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The Effect of Phosphorus Foliar Application on Some Physiological and Productive Characteristics of Strawberry Fruits

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Annotation: The present study was planned and designed to determine the effect of phosphorus spraying on the physiological characteristics and productivity of strawberries. The experiment was carried out in an unheated polyethylene tunnel 9m × 25m, strawberry transplants var. Festival were obtained from commercial nursery sources, planted in a raised-bed system at 20 × 80 cm spacing, mulched with black plastic, double row plants staggered 25 cm, on the 30 of October. Design of experiments The experiment is conducted as Randomized Complete Block Design (RCBD) under the factorial arrangement (3*3), with three replications. The results showed the effect of spraying with phosphorus on the number of fruits in strawberry plants. At concentration 0, the average number of fruits was 7.2±1.48 (fruit. plant-1), while at concentration 2 mg. L-1, the average number of fruits was 10.2±1.58 (fruit. plant-1), and the average number of fruits at concentration 4 mg. L-1 was 12.2±1.79 (fruit. plant-1). for, weight of fruits, At concentration 0, the average weight of fruits was 14.86±1.75 (gm. plant-

1), while at concentration 2 mg. L-1, the average weight of fruits was 19.34±3.63 (gm. plant-1), and the average weight of fruits at concentration 4 mg. L-1 was 28.02±8.3 (gm. plant-1). for, total sugars of fruits, At concentration 0, the average total sugars of fruits were 3.04±0.14 (gm. 100 gm fresh weight-1), while at concentration 2 mg. L-1, the average total sugars of fruits were 3.77±0.06 (gm. 100 gm fresh weight-1), and the average total sugars of fruits at concentration 4 mg. L-1 was 4.13±0.11 (gm. 100 gm fresh weight-1). It was found that spraying with phosphorus plays an important role in improving the physiological and productive characteristics of strawberry fruits. Therefore, phosphorus can be used to improve strawberry productivity.

Keywords: phosphorous, strawberry, foliar application, productive characteristics.

Introduction

One of the vital minerals that plants require in significant quantities throughout their life cycle is phosphorous. This nutrient is part of nucleic acids, as well as coenzymes and phosphoproteins and phospholipids that are involved in energy transfer in cells by way of respiration and photosynthesis (1,2). Subsequently, Bechtaoui et al. (3) shown that supplementing with phosphorus fertilizer may aid plants in surviving abiotic stressors. A lack of phosphorous (P) causes blooms to abscise, which decreases the yield (2,4). However, according to Mohamed et al. (5), employing appropriate fertilizer sources is a practical cultivation technique since it can boost the efficiency of phosphorus usage and enhance crop quality and yield. One of the most crucial elements in raising the potential yield of plants is the balanced usage of various nutritional elements. After nitrogen, phosphorus has been found to be the most effective necessary nutrient in many agricultural production systems (6,7). The strawberry (Fragaria x ananassa Duch.), a member of the Rosaceae family, is a significant crop in many nations due to its numerous nutritional and therapeutic advantages as well as its capacity to adapt to a variety of environmental circumstances. Over the last 20 years, strawberry production has tripled worldwide. According to the majority of authorities, the strawberry plant originated in North America and has since migrated to other nations (8,9). The nutritional value of strawberries is excellent. Vitamins, minerals, organic acids, 1% fiber, 10% sugars, and 85–90% water are all present in fresh fruits. Among fruits and vegetables, it has the highest iron content and a high proportion of vitamin C (10,11). Phosphorus improves early plant maturity and stalk strength, increases root growth, grain,

fiber, and forage yield, and fosters resistance to winter mortality and root rot disease (12,13). The functioning of enzymes necessary for growth and essential processes depend heavily on phosphorus (13). Because it aids in the storage and transfer of energy within plants during the process of photosynthesis, phosphorus is frequently referred to as the "energizer" and is a crucial nutrient for the growth, vigor, and overall health of all plants (14). Based on the above, the present study was planned and designed to determine the effect of phosphorus spraying on the physiological characteristics and productivity of strawberries.

Materials and Methods

Strawberry transplants from commercial nurseries were used in the experiment, which was conducted in a 9 m × 25 m unheated polyethylene tunnel. The transplants were placed in a raised-bed system with a 20 × 80 cm spacing, mulched with black plastic, and double row plants spaced 25 cm apart. On October 30, the transplants were sterilized with a fungicide solution before being placed on the ground to prevent fungal diseases.

Experimental design

The research is conducted using a factorial experiment (3 * 3) with three replications in accordance with the Randomized Complete Block Design (RCBD). Three phosphorus values (0, 2, and 4) mg.L-1 were the contributing factor. Ten plants are included in each of the experiment's experimental units, and statistical analysis is done using the Genstat tool.

Studied indicators

The measurements which were recorded by taking 5 plants (each treatment) from an experimental unit in all three cuttings:

1. Fruit number (fruit, plant-1)

This is given by the total fruit produced by all fairies divided by the number of plants in the experimental unit.

2. Weight of the fruit (gm. fruit-1)

Where It is computed as follows:

Fruit weight (gm. fruit-1) = total weight of fruits recorded from one plant/number of fruits counted in the same plant.

3. Fruit value in case of total sugars (gm. 100 gm fresh weight-1):

A Digital Refract meter, model DR201-95 (Kruss, German was used for determination of brix value (15).

Results and discussion

Table 1 shows the effect of spraying with phosphorus on the number of fruits in strawberry plants. At concentration 0, the average number of fruits was 7.2±1.48 (fruit. plant^{-1}), while at concentration 2 mg. L-1, the average number of fruits was 10.2±1.58 (fruit. plant^{-1}), and the average number of fruits at concentration 4 mg. L^{-1} was 12.2±1.79 (fruit. plant^{-1}).

Table (1): the effect of Phosphorus spraying on the number of fruits

Phosphorus conc. / Plant No.	0	2 mg.L-1	5 mg.L-1
No. 1	8	9	11
No. 2	7	10	12
No. 3	9	12	14
No. 4	6	11	10
No. 5	5	8	14
Mean SD	7.2±1.48	10.2±1.58*	12.2±1.79 **

* mean there is a significant (P≤0.05) difference, ** mean there is a high significant (P≤0.05) difference.

Energy chemicals including ATP, ADP, NADP, and NADPH are made of phosphorus. The photosynthetic mechanism and other energy-demanding activities in plant metabolism use the energy in these molecules to generate carbohydrates. Phosphorus is also included in the structure of the nucleic acids that make up DNA, RNA, genes, and chromosomes. Phosphorus plays a crucial role in nutrient absorption against the forces of osmosis, cell division, leaf expansion, and fruit development and maturity (16,17). This supports the findings of the current study, which showed that phosphorus directly increased the number of fruits per plant. The efficient utilization of carbohydrates and their movement in plants depend on phosphorus being adequate in plant tissues.

Table 2 shows the effect of spraying with phosphorus on the weight of fruits in strawberry plants. At concentration 0, the average weight of fruits was 14.86±1.75 (gm. plant-1), while at concentration 2 mg. L-1, the average weight of fruits was 19.34±3.63 (gm. plant-1), and the average weight of fruits at concentration 4 mg. L-1 was 28.02±8.3 (gm. plant-1).

Table (2): the effect of Phosphorus spraying on the weight of fruits

Phosphorus conc. / Plant No.	0	2 mg.L-1	5 mg.L-1
No. 1	14.9	15.7	20.1
No. 2	14.5	21.1	32.5
No. 3	17.8	24.6	31.5
No. 4	13.5	18.9	18.5
No. 5	13.6	16.4	37.5
Mean SD	14.86±1.75	19.34±3.63*	28.02±8.3 **

* mean there is a significant (P≤0.05) difference, ** mean there is a high significant (P≤0.05) difference.

Based on the finding for various concentration levels of phosphorus (Table 2). According to Shehata et al. (18), the compost + mineral fertilizer application gave heavier fruits (11.98 g); however, fruit weight of the organic Albion type strawberry became 18.03 g according to Sener and Turemis (19). Strawberries in low tunnels grew in St. Paul city weighed 14.05 g, while it was 18.25 g for Morris city; reported by Petran et al. (20). According to Soni et al. (21) the application of vermicomposting, poultry manure, and phosphor (11.83 g) reached the maximum fruit weight in the Sweet Charlie strawberry cultivar. During their investigation, Cabiloski et al. (22) found no variation in fruit weight between treatments.

Table 3 shows the effect of spraying with phosphorus on the total sugars of fruits in strawberry plants. At concentration 0, the average total sugars of fruits were 3.04±0.14 (gm. 100 gm fresh weight^{-1}), while at concentration 2 mg. L-1, the average total sugars of fruits were 3.77±0.06 (gm. 100 gm fresh weight^{-1}), and the average total sugars of fruits at concentration 4 mg. L-1 was 4.13±0.11 (gm. 100 gm fresh weight^{-1}).

Table (3): the effect of Phosphorus spraying on the total sugars of fruits

Phosphorus conc. / Plant No.	0	2 mg.L-1	5 mg.L-1
No. 1	3.21	3.84	4.18
No. 2	3.13	3.78	4.09
No. 3	2.89	3.73	4.25
No. 4	2.92	3.81	3.95
No. 5	3.03	3.68	4.17
Mean SD	3.04±0.14	3.77±0.06*	4.13±0.11 **

* mean there is a significant (P≤0.05) difference, ** mean there is a high significant (P≤0.05) difference.

In agricultural production, yield is the most crucial and ultimate objective to attain in terms of unit area efficiency. Additionally, yield is the primary determinant of agricultural production revenue. Consumer demand is positively impacted by strawberry fruit's sweetness, which is a crucial characteristic of marketable fruit. The amount of soluble solids in strawberry fruit, of which roughly 80% or 90% is sugar (23), is a crucial component that influences the fruit's flavor. Unlike other strawberry cultivars, Albion has a higher sugar content (24). In 2010, 2011, 2011 and 2012 Paparozzi et al. (24) examined the selection of strawberry varieties in relation to fruit production, number and sweetness of fruits as well as phytonutrient contents and reported a total sugar content ranging from 2.18–16.15 mg 100 g^{-1}, 2.96–8.75 mg 100 g^{-1} and 4.18–9.98 mg 100 g^{-1} respectively. With Albion strawberry cultivar, they obtained the total sugar of 16.15 mg 100 g^{-1} in 2010; 6.28 mg 100 g^{-1} in 2011 and 5.65 mg 100 g^{-1} for the year ago latter mentioned fruit used at concentrations (compound). Mahmood et al., in their investigation, (25) applied HPLC to determine certain soluble sugars and organic acids in strawberry, cherry and mulberry fruits from different ripeness stages. They concluded that TSV in strawberries varied from 3.61 to 4.95 mg per 100 g of the sample. The Albion type of strawberry contained the lowest total sugar value, with a concentration of 5.38 mg, 100 g^{-1} and the other varieties from 4.44 to 6.28 (mg.100 g^{-1}) (23).

Conclusions

Based on the results of the current investigation, it was found that spraying with phosphorus plays an important role in improving the physiological and productive characteristics of strawberry fruits. Therefore, phosphorus can be used to improve strawberry productivity.

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