to 12.63 g, with a significant difference from the control treatment which recorded the lowest dry weight of the total vegetative amounted to 6.63 g.

The leaves content of total chlorophyll (mg. 100 g^{-1} fresh weight)

Table (5) shows that dry yeast had a significant effect on the leaves content of total chlorophyll, where the S2 treatment gave the highest chlorophyll content amounted to (56.99 mg. 100 g^{-1} fresh weight), which was not significantly different from the S1 treatment, which gave (55.20 mg. 100 g^{-1} fresh weight), while the control treatment showed the lowest content of chlorophyll amounted to (50.95 mg. 100 g^{-1} fresh weight). While the highest content of chlorophyll in the B4 treatment amounted to (58.63 mg. 100 g^{-1} fresh weight), with a significant difference from the control treatment which amounted to (50.83 mg. 100 g^{-1} fresh weight). As for the interaction between the two factors, the B4S2 treatment was significantly excelled in increasing the leaves content of chlorophyll, which amounted to (62.18 mg. 100 g^{-1} fresh weight) compared to the B0S0 treatment which recorded the lowest content of chlorophyll amounted to (48.11 mg. 100 g^{-1} fresh weight).

Table 3: Effect of spraying with dry yeast and boron and the interaction between them in the number of leaves (leaf.plant^{-1}) for the season 2016 - 2017.

Levels of dry yeast suspension (S) g.L^{-1}	Levels of boron (B) g.L^{-1}			Effect of dry yeast suspension
	B0	**B2**	**B3**	
S0	8.22 e	8.13 e	12.22 a	9.52 c
S1	11.30 b	10.50 c	11.50 b	11.10 a
S2	10.00 c	10.45 c	12.50 a	10.98 b
Effect of boron	9.84 b	9.69 b	12.07 a	

Table 4: Effect of spraying with dry yeast and boron and the interaction between them in the dry weight of the total vegetative (g.plant^{-1}) for the season 2016 - 2017.

Levels of dry yeast suspension (S) g.L^{-1}	Levels of boron (B) g.L^{-1}			Effect of dry yeast suspension
	B0	**B2**	**B3**	
S0	6.63 f	7.79 e	11.45 b	8.62 c
S1	7.80 e	8.69 d	11.53 b	9.34 b
S2	9.01 c	9.47 c	12.63 a	10.37 a
Effect of boron	7.81 c	8.65 b	11.87 a	

Table 5: Effect of spraying with dry yeast and boron and the interaction between them in the leaves content of total chlorophyll (mg. 100 g^{-1} fresh weight) for the season 2016 - 2017.

Levels of dry yeast suspension (S) g.L^{-1}	Levels of boron (B) g.L^{-1}			Effect of dry yeast suspension
	B0	**B2**	**B3**	
S0	48.11 e	49.21 de	55.53 c	50.95 b
S1	52.80 d	54.63 c	58.19 b	55.20 a
S2	51.60 d	57.21 bc	62.18 a	56.99 a
Effect of boron	50.83 c	53.68 b	58.63 a	

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The fruits content of total sugars ($g.100\ g^{-1}$ fresh weight)

Table (6) shows a significant increase in the fruit content of total sugars as a result of treating with dry yeast, where the S2 treatment recorded the highest the fruit content of total sugar amounted to (9.26 $g.100\ g^{-1}$ fresh weight) compared to the control treatment which amounted to (8.56 $g.100\ g^{-1}$ fresh weight), while the S1 treatment amounted to (9.13 $g.100\ g^{-1}$ fresh weight), with the insignificant difference from the S2 treatment. While the highest fruits content of total sugar resulted from the B4 treatment amounted to (11.00 $g.100\ g^{-1}$ fresh weight) significantly excelling on the B2 treatment, which amounted to (9.43 $g.100\ g^{-1}$ fresh weight), while the B0 treatment recorded the lowest fruit content of total sugars amounted to (6.53 $g.100\ g^{-1}$ fresh weight). The interaction between dry yeast and boron had a clear effect, where the B4S2 treatment gave the highest content of total sugar amounted to (11.90 $g.100\ g^{-1}$ fresh weight), while the B0S0 treatment gave the lowest content of total sugar amounted to (5.60 $g.100\ g^{-1}$ fresh weight).

Plant yield ($g.plant^{-1}$)

Table (7) indicates that the increase in the concentration of the dry yeast led to a significant increase in this trait due to treating with dry yeast, where the S2 treatment recorded the highest height in this trait amounted to (682.58 $g.plants^{-1}$), which significantly excelled on the control treatment amounted to (301.95 $g.plant^{-1}$). As for the effect of boron, the results of the same table indicate a significant increase in the average yield of the B4 treatment, where it amounted to (713.28 $g.plants^{-1}$) compared to the control treatment which amounted to (286.53 $g.plants^{-1}$). The interaction between dry yeast and boron had a clear effect in this trait, where the B4S2 treatment gave the highest yield amounted to (942.25 $g.plants^{-1}$), while the B0S0 treatment gave the lowest yield amounted to (218.10 $g.plants^{-1}$).

The total yield for one greenhouse ($kg.\ greenhouse^{-1}$)

Table (8) shows that the high concentration of dry yeast led to a significant increase in this trait. where the plants treated with the concentration of (2 $g.L^{-1}$) gave the highest yield for greenhouse amounted to (535.07 $kg.\ greenhouse^{-1}$) compared to the control treatment which gave the lowest yield amounted to (282.12 $kg.\ greenhouse^{-1}$). While the plants treated with a concentration of (1 $g.L^{-1}$) gave a yield amounted to (393.92 $kg.greenhouse^{-1}$). As for the effect of spraying with boron, it is noticed from the table that the B4 treatment recorded the highest yield for the greenhouse amounted to (606.67 $kg.greenhouse^{-1}$) after it was (243.90 $kg.greenhouse^{-1}$) in the control treatment, which was significantly decreased from the B2 treatment in this trait. The interaction between dry yeast and boron had a clear effect in this trait, where the B4S2 treatment gave the highest yield amounted to (782.70 $kg.greenhouse^{-1}$), while the B0S0 treatment gave the lowest yield amounted to (187.21 $kg.greenhouse^{-1}$).

Table 6: Effect of spraying with dry yeast and boron and the interaction between them in the fruits content of total sugars ($g.100\ g^{-1}$ fresh weight) for the season 2016 - 2017.

Levels of dry yeast suspension (S) $g.L^{-1}$	Levels of boron (B) $g.L^{-1}$			Effect of dry yeast suspension
	B0	**B2**	**B3**	
S0	5.60 f	9.70 c	10.40 b	8.56 b
S1	6.80 ef	9.90 cd	10.70 b	9.13 ab
S2	7.20 e	8.70 d	11.90 a	9.26 a
Effect of boron	6.53 c	9.43 b	11.00 a	

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Table 7: Effect of spraying with dry yeast and boron and the interaction between them in the Plant yield ($g.plant^{-1}$) for the season 2016 - 2017.

Levels of dry yeast suspension (S) $g.L^{-1}$	Levels of boron (B) $g.L^{-1}$			Effect of dry yeast suspension
	B0	**B2**	**B3**	
S0	218.10 e	286.50 e	401.25 c	301.95 c
S1	289.25 e	395.25 d	796.34 b	494.61 b
S2	352.25 d	753.25 b	942.25 a	682.58 a
Effect of boron	286.53 c	478.33 b	713.28 a	

Table 8: Effect of spraying with dry yeast and boron and the interaction between them in the total yield for one greenhouse ($kg. greenhouse^{-1}$) for the season 2016 - 2017.

Levels of dry yeast suspension (S) $g.L^{-1}$	Levels of boron (B) $g.L^{-1}$			Effect of dry yeast suspension
	B0	**B2**	**B3**	
S0	187.21 g	245.01 f	414.14 d	282.12 c
S1	233.40 f	325.19 e	623.17 b	393.92 b
S2	311.10 e	511.41 c	782.70 a	535.07 a
Effect of boron	243.90 c	360.53 b	606.67 a	

It is clear from the above that there are differences in the response of vegetative growth and plant yield to the levels of dry yeast and boron, and these differences represent positive effects in the studied traits. It was observed that the spraying treatments with dry yeast were significantly excelled on the control treatment in increasing the vegetative growth, which led to an increase in the fruit content of the total sugars and the plant yield, and then the increase in the quantity of the greenhouse as shown in Table (6, 7, 8). The effect of the addition of dry yeast on the total vegetative may be due to the fact that leaves are an important center in which many physiological and biological processes occur, as well as an effective method of absorbing and transferring nutrients better within the plant (1). On the other hand, the importance of bread yeast to improve the traits of vegetative growth due to what contain of nutrients such as nitrogen as shown in Table (1), as well as amino acids, which may be attributed to the increase and activate the vital activities of plants by stimulating the enzymatic systems and increase the composition of nucleic acids DNA and RNA (13), and to stimulate it in the production of plant hormones Auxins and Cytokines, which encouraged the process of cellular division and elongation of cells (2). Or the result of containing dry yeast on some of the macro and microelements that have a role in promoting elongation and cell division (9) Which reflected positively on the increase in plant height as shown in Table (2), the number of leaves as shown in Table (3) and the dry weight of the total vegetative as shown in Table (4). In addition, dry yeast contains many nutrients that have a direct or indirect role in the manufacture of chlorophyll, which is reflected in increasing the leaves content of chlorophyll as shown in Table (5). Which increased the fruits content from total sugars as shown in Table (6) by increasing the efficiency of the photosynthetic process, and the role of potassium on the transferring the products of photosynthesis process to fruits, thus increasing the concentration of total sugars in them. As for the superiority spraying treatments with boron, it may be due to the role of boron associated with carbohydrate chemistry and all cellular life events such as division, differentiation, maturity, respiration, growth, and pollen germination (8), where the increase in plant height as shown in Table (2), the number of leaves as shown Table (3) and the leaves content chlorophyll as shown Table (5) is due to the role of the boron element in the development of roots initiators, thus improving nutrient absorption, thus stimulating vegetative growth of the plant. As well as the role of the boron element in the transfer of sugars from the places of manufacture to areas of growth and entry of the element in the structure of the cellular wall and enzymatic reactions and cellular divisions for the plant cell of the Meristematic tissue and its entry into the composition and manufacture of carbohydrates and protein (20), which reflected on increasing the Dry weight for total vegetative as shown in Table (4). As for increasing the fruits content of total sugars as shown in Table (6), it may be due to the role of the boron element in the transport of sugars from the places of manufacture to the fruits with the increase of boron element (3). The increase in the trait of plant yield as shown in Table (7) can be attributed to the role of the boron element in the formation of the pollen tube and the fertilization process in the flowers, which increases the percentage of the fruit set and the positive reflection in raising the productivity of the plant, thus increasing the average production of the greenhouse as shown in Table (8) (14).

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