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Response Of Growth, Productivity, And Marketability Of Strawberry To Potassium Silicates And Pomegranate Peel Aqueous Extract

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Abstract
The experiment was conducted in one of the agricultural fields in Babil Governorate, Iraq, during the 2024 growing season on "Ruby Gem" strawberry plants obtained from Turkish companies to investigate how certain growth, productivity, and marketability characteristics of strawberry fruits are affected by potassium silicates at concentrations of 0, 2.50, and 5.00 mL/L and aqueous pomegranate peel extract at concentrations of 0, 5, and 10 g/L following ten days of storage at 2°C with relative humidity between 80 and 85%. The findings indicated that potassium silicates applied topically at a dosage of 5.00 mL/L considerably raised the plant's height (20.74 cm), leaf count (37.20 leaves/plant), and fruit weight (30.33 g and fruit volume (56.23 mL), substantially lowering the weight loss percentage to 5.60% in contrast to the control treatment, which had the lowest values for these characteristics. In comparison to the control, the maximum percentage of vitamin C (39.84%) was obtained at a concentration of 2.50 mL/L. Plant height (19.98 cm), leaf number (34.05 leaves/plant), fruit weight (27.74 g), fruit volume (57.95 mL), and vitamin C content (41.94%) were among the features that were significantly raised by the aqueous pomegranate peel extract treatment at 10 g/L, while weight loss was decreased to 6.16%. compared to the control treatment. Plant height, leaf count, fruit weight, fruit volume, post-storage weight loss, and total soluble solids (TSS) percentage all significantly increased in the A2B2 interaction treatment (23.30 cm, 38.63 leaves/plant, 38.93 g, 61.24 mL, 4.66%, and 8.60%, respectively) in comparison to the other treatments.

1. INTRODUCTION

Grown worldwide, the strawberry (*Fragaria ananassa* Duch) is a small, perennial fruit with substantial commercial value. According to [1], it belongs to the Rosaceae family, specifically the Rosales order. Despite being produced across Europe, Asia, Africa, and America, strawberries are believed to have originated in North America [2]. Strawberries are often found between latitudes 51° and 55°, however some varieties may grow as far north as 70° N in tropical settings [3]. Global strawberry cultivation is expected to cover 389,665 hectares and produce 9,175,384 tons of fruit. China is the largest producer, with an area of 19,919 hectares and a production of 1,211,090 tons [4]. The US comes in second. The area and productivity under cultivation in Iraq are not quantified. Potassium silicate mostly contains silicon and potassium, two essential minerals for plants. Since potassium is necessary for plant growth and development, it has an impact on plant health and productivity [5].

One of the most common elements in soil is silicon, which [3] claim that giving plants this element boosts their resistance to abiotic stresses and stimulates their antioxidant systems. Silicon deposition in stems and leaves increases tissue resistance to mechanical damage and acts as a physical barrier against pests and pathogens [6]. When silicon is present, the quantity of hemicellulose and lignin in cell walls rises, making them more rigid [7]. Pomegranate peel extract may be used as a safe, affordable, and valuable component in food products as well as a biodegradable preservative [8]. Bioactive compounds abound in it, particularly flavonoids like cyanidin glucosides, pentosides, and anthocyanins, as well as phenolic acids including coumaric acid, gallic acid, ellagic acid, caffeic acid, chlorogenic acid, ferulic acid, syringic acid, vanillic acid, and cinnamic acid. The extract also has antioxidant and antimicrobial properties. [4, 7, 8]. Strawberries are particularly vulnerable to fungal infections and mechanical damage because of their softness and tendency to

lose firmness during marketing and storage. Fruit firmness loss is principally driven by cell wall collapse and middle lamella dissolution, both of which are regulated by pectin degradation [9].

2. MATERIALS AND METHODS

2.1 Designing and executing experiments:

During the 2023–2024 growing season, two factors were used in this factorial experiment: potassium silicates (A) at concentrations of 0, 2.50, and 5.00 mL/L and pomegranate peel aqueous extract (B) at concentrations of 0, 5, and 10 g/L. The experiment was carried out using a Complete Randomized Blocks Design (RCBD). Three replications (3×3) were used in the experiment, yielding 81 experimental units in total. The seedlings were planted on 28/10/2023, and the first foliar application was made on 20/12/2023, followed by subsequent applications every 10 days. Spraying was performed until complete wetting in the early morning hours, with a surfactant added to break the surface tension. The data were analyzed using the GENSTAT program, and the means were compared based on the least significant difference (L.S.D) at a probability level of 0.05.

2.2 Preparation of the Extract: Pomegranate Peel Extract:

The extract was prepared by soaking ground pomegranate peels (tanned) in water for 12 hours, after which it was filtered, and spraying was carried out.

2.3 Growth Indicators:

- **Plant Height (cm):** Plant height was measured from the soil surface to the top of the plant using a measuring tape. The average plant height per experimental unit was calculated.
- **Number of Leaves (leaves/plant):** The number of leaves was counted for five plants from each experimental unit, and the average number of leaves per plant was calculated by dividing the total number of leaves by five.
- **Fruit Weight (g):** Fruit weight was calculated using the following formula: Average fruit weight (g) = Total weight of fruits per plant / Total number of fruits.
- **Fruit Volume (mL):** The fruit volume was measured using the water displacement method.

2.4 Storage Experiment:

According to CRD, the fruits from every treatment were kept in a dedicated refrigerator. For ten days, a 250 g sample of uniform fruits from each treatment was kept at 2°C in perforated plastic containers. The GENSTAT program was used to statistically evaluate the data, and the L.S.D. test was used to compare the means at a 0.05 probability level. Storage Experiment Indicators:

- **Vitamin C (mg/g fresh weight):** Vitamin C content was determined using the 2,6-Dichlorophenol-Indophenol dye method as outlined by [10].
- **Percentage of Weight Loss:** The weight of the fruit sample was measured on the first day of harvest and again after 10 days of storage using a digital scale. The percentage of weight loss was calculated using the following formula: Percentage of weight loss = [(Initial weight - Final weight) / Initial weight] * 100.
- **Percentage of Total Soluble Solids (TSS):** This percentage was measured using a hand refractometer. Juice from five randomly selected fruits per experimental unit was used.

3. RESULTS AND DISCUSSION

The table(1,2) shows that foliar spraying with potassium silicates and pomegranate peel aqueous extract had a substantial effect on several strawberry plant parameters. When compared to the control treatment, the A2 treatment considerably raised the potassium silicates (A) plant height (20.74 cm), number of leaves (37.20 leaves/plant), fruit weight (30.33 g), and fruit volume (56.23 mL). Similarly, the pomegranate peel extract (B) had a significant effect on the plants' growth indicators, with the B2 treatment showing the best results in terms of plant height (19.98 cm), fruit weight (27.74 g), fruit volume (57.95 mL), and leaf count (34.05 leaves/plant), in contrast to the control. With values of 23.30 cm, 38.63 leaves/plant, 38.93 g, and 61.24 mL, respectively, the A2B2 treatment demonstrated the greatest outcomes for plant height, number of leaves, fruit weight, and fruit volume in terms of the interaction effect.

Table 1. Effect of foliar spraying with potassium silicates and pomegranate peel aqueous extract on plant height, number of leaves, fruit weight, and fruit volume of strawberry plants.

Treatments	Plant Height (cm)	Number of Leaves (leaves/plant)	Fruit Weight (g)	Fruit Volume (ml)
A0	15.90	24.85	19.03	51.41
A1	18.48	32.04	21.94	54.04
A2	20.74	37.20	30.33	56.23
L.S D A	0.06	0.26	0.50	0.49
B0	16.73	28.47	19.97	48.98
B1	18.40	31.58	23.59	54.75
B2	19.98	34.05	27.74	57.95
LSDB	0.06	0.26	0.50	0.49
A0B0	12.83	18.75	16.06	46.33
A0B1	16.99	26.15	20.24	53.18
A0B2	17.88	29.67	20.78	54.71
A1B0	18.25	30.61	20.75	49.43
A1B1	18.45	31.67	21.58	54.79
A2B2	18.75	33.86	23.50	57.89
A2B0	19.12	36.05	23.09	51.18
A2B1	19.78	36.92	28.96	56.28
A2B2	23.30	38.63	38.93	61.24
LSD AB	0.11	0.45	0.86	0.85

Table 2. Effect of foliar spraying with potassium silicates and pomegranate peel aqueous extract on Vitamin C content after storage, percentage of weight loss, and TSS after storage of strawberry plants.

Treatments	Vitamin C After Storage (%)	Percentage of Weight Loss After Storage (%)	TSS
A0	37.99	7.91	7.78
A1	39.84	6.12	7.73
A2	38.75	5.60	8.10
L.S D A	1.263	0.167	0.12
B0	35.97	6.98	7.51
B1	38.97	6.49	7.96
B2	41.94	6.16	8.14
LSDB	1.263	0.167	0.12
A0B0	34.27	8.37	7.42
A0B1	40.19	7.81	8.08
A0B2	39.52	7.56	7.85
A1B0	37.95	6.23	7.35
A1B1	37.53	5.86	7.87
A1B2	44.05	6.27	7.98
A2B0	35.70	6.34	7.76
A2B1	39.20	5.81	7.93
A2B2	41.36	4.66	8.60
LSD AB	2.188	0.289	0.21

The foliar application of potassium silicates has been demonstrated to boost growth indicators because silicon increases the size of chloroplasts and the number of thylakoids, which raises the amount of chlorophyll and

eventually increases photosynthetic production [10]. Silicon, which is deposited in cell walls, also regulates food intake and passage across cell membranes [11]. It also controls sugar metabolism and hormone levels [12]. The nutrient contains a significant amount of potassium, an element required for various physiological processes in plants. Potassium has a direct impact on photosynthetic activity, and metabolic regulation [13], which are required for the plant to complete its life cycle. Furthermore, potassium stimulates around 60 enzymes and plays a direct role in protein synthesis [14].

Furthermore, it improves nutrient absorption and facilitates the movement of nutrients from the leaves to the roots [15]. This promotes vigorous vegetative and reproductive growth; this has a positive impact on yield indicators. This finding is congruent with what [16] found. Potassium silicates are hypothesized to help preserve the quality of strawberry fruit during storage by forming a layer beneath the epidermis that prevents gas exchange and transpiration. Furthermore, it acts as a physical barrier against diseases and pests [18], potentially reducing fruit damage and, as a result, spoilage. Furthermore, the potassium concentration in the spray solution promotes the flow of nutrients from the leaves to the fruits [19], which is consistent with [20] findings.

The impact of each component on rising these indicators separately may be the reason for the rise in growth indicators caused by the interplay of the parts under investigation. When these interactions were combined, the plant's nutritional state improved and it became more balanced. According to [21, 22, 23], this had a positive impact on the plant's growth and development. Because pomegranate peel extract includes a high concentration of polyphenols, it appears to have a significant effect on strawberry fruit preservation. In addition to modifying membrane proteins, these chemicals interact with the membrane's phospholipids, reducing permeability and water loss. It can also reduce respiration rate and oxygen permeability. It can also impair sugar metabolism and limit bacterial development and reproduction by suppressing enzyme activity in the respiratory pathway's tricarboxylic acid (TCA) cycle. This increases the shelf life of strawberries and inhibits deterioration [24].

4. CONCLUSION

The treatment of strawberry plants with 5.00 mL/Liter potassium silicate spray and 10 g/Liter aqueous extract spray, as well as their interaction, resulted in improvements in the majority of study indicators. After 10 days of storage at a temperature of 2 degrees Celsius and a relative humidity of 80-85%, along with field spraying with potassium silicate at a concentration of 5.00 ml/liter and spraying with an aqueous extract at a concentration of 10 g/Liter, the fruits' quality indicators improved significantly.

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