

Response of Strawberry Varieties (*Fragaria x ananassa* Duch) Produced From Tissue Culture to Amino Acid Terra-Sorb Complex in Some of Physical Properties of Fruits under Unheated Greenhouse Conditions

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Abstract

This study was performed in the Agricultural Research Station, affiliated to the College of Agriculture and Marshlands , Thi-Qar University which lies within the longitude (46.22) and latitude (31.05) during the growing season 2023-2024 to study the response of strawberry varieties *Fragaria x ananassa* Duch ;Monterey, Albion and Rubygem ,produced from tissue culture and sprayed with Terra-Sorb Complex in concentrations of (0, 1, 2, 3) ml.L⁻¹ and their interactions on some of the physical qualities of fruit under unheated plastic house conditions. The experiment was carried out as a factorial experiment using Randomized Complete Block Design (R.C.B.D) and three block (3*3*4) became 36 treatment combinations averages compared to the Least Significant Differences (L.S.D) at probability level 0.05.

Results can be summarized as follows:

The fruits of the variety Albion showed a moral superiority in the number of fruits reaching (11.77 fruit.plant⁻¹) comparison with variety Monterey register (9.72 fruit.plant⁻¹) and the length and diameter of the fruit moral superiority (39.74 , 32.64) mm compared to the Monterey variety that they registered (33.06 , 26.79) mm respectively variety record Albion also morally superior fruit size record (14.59 cm³) while variety Rubygem highly morally outweighed by the average tender weight of fruits reaching (83.74 g.plant⁻¹) comparison with variety Monterey record (74.88 g.plant⁻¹).

The spraying of Terra-Sorb Complex plants leads to a high morale increase as the spraying exceeds the concentration of 3 ml.L⁻¹ in high spirits record highest average number of fruits reached (12.29 fruit.plant⁻¹) for comparison treatment the comparison reaching (8.81 fruit.plant⁻¹) the length and diameter of the fruit reached (46.24 ,37.51) mm measured by comparison treatment (28.04 ,22.88) mm its size reached (16.39 cm³) measure by comparison treatment reached (10.74 cm³) The tender weight of the fruit has reached (97.82 g.plant⁻¹) measure by comparison treatment (58.37 g.plant⁻¹).

Results showed the overlap between the variety and the spraying by Terra-Sorb Complex a clear high-morale effect on the profiled qualities as Albion class overlap outweighs by concentration 3 ml.L⁻¹ with remarkable morale in fruit preaching, fruit length, fruit diameter and fruit size and the tender weight of fruits reaching (13.55 fruit.plant⁻¹, 50.48 mm, 44.48mm, 18.63 cm³,99.63 g.plant⁻¹) respectively.

Keywords. *Fruit weight , Fruit length , Fruit diameter , Amino acids , Strawberry.*

I. Introduction

Name in english Strawberry follows the family Rosaceae , the strawberry plant is a fruit to add annual rings in the crown area, when growing strawberries as a perennial crop, they are a fruit crop when they are renewed annually, as in Egypt, they are vegetable crops and are perennials Strawberry cultivation is

believed to have entered Iraq in an accidental state in the middle of the last century in home gardens (Al-Saidi,2000 and Hassan,2002). Strawberries are used as flavors and aromas in many and wide fields as lip gloss, perfumes, soap and other products that enhance the economic importance of strawberries in a wider range of the world , it is a fruit of the temperate regions that has expanded its cultivation in the tropics and subtropics(Singh et al., 2008). The fruits of the strawberry plant are called protective fruits, as they contain many vitamins, including A, B and C, as well as minerals, including P, Ca and Fe and fruits are easily digested because they contain some of the different organic acids as well as digestive enzymes (Kriti,2016). The technique of plant tissue cultivation in strawberry multipliers is an alternative to traditional farming methods as it is one of the methods currently used in many types of herbal and timber plants. this method is important in obtaining a large number of plants similar to the mother in a short time as well as producing a plant free from insect and pathological scourges(Ibrahim et al., 2012).

Paper composting using amino acids and microelements is a modern method used to improve growth and production amino acids are vital stimulants that are easily absorbed and transmitted within plant cells and directly affect enzymatic processes, contributing to the rapid absorption of nutrients from the soil and transporting into plant cells and opening the gaps, and have a catalytic role for plants because the presence of nitrogen in their composition is ready to absorb, When spraying plants with amino acids, plants are more reserved for inappropriate climatic conditions (Al-Zubaidy and Al-Hamzawi ,2016)(Amin,2019). Previous studies have shown that treatment has improved growth qualities as well as increased plant productivity and most quality plant qualities (Sarhan and Mahmood ,2020). It is highly essential in stimulating growth of the plant and also maintains the pH of the tissue and a major source of nitrogen that the plant uses to manufacture proteins, produce energy and increase the plant's potential for its vegetative and root growth, the effect of which is reflected in the plant's crop and components (Al-Mashhadany et al., 2022). Showed Al-Tamimi (2022) the spraying of amino acids increases the efficiency of metabolic and antioxidant activities by raising the amount of enzymes in plant cells, contributes to the construction of carbohydrates and protein, activates photosynthesis through the construction of chlorophyll, encourages the formation of enzymes that are associated with increasing plant resistance to inappropriate environmental conditions and extreme stresses, and stimulates the effectiveness of philosophical activities and vital kimos. That's why the research aims:

To indicate the impact of Terra-Sorb Complex spraying on strawberry plant varieties and their production, compare them, study their response to local conditions, identify the best type and concentration of amino acid

II. Materials and methods

This study was conducted in an unheated plastic house area 450 m² in performed in the Agricultural Research Station, affiliated to the College of Agriculture and Marshlands , Thi-Qar University which lies within the longitude (46.22) and latitude (31.05) during the growing season 2023-2024 (AL-Zubaidy and Hsabah,2022) (Al-nassrallah and Al-Sadi,2023), To find out the response of three varieties of the strawberry plant produced from textile agriculture and Terra-Sorb Complex in some physical qualities of fruit. The land was prepared from tillage and smoothing and divided into three sectors each sector, comprising 12 experimental units, the length of the experimental unit 3 m and 1 m wide, the distance between one seedling and another 30 cm, leaving a distance of 1 m between each experimental unit and a height of 35 cm and covered with black plastic cover, and the drip irrigation system was distributed before planting Seedlings from textile farming imported from Turkey were planted according to the experimental unit at random on 26/11/2023, the vegetation of plants was sprayed to full wet with four sprinkles during the growing season between one and 10 days, and the 16 L dorsal sprinkler was used for early morning transactions. The experiment was carried out according to Randomized Complete



Block Design (R.C.B.D) Included effect two factors are spray 4 concentrations of Terra-Sorb Complex and she (0, 1 , 2 and 3) mL.L⁻¹ manufacturer Bioiberica-Spain it contains 20% amino acids, 5.5% total nitrogen, 5% organic nitrogen and 35% organic substances, including micronutrients (B, Fe, Mn, Zn and Mo) in proportions (0.5, 1, 0.1, 0.1 and 0.001%) and three varieties of strawberry plant (Rubygem ,Monterey and Albion) produced from tissue culture. The results were then analyzed using a program GenStat(2007) then test the difference between averages by (L.S.D) at probability level 0.05 (Al-Rawi and khalfalh, 2000).

After the completion of the experiment on 2024/4/28 , some physical characteristics of the fruit were tested and 6 plants were randomly taken from each experimental unit of the three repetitions:

- 1.Number of fruits for the plant (fruit.plant⁻¹): Calculated the number of deafness up to the fraternal fairy and divided the number of plants in the experimental unit (Al-Handel and Ghanim, 2021).
- 2.Fruit length (mm): The readings were taken for the fruit by Vernier (Hussein,2022).
- 3.Fruit diameter (mm): Measured diameter of 6 fruits per experimental unit using Vernier (Hussein,2022).
- 4.Fruit size (cm³) : The average size of 6 fruits per experimental unit was calculated using the joking water method of the glass cylinder listed according to the following formula: the average size of the fruit = the joking water volume of the fruit ÷ the number of fruits (Hussein,2022).
- 5.Soft weight of fruits (g.plant⁻¹): The tender weight was calculated by taking 6 fruits from each experimental unit and measuring their weight using the sensitive balance.

III. Results and discussion

1-Average number of fruits (fruit.plant⁻¹)

Table (1) shows the effect of the variety and the spraying of Terra-Sorb Complex and their overlaps in the number of (fruits. Plant⁻¹), the variety has a high-moral impact on the number of(fruits. Plant⁻¹) the Albion variety exceeds the highest rate of 11.77 fruits. Plant⁻¹ compared to Monterey, which had the lowest record rate of 9.72 fruits. Plant⁻¹.The Terra-Sorb Complex spray led to high-morale differences in the number of fruits, outpacing the spray with a concentration of 3 mL.L⁻¹ which amounted to 12.29 fruits.Plant⁻¹ is moral about the comparison transaction, which recorded 8.81 fruits.Plant⁻¹. From the same table, the results of the overlap between the items and the Terra-Sorb Complex were shown exceeding the spray at a concentration of 3 mL.L⁻¹ overlap with the Albion variety of 13.55 fruits.Plant⁻¹ in high spirits than the comparison transaction of 8.67 fruits.Plant⁻¹ variety Rubygem.

Variety	Terra-Sorb Complex concentrations mL.L ⁻¹				Average variety
	0	1	2	3	
Albion	8.94	11.74	12.83	13.55	11.77
Rubygem	8.67	9.78	11.22	12.61	10.57
Monterey	8.83	9.17	10.16	10.72	9.72
Average Terra-Sorb Complex	8.81	10.23	11.41	12.29	
L.S.D ≤ 0.05					
Variety	Terra-Sorb Complex		Variety * Terra-Sorb Complex		



0.4169	0.4814	0.8337	Table
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1.Effect of variety and spraying with Terra-Sorb Complex mL.L⁻¹ and their interactions on number of fruits fruit.plant⁻¹.

2- Fruit length (mm)

Table (2) shows the effect of the variety the Terra-Sorb Complex and their interventions in fruit length , with high magnet superiority in the length of the fruit Albion exceeds the rest of the variety and scores the highest average of 39.74 mm while the lowest average was 33.06 mm for the variety Monterey ,Terra-Sorb Complex spray results showed a high moral effect and outperformed the spray with a concentration of 3 mL.L⁻¹ with the highest value of 46.24 mm for the comparison transaction recorded 28.04 mm. The interfaces between the variety and the spray factors of the Terra-Sorb Complex showed the results with a moral increase as the spray effect was concentrated at 3 mL.L⁻¹ and Albion have the highest overlap rate of 50.48 mm than the comparison transaction of Monterey, which recorded the lowest length of 24.18 mm.

Table 2.Effect of variety and spraying with Terra-Sorb Complex mL.L⁻¹ and their interactions on Fruit length mm.

Variety	Terra-Sorb Complex concentrations mL.L ⁻¹				Average variety
	0	1	2	3	
Albion	26.80	36.38	45.29	50.48	39.74
Rubygem	33.15	37.93	39.34	41.67	38.02
Monterey	24.18	27.95	33.56	46.57	33.06
Average Terra-Sorb Complex	28.04	34.09	39.40	46.24	
L.S.D ≤ 0.05					
Variety	Terra-Sorb Complex		Variety * Terra-Sorb Complex		
0.638	0.737		1.277		

3-Fruit diameter (mm)

Table (3) shows the effect variety their interventions in the fruit of diameter the items have a high morale effect, the Albion variety has exceeded and scored the highest fruit in diameter reach 32.64 mm comparison with variety Monterey which recorded the lowest rate 26.79 mm. The same table shows that the spray concentration is 3 mL.L⁻¹ in Terra-Sorb Complex is higher in morale than 37.51 mm by comparison treatment which was the lowest at 22.88 mm. The overlap between the variety and the spraying of Terra-Sorb Complex shows moral superiority as the overlap is sprayed at a concentration of 3 mL.L⁻¹ for the variety Albion exceeded in high spirits which was 44.48 mm, while the comparison transaction for the variety Monterey recorded the lowest overlap of 21.09 mm.



Table 3.Effect of variety and spraying with Terra-Sorb Complex mL.L⁻¹ and their interactions on Fruit diameter mm.

Variety	Terra-Sorb Complex concentrations mL.L ⁻¹				Average variety
	0	1	2	3	
Albion	21.92	26.17	37.98	44.48	32.64
Rubygem	25.63	27.71	29.28	32.55	28.79
Monterey	21.09	24.44	26.15	35.49	26.79
Average Terra-Sorb Complex	22.88	26.10	31.14	37.51	
L.S.D ≤ 0.05					
Variety	Terra-Sorb Complex		Variety * Terra-Sorb Complex		
0.566	0.654		1.132		

4- Fruit size (cm³)

Table (4) results variety effect and Terra-Sorb Complex their overlaps in the fruit size, the variety have a high moral effect in the size of the fruit cm³, since the variety Albion has a moral effect by registering the highest fruit size of 14.59 cm³ while the lowest size of 12.39 cm³ is recorded for the variety Monterey, the Terra-Sorb Complex spray treatment has a high-moral effect a high-moral differentiation of the 3 mL.L⁻¹ spray treatment has been observed a higher average fruit volume of 16.39 cm³ compared to the comparison transaction recorded the lowest volume of 10.74 cm³. From the same table is a high elevation of the bilateral overlap between the variety and the spraying of Terra-Sorb Complex, giving the highest overlap of this adjective with Albion and sprayed with a concentration of 3 mL.L⁻¹ was 18.63 cm³ compared to the comparison of Monterey, which gave the lowest size of 9.11 cm³.

Table 4.Effect of variety and spraying with Terra-Sorb Complex mL.L⁻¹ and their interactions on Fruit size cm³.

Variety	Terra-Sorb Complex concentrations mL.L ⁻¹				Average variety
	0	1	2	3	
Albion	10.41	13.34	16.00	18.63	14.59
Rubygem	12.71	13.48	14.23	15.05	13.87
Monterey	9.11	11.67	13.27	15.50	12.39
Average Terra-Sorb Complex	10.74	12.83	14.50	16.39	
L.S.D ≤ 0.05					
Variety	Terra-Sorb Complex		Variety * Terra-Sorb Complex		
0.620	0.716		1.240		



5- Soft weight of fruits (g.plant⁻¹)

Table (5) results the effect of the variety and the Terra-Sorb Complex spraying and their interference in the fruit's soft weight, the variety has a high morale effect on the soft weight of the fruit g.plant⁻¹ where the item Rubygem morally outperformed the highest soft weight of fruit at 83.74 g.plant⁻¹ compared to the Monterey variety which gave the lowest weight with a record of 74.88 g.plant⁻¹, the table results indicate high-morale superiority of Terra-Sorb Complex spraying transactions over spraying at a concentration of 3ml.L⁻¹ with high morale and a higher weight of 97.82 g.plant⁻¹ measured by comparison treatment, giving a lower weight of 58.37 g.plant⁻¹. The same table indicated that there was a high-moral effect of the overlap factors between the variety and the Terra-Sorb Complex in the rate of soft weight of the fruit, which recorded the best overlap of the concentration of 3 ml.L⁻¹ and variety Albion amounted to 99.63 g.plant⁻¹ while less weight was recorded for the comparison treatment of the variety Monterey record 53.91 g.plant⁻¹.

Table 5.Effect of variety and spraying with Terra-Sorb Complex mL.L⁻¹ and their interactions on soft weight of fruits g.plant⁻¹.

Variety	Terra-Sorb Complex concentrations mL.L ⁻¹				Average variety
	0	1	2	3	
Albion	65.41	71.79	89.92	99.63	81.69
Rubygem	55.80	86.44	94.37	98.36	83.74
Monterey	53.91	65.60	84.55	95.46	74.88
Average Terra-Sorb Complex	58.37	74.61	89.62	97.82	
L.S.D ≤ 0.05					
Variety	Terra-Sorb Complex			Variety * Terra-Sorb Complex	
1.379	1.592			2.758	

Through the results of tables (1) the number of fruits, (2) the length of the fruit, (3) the diameter of the fruit, (4) the size of the fruit and (5) the soft weight of the fruit, it became clear that the variation between the varieties of the strawberry plant in some characteristics of the physical fruits was due to the genetic factors between them and the effect of environmental factors in these qualities or genetic changes in the nature of the varieties of the growth (Salman and Jaber ,2018) he agrees with (Singh et al.,2008). It may also be attributed to varieties' varied genetic behaviour in the transformation of agro-process actors and the extent to which varieties respond to local climatic conditions (Khazaal,2023) he agrees with (Chiomento et al.,2021).

The results obtained can be explained by the role of amino acids rich in the necessary nutrients that lead to the division and expansion of cells, the increase in the construction of chlorophyll, thereby increasing the number of fruits table (1), the length of the fruit table (2), the diameter of the fruit table (3), the size of the fruits table (4), the weight of the soft fruit table (5), and the result thereby improving the qualitative plant characteristics show Nezime et al.,(2002) the role of amino acids and their effect on some physical properties, as spraying plants with organic, paper-based stimuli to amino acids that increase chlorophyll content, stimulate production, improve its quality and increase climate inadequacy. Its role in regulating and facilitating the transfer of ions is complicated and unclear, as its primary role in metabolism is due to secondary compounds and the enzymatic plant system, especially oxidation and reduction (Morales and Stall,2003).

Organic fertilizer added or sprayed as it works to produce organic acids contributes to the formation of some growth organizations that lead to an increase in the number of flowers and thus the number



of fruits for the plant and may improve the fruit nodes (Shahab et al., 2010), close them to the stomachs, and reduce the toxicity of heavy metals (Anjum et al., 2014).). It may be that organic acids are an essential source of proteins because they are essential enzymes for vital potentials. They may regulate chromosomes, preserve membranes and protein persistence, and their role in improving balance, which stimulates buds, regulates flowers, regulates the transport of melts and nutritious mineral elements and their accumulation in flowers and thus fruits (Hassan et al., 2014) this is consistent with what he said (Walter et al., 2006 ; Meltsch et al.,2006).We also find that it acts as a growth stimulant and also regulates the physiological activities of the plant as well as improving growth and production and its quality, absorbing nutrients and adapting to environmental stress factors (Yakhin et al., 2017).

Processing the plant with prefabricated amino acids with a spray on the vegetable total accelerates its absorption through leaves or roots, making it easier for the plant to use directly and saving the energy used in manufacturing to perform its vital functions amino acids are natural stimuli that contribute and improve the balanced growth of plants and encourage the plant to increase its responsiveness to composting and disease resistance as well as provide the plant with the energy needed to manufacture protein and its nitrogen needs and also prevent the plant from being poisoned with ammonia (Enad and Alhayany,2019) and you agree with that (Al-Marjani,2011). Previous studies have shown that spraying plants with amino acids is good at plant growth standards and supplying production (Sarhan and Mahmood,2020) and these findings are in line with the findings of (Ragheb 2016 ; Darwish 2019). As Ghilan et al.,(2024) paper spraying of amino acids is an effective way to achieve a moral effect and increase in complex and productive fruits because it is considered a basic building unit of protein and a stress-proof agent and contributes to the easy absorption of the necessary nutrients most amino acids are prefix compounds to synthesize some of the plant hormones, and also play an integrative complex role such as growth, nutritional regulation, and development, resistance to stresses and others so that the plant adapts to its surrounding environment is consistent with the results of the study (Yang et al.,2022).

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