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Impact of Different Organic Extracts on Growth and Yield of Chili Pepper (*Capsicum frutescens* L.)

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Abstract

There are many ways to increase the quality and productivity of the chili pepper plant, one of which is the use of organic fertilizer, to improve the properties of the soil as well as provide the nutrients needed. A pot experiment was carried out in the greenhouse of the Faculty of Agriculture, Samarra University, during the agricultural season 2022, with the aim of studying the effect of using seven types of fertilizers (bread yeast fertilizer A2, decomposed cow dung fertilizer A3, tea residue fertilizer A4, coffee residue fertilizer A5, rice soaked fertilizer A6, and chemical fertilizer A7in addition to the control A1) on the growth and yield of chili pepper using a randomized complete block design with four replications. The results were as follows: Fertilizer treatment A3 was significantly superior in vegetative growth characteristics, as the plant length reached 81.69 cm, stem diameter 7.95 mm, number of branches 10.75, and number of leaves 95.0 leaves. $Plant^{-1}$, leaf area 178.14 cm^2, number of fruits 34.26 fruits. $Plant^{-1}$, and total yield 1.76 $kg.plant^{-1}$, while treatment A2 excelled in the characteristics of root length 27.84 cm and root fresh weight 26.75 g. Fertilization treatment A4 had the lowest rate in all traits.

1. Introduction

Chili peppers (*Capsicum frutescens* L.) is an important summer vegetable crop. It is one member of Solanaceae family. It is a rich source of vitamins A and C, carotenoids and antioxidant compounds as polyphenols. In addition it contains good proportions of potassium, phosphorus, magnesium, iron and calcium. Its fruits contain a group of effective alkaloids called capsaicinoids, which are responsible for the hot taste, and one of the most famous of its compounds is (capsaicin3) NO27H18C, which is used in curative and preventive uses such as treatment of rheumatism, pain medication, antibacterial and antifungal agents, prevention of some types of cancer, reducing cholesterol and burning body fat [1], [2]. Organic agriculture is the old modern technology for producing vegetable crops by natural methods without adding manufactured chemicals and giving nutrients that the plant needs in a balanced manner by adding organic materials with a certain level of degradation suitable for soil, climate and crop conditions [3]. The organic agricultural is a management and production systems that promote biodiversity and soil bioactivity, and depend on reducing off-farm production inputs and on agricultural practices aimed at restoring and maintaining the vital balance [4].

Organic matter has a major and important role in soil ecosystems, as it improves the most physical, chemical and biological properties of soil, then lead to effect on soil productivity [5]. Organic matter is also an important source of nutrients in the soil such as nitrogen, phosphorus, sulphur and a number of microelements. So its presence in the soil reflects positively on plant growth and productivity [6], [7]. There are many studies mentioned that the addition of organic fertilizer with inorganic fertilizer increased the growth and productivity of chili pepper. The result of studies also showed that the mixture of compost tea and dry yeast used in fertilizing sweet pepper led to a significant increase in vegetative growth, quality of fruits (height, diameter and fresh weight), total yield, leaf mineral content (N, P, and K) and fruit content of nutritional value (calcium), and vitamin C [8].

Organic agriculture preserves the environment, as it reduces water pollution with chemicals and pesticides, reduces the use of non-renewable sources and manufactured materials, and thus reduces global warming. In addition, the use of organic waste will reduce production costs and help obtain safe, healthy food. Due to the spread of the phenomenon of pollution in agricultural products, soil and water with chemical fertilizer and pesticides, which has led to an urgent need to use fertilizers based on natural substances in agriculture Instead of chemicals [9]. However, this study aimed to know impact of extracts of bread yeast, cow dung, coffee and tea residues and rice husk on growth and yield of chili pepper plants.

2. Theoretical Part

The experiment's location and growing technique: The pots experiment was conducted in the spring season of 2022 at the greenhouse of the faculty of agriculture - Samarra University. Three seeds were sown in pots (10 kg) on 21/2/2022, and after a month of sowing, they were stayed two seedlings in each pot. After that, had been adding 250 ml of each extract weekly. The plants were irrigated when needs. This experiment was carried out as simple experiment according to Randomized Complete Bock Design (RCBD) with four replications. It consisted of seven treatments. So, the total of experimental units are 28 units. The experimental unit contained two plants. The analysis by ANOVA was carried out using the SPSS software (version 24). The importance of the differences among treatments was approximated using the least significant difference test (LSD) at level 0.05.

3. Experimental Procedure

Treatments:
A1: Control treatment.
A2: Fertilization by extract of baking yeast, by dissolving (6 g L^{-1}).
A3: Fertilization by extract of decomposed cow dung (5 kg 20 L^{-1}).
A4: Fertilization by tea extract (6 g L^{-1}).
A5: Fertilization by coffee extract (6 g L^{-1}).
A6: Fertilization by rice extract (100 g L^{-1}).
A7: Chemical fertilization (6 g of NPK (20:20:20) per litter of water).
Studied traits: Plant height (cm), stem diameter (mm), number of branches.plant^{-1}, number of leaves.plant^{-1}, root length (cm), root fresh weight (g), number of fruits.plant^{-1}, fruit weight (g),
Leaf area (cm^2) was calculated by the following equation [10]:

$$\mathbf{LA=0.57\times LW} \quad \text{.....} \quad \mathbf{(1)}$$

Where: LA: leaf area, W: leaf width, L: leaf length. Total yield (kg plant^{-1}) was calculated by the following equation. [11]:

$$\mathbf{Total\ yield\ (kg\ plant^{-1}) = average\ number\ of\ fruits\ per\ plant \times average\ weight\ of\ one\ fruit} \quad \text{.....} \quad \mathbf{(2)}$$

4. Results and Discussion

4.1. Plant Height

Table (1) indicates that using organic extracts had a significant effect on the height of pepper plants. All treatments, except for the tea extract, had highest values comparison to control treatment. At the same time, Figure (1) it becomes evident that fertilizing with decomposed cow dung extract increased significantly 105.92% compared with the control treatment. This could be attributed to the high percentage of nitrogen present in cow

dung, which promotes vegetative growth and increases the height of the plant. These results are consistent with previous studies. For instance, [8] found that a combination of tea fertilizer and dry yeast significantly increased the height of sweet pepper plants. Similarly, [12] and [7] reported that organic fertilizers have a positive effect on the height of chili pepper plants. Additionally, [13] discovered that a mixture of spraying liquid organic fertilizers and biofertilizers led to an increase in plant height when investigating the influence of organic and biofertilizers on the growth of hot pepper.

Table (1): The effect of organic fertilization treatments on the vegetative characteristics of pepper.

Treatments	Plant height (cm)	Stem diameter (mm)	Number of branches.plant^{-1}	Number of leaves.plant^{-1}	Leaf area (cm^2)
A1	39.67	6.02	7.50	73.00	156.63
A2	79.58	7.44	9.75	89.00	169.70
A3	81.69	7.95	10.75	95.00	178.14
A4	30.14	2.26	5.00	60.75	130.78
A5	54.18	4.79	7.25	71.50	147.44
A6	75.94	7.02	8.75	88.25	164.65
A7	52.68	3.60	6.50	69.75	139.98
LSD	3.85	0.39	0.90	2.59	5.11

Table (2): Effect of organic fertilization treatments on roots, fruits and total yield of pepper.

Treatments	Root length (cm)	Root fresh weight (g)	Number of fruits.plant^{-1}	Fruit weight (g)	Total yield.plant^{-1} (kg)
A1	26.70	25.46	43.71	28.39	1.24
A2	27.84	26.75	48.50	33.39	1.62
A3	25.81	25.03	51.50	34.26	1.76
A4	15.06	12.62	32.14	24.16	0.78
A5	23.39	23.53	41.87	26.21	1.10
A6	24.78	24.78	47.06	29.32	1.38
A7	20.20	21.13	41.31	25.69	1.06
LSD	0.69	1.16	1.37	0.48	0.08

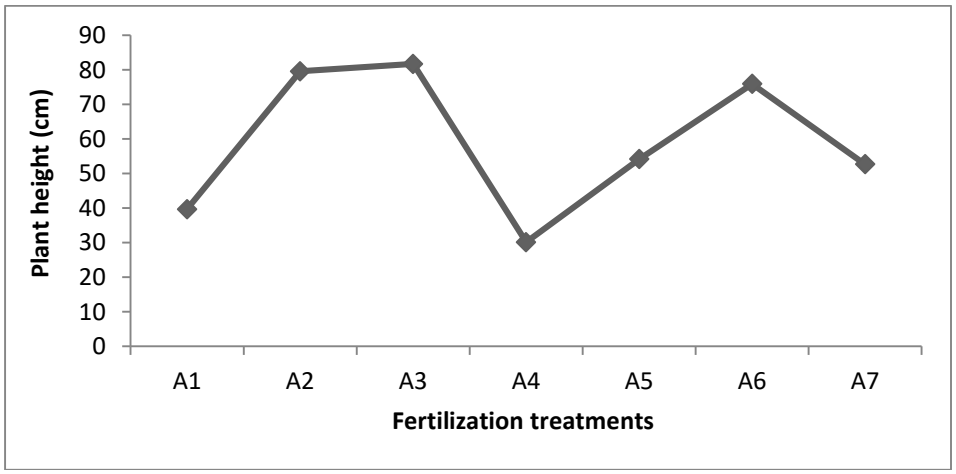

Figure (1): Effect of fertilization treatments on plant length.A1: Control treatment, A2: Fertilization by extract of baking yeast, A3: Fertilization by extract of decomposed cow dung, A4: Fertilization by tea extract, A5: Fertilization by coffee extract, A6: Fertilization by rice extract, A7: Chemical fertilization.

4.2. Stem Diameter

Table (1) shows that using organic fertilizer results in a significant increase in stem diameter, except for fertilization treatments with tea and coffee extracts and chemical fertilizer, which did not significant difference with control treatment. Figure (2) displays that fertilization treatment with decomposed cow dung extract gave significant increment comparison to control treatment by 32.05%. This may be due to the fact that the fertilizer is organic and provides the elements N, P, K, Ca, Mg, and S. It releases nutrients slowly and continuously, reducing nutrient loss due to soil leaching. This finding is consistent with research in [7], [12], and [14], which found that organic and inorganic fertilizers produce the best results. However, [13] disagreed, stating that the chili pepper plant's diameter was not significantly affected by the treatment.

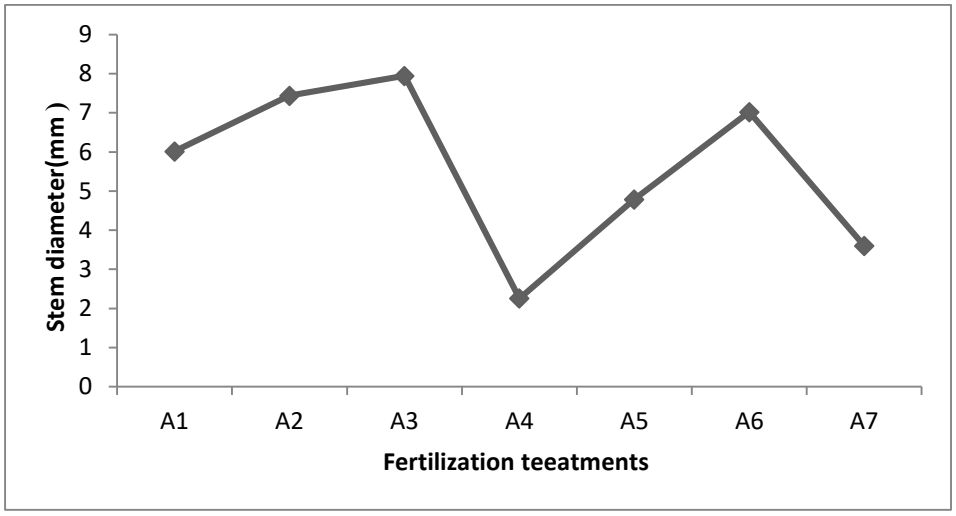

Figure (2): Effect of fertilization treatments on stem diameter. A1: Control treatment, A2: Fertilization by extract of baking yeast, A3: Fertilization by extract of decomposed cow dung, A4: Fertilization by tea extract, A5: Fertilization by coffee extract, A6: Fertilization by rice extract, A7: Chemical fertilization.

4.3. Number of Branches.plant^{-1}

Table (1) refers that using organic extracts had a significant impact on the number of branches in pepper plants, with the exception of the fertilization treatments (tea, coffee extracts and chemical fertilizer), which did not significant difference with control treatment. Figure (3) illustrates that spraying decomposed cow dung extract resulted in a 43.33% increase in the number of branches in pepper plants compared to the control treatment. It's possible that the reason for the observed differences is due to the effect of organic fertilizers on plants. The nutrients found in organic fertilizers, such as nitrogen, phosphorus, potassium, vitamins, and growth regulators, activate many enzymes and biological and physiological processes in plants. This stimulation results in plant growth, as well as cell division and elongation. As a result, there is an increase in plant height, number of branches, number of leaves, and leaf area. This is supported by a study [8] where it was found that a combination of compost tea fertilizer and dry yeast led to a significant increase in the number of branches in sweet pepper plants.

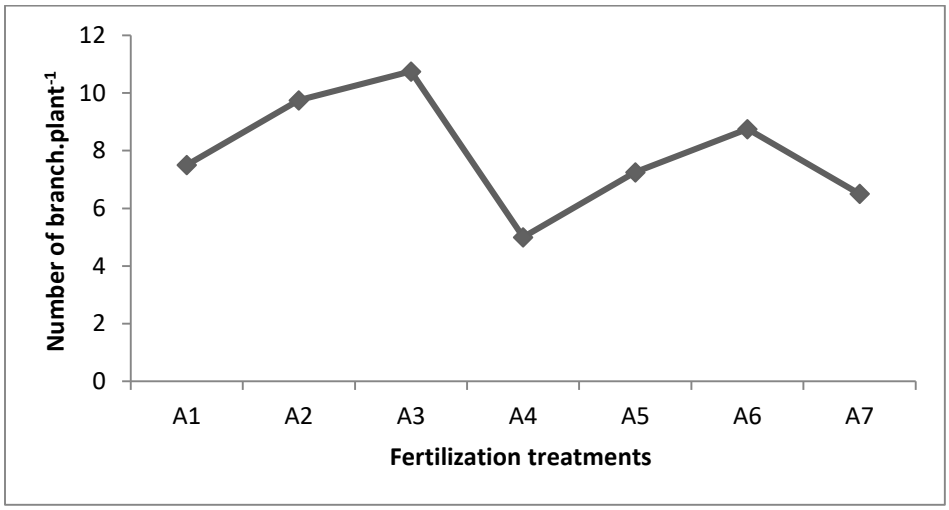

Figure (3): Effect of fertilization treatments on number of branches.plant-1. A1: Control treatment, A2: Fertilization by extract of baking yeast, A3: Fertilization by extract of decomposed cow dung, A4: Fertilization by tea extract, A5: Fertilization by coffee extract, A6: Fertilization by rice extract, A7: Chemical fertilization.

4.4. Number of Leaves.plant^{-1}

Table (1) shows that there were significant positive differences in the number of leaves among the organic fertilization treatments, except for the coffee, tea extracts and chemical fertilizer, which did not significant difference to control treatment. Figure (4) shows that the application of decomposed cow dung extract as a fertilizer led to a 30.14% increase in the number of leaves compared to the control treatment. The possible reason behind the superior performance of organic fertilizers is the increase in carbon metabolism and the accumulation of nutrients, which ultimately leads to an improvement in the plant's vegetative characteristics and an increase in the number of leaves [11]. These findings are consistent with previous studies cited in references [8] and [15].

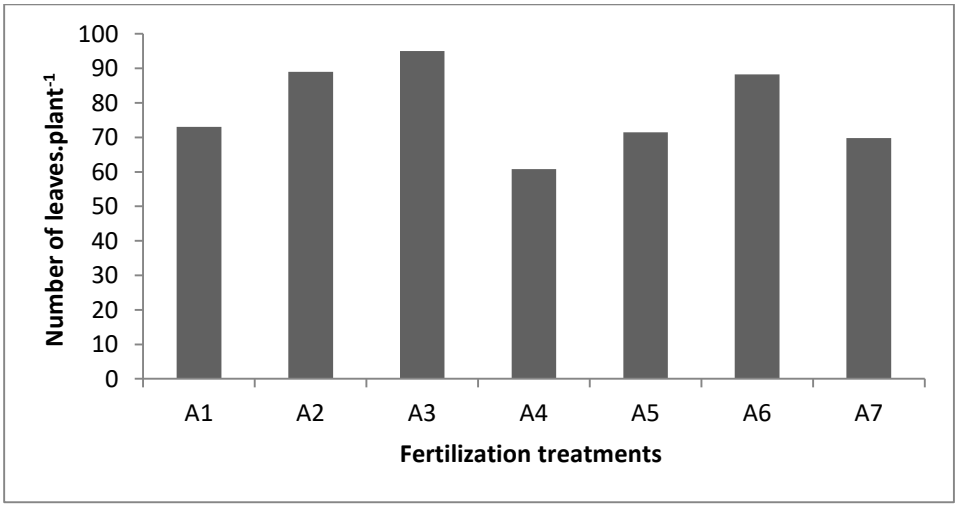

Figure (4): Effect of fertilization treatments on number of leaves.plant-1. A1: Control treatment, A2: Fertilization by extract of baking yeast, A3: Fertilization by extract of decomposed cow dung, A4: Fertilization by tea extract, A5: Fertilization by coffee extract, A6: Fertilization by rice extract, A7: Chemical fertilization.

4.5. Leaf Area (cm^2)

Table (1) appears that all types of organic extracts, except tea, coffee extracts and chemical fertilizer, have a positive effect on the leaf area of pepper plants. The increase value of leaf area was found to be the highest (13.73%) in the case of fertilization with decomposed cow dung extract compared to the control treatment Figure

(5). Organic fertilizers play a crucial role in enhancing the percentage of nitrogen in plants, which, in turn, increases the concentration of chlorophyll in leaves and encourages growth. This increase in cell size leads to an overall increase in the plant's cover and leaf area. The findings support the previous research studies (16) and (8) which also found that organic fertilizers significantly enhance the leaf area of pepper plants.

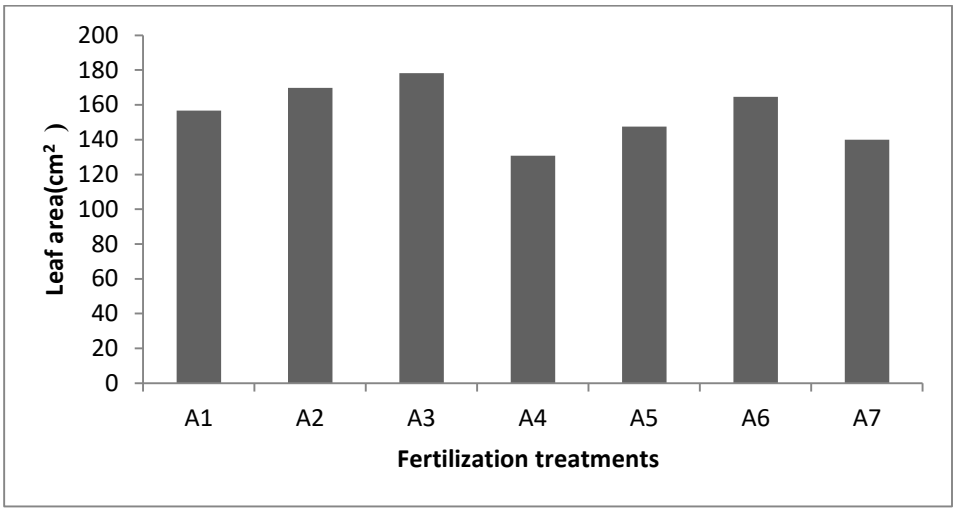

Figure (5): Effect of fertilization treatments on Leaf area. A1: Control treatment, A2: Fertilization by extract of baking yeast, A3: Fertilization by extract of decomposed cow dung, A4: Fertilization by tea extract, A5: Fertilization by coffee extract, A6: Fertilization by rice extract, A7: Chemical fertilization.

4.6. Root Length

According to the findings in Table (2), there were significant negative differences in root length among the different fertilization treatments. The tea extract fertilization treatment resulted in the lowest root length rate, while the yeast extract fertilization treatment performed better than the control treatment Figure (6). The root length increased by 4.27% compared to the control treatment. Organic fertilizers have a significant impact on improving the physical and chemical properties of soil, they increase the availability of necessary elements and water retention while activating beneficial micro-organisms in the soil, these micro-organisms convert non-absorbable nutrients into simple substances that are easy to absorb, leading to positive effects on root length.

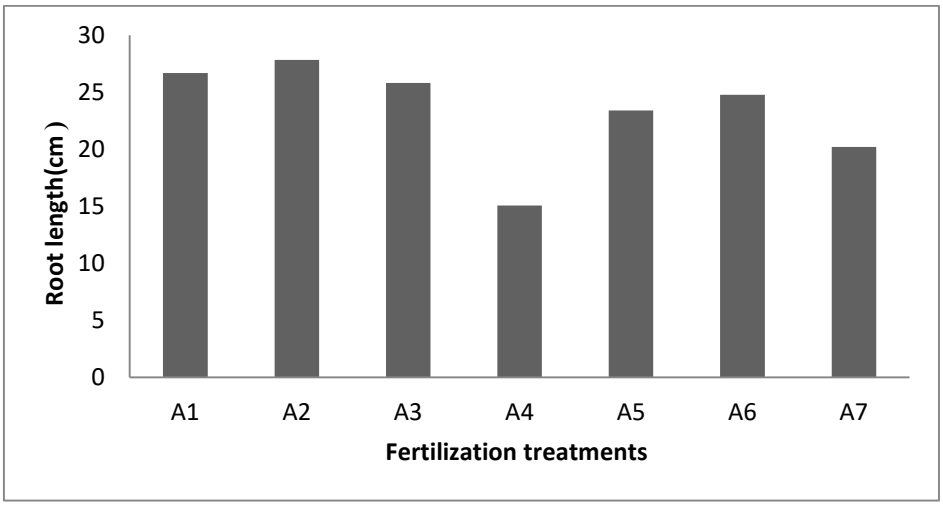

Figure (6): Effect of fertilization treatments on root length. A1:Control treatment, A2:Fertilization by extract of baking yeast, A3:Fertilization by extract of decomposed cow dung, A4:Fertilization by tea extract, A5:Fertilization by coffee extract, A6:Fertilization by rice extract, A7: Chemical fertilization.

4.7. Root Fresh Weight (g)

Table (2) indicates significant negative differences in the weight of fresh roots. The control treatment outperformed the fertilization treatments, except for the one with yeast extract. In Figure (7), it is evident that the fertilization treatment with yeast extract outperformed all other treatments. The weight of fresh roots increased by 5.07% compared to the control treatment. This may be due to the important role that baking yeast plays in the maturation of chloroplasts and the secretion of growth stimulators such as cytokines. Cytokines stimulate cell proliferation and differentiation, thus controlling the growth of the vegetative and root systems. These findings align with the results reported in reference [19].

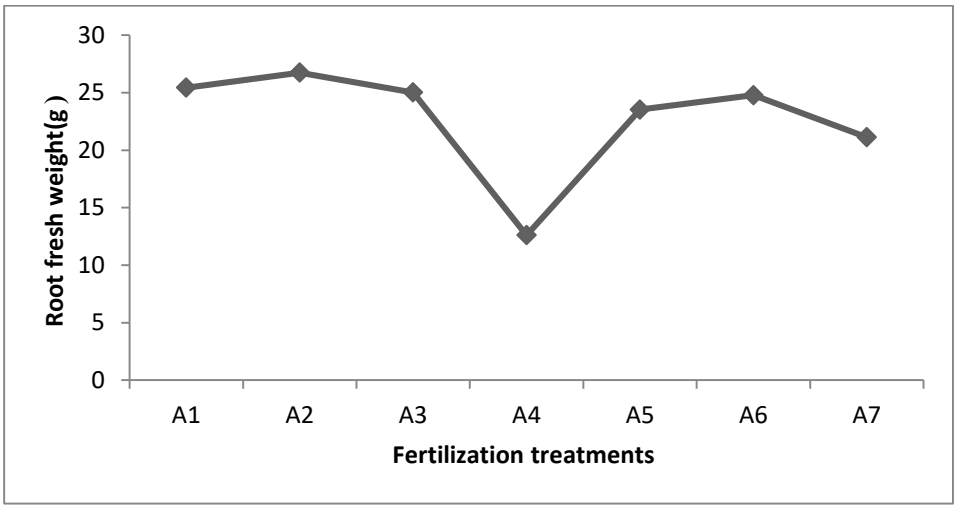

Figure (7): Effect of fertilization treatments on root fresh weight. A1: Control treatment, A2: Fertilization by extract of baking yeast, A3: Fertilization by extract of decomposed cow dung, A4: Fertilization by tea extract, A5: Fertilization by coffee extract, A6: Fertilization by rice extract, A7: Chemical fertilization.

4.8. Number of Fruits.plant^{-1}

The results presented in Table (2) indicate a significant increase in the number of fruits per plant when using organic fertilization treatments, except tea, coffee extracts and chemical fertilizer, which did not perform better than the comparison control treatment. From Figure (8), it is clear that the highest increase in the average number of fruits on pepper plants was for the fertilization treatment with decomposed cow dung extracts, where the increase rate reached 10.96% compared to the control treatment, while the lowest rate was for the fertilization treatment with tea extract. The significant effects observed in the growth of plants may be attributed to the application of both small and large organic fertilizer nutrients. This helps in increasing vegetative growth, main branches, leaves and leaf area, and ultimately, flowers. This leads to increased productivity and growth of the plant, resulting in a higher number of fruits. These findings are consistent with previous studies [7] and [20].

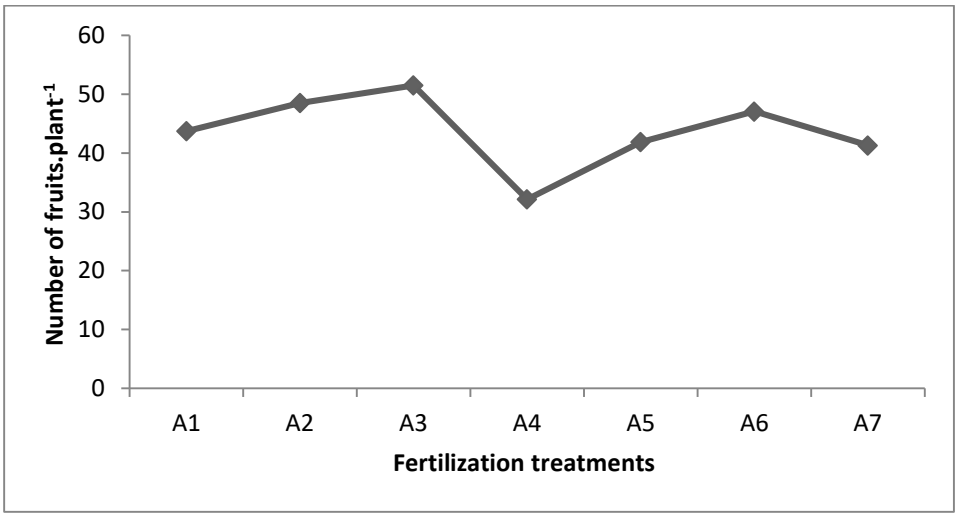

Figure (8): Effect of fertilization treatments on number of fruits.plant-1. A1: Control treatment, A2: Fertilization by extract of baking yeast, A3: Fertilization by extract of decomposed cow dung, A4: Fertilization by tea extract, A5: Fertilization by coffee extract, A6: Fertilization by rice extract, A7: Chemical fertilization.

4.9. Fruit Weight

Table (2) shows the significant response of the weight of pepper fruits to the organic fertilization treatments, except for fertilization with tea, coffee extracts and chemical fertilizer, as it was less than the control treatment. Figure (9) also shows that the highest value of fruits weight was obtained from adding decomposed cow dung extract, where the percentage of increase was 20.68% compared to the control treatment. Organic fertilizers are rich in nitrogen, as nitrogenous compounds constitute an important part of the total weight of plantsو and increasing nitrogen stimulates the formation of protoplasm, increasing cells, and plant growth and productivity, pepper plants in particular, have a relatively large demand for the nutrients necessary for the plant to grow and form fruits, and its development [19]. The weight of the pepper fruit increased with the use of organic fertilizer, as previously reported in studies [7], [11], and [20].

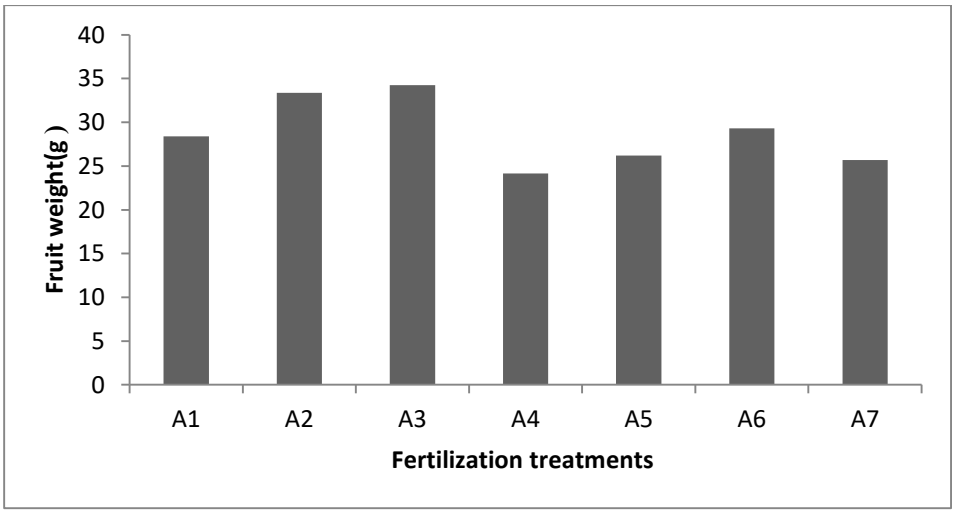

Figure (9): Effect of fertilization treatments on fruit weight. A1: Control treatment, A2: Fertilization by extract of baking yeast, A3: Fertilization by extract of decomposed cow dung, A4: Fertilization by tea extract, A5: Fertilization by coffee extract, A6: Fertilization by rice extract, A7: Chemical fertilization.

4.10. Total Yield

The results showed that organic fertilization significantly increased the total yield compared to the control treatment, except for the fertilization by tea, coffee extracts and chemical fertilizer (Table 2). Figure 10 shows that the highest treatment value fertilization by extract of decomposed cow dung, which increased by 41.94%

over the control treatment. The effect of organic fertilizer may be due to an increase in N and K elements in the plant, which are of great importance in many vital processes within the plant's tissue, resulting in improved nutrient needs of the plant, thereby improving vegetative growth and increasing the area of leaves, which in turn increase carbonaceous representation products, the accumulation of carbohydrates and proteins, their transmission to fruits, and their quality by increasing their number and weight, and thus increasing the yield [11]. These results are consistent with [8], [11].

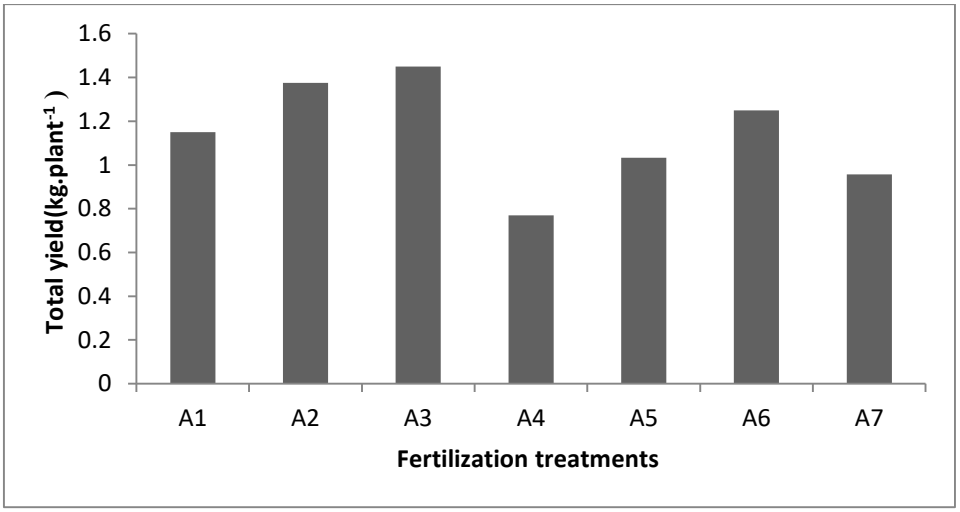

Figure (10): Effect of fertilization treatments on total yield. A1: Control treatment, A2: Fertilization by extract of baking yeast, A3: Fertilization by extract of decomposed cow dung, A4: Fertilization by tea extract, A5: Fertilization by coffee extract, A6: Fertilization by rice extract, A7: Chemical fertilization.

5. Conclusions

Farmers used to consume chemical fertilizer. In the past, the shift to organic fertilizer farming began due to its many advantages. It is low-cost, increases plant growth and productivity, improves quality, improves soil fertility and ensures a healthy and safe environment. Using plant and animal residues as organic fertilizer has many benefits in addition to getting rid of these residues and turning them into cheap fertilizer. Accordingly, we applied this experiment using seven types of fertilizers (fertilization by extract of baking yeast, fertilization by extract of decomposed cow dung, fertilization by tea extract, fertilization by coffee extract, fertilization by rice extract and chemical fertilization, in addition control treatment) and observing their effect on the growth and productivity of the chili pepper plant, the results showed superiority of extract of decomposed cow fertilizer treatment in the characteristics of plant height, stem diameter, number of branches, number of leaves, leaf area, number of fruits, fruit weight, and total yield, while the treatment of fertilization by extract of baking yeast excelled in the characteristics of root length, and fresh weight of roots. Fertilization treatment with tea extract had the lowest rate in all traits.

Conflict of Interest: The authors declare that there are no conflicts of interest associated with this research project. We have no financial or personal relationships that could potentially bias our work or influence the interpretation of the results.

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