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Proceeding Paper

Experimental Study on the Influence of Chitosan-Based Solution on Eggplant and Green Pepper Plants †

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Abstract: Water shortages are one of the main factors affecting plant growth, development, and yield, particularly in poor counties. Using chitosan biopolymer improves water efficiency and plant growth. It was therefore decided to investigate the effects of a chitosan-based solution on eggplant and pepper growth, moisture content, and thermal conductivity. After a 30 day period of evaluation, the plant whose soil contained chitosan's results showed that the soil moisture content was higher than the plant whose soil did not contain chitosan. As a result of the use of the chitosan solution prepared in this study, water consumption was reduced while watering the plants by almost 170%. The electrical conductivity experiment revealed that the plants treated with the chitosan solution had higher electrical conductivity than the plants irrigated with water only. Results also demonstrated that eggplant plants preserve water compared to the pepper plant by roughly 10%.

Keywords: chitosan; biopolymer; eggplant; green pepper; water consumption

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1. Introduction

One of the most popular biopolymers due to its eco-friendly properties and its ability to facilitate the use of reagents effectively while reducing possible waste is chitosan [1]. One of the key reasons that chitosan is advantageous for plant development is that it is a biopolymer derived from chitin, a natural polymer found in the shells of crustaceans such as shrimp and crabs [2]. In the soil and on the roots of plants, chitosan interacts positively with negatively charged molecules. This interaction can increase the availability of nutrients in the soil and improve plant uptake [3]. Many plants, including gerbera, crop, and several other plants, have shown positive growth effects when treated with chitosan.

When used in fertilizers, chitosan stands out from other materials because of its unique capacity to improve plant growth and development in a variety of ways. Studies have shown that chitosan helps plants germinate their seeds, develop their roots, absorb nutrients, and adapt to stress [4]. It can also increase the activity of helpful bacteria in the soil, which can boost plant development even more. Furthermore, chitosan has been discovered to have antifungal and antibacterial characteristics, which can aid in the protection of plants against a variety of illnesses [5].

There are a number of qualities that make chitosan a useful fertilizer ingredient. Firstly, it has a high cation exchange capacity (CEC), which means it can retain and release nutrients like nitrogen, phosphorus, and potassium [6]. This feature makes it an efficient slow-release fertilizer, helping plants absorb nutrients over a longer period of time [7]. Secondly, chitosan has been shown to improve soil structure. It can improve soil aggregation and water-holding capacity, which increases nutrient availability for plants. Aside from encouraging good soil bacteria, chitosan can also aid in the management of plant diseases and the development of plants [8]. Thirdly, chitosan has been shown to promote plant growth and development. It can increase the number of lateral roots and root biomass, resulting in increased nutrient intake and plant development. In addition to boosting the growth and yield of plants, chitosan boosts the activity of photosynthetic enzymes [9].

2. Methodology

2.1. Materials

Chitosan powder (CS) was obtained from Weifeng Kehai Ltd., Shandong, China with a molecular weight of 471 kDa and a degree of deacetylation of 84% $\pm$ 2% [10]. Glacial acetic acid with a Grade $\geq$ 99.7%, was used.

2.2. Solution Preparation

A 2.5% chitosan solution was prepared by dissolving 2.5 g of chitosan powder in 100 mL of tap water containing 1 v/v % acetic acid. First, 2.5 g of chitosan powder was added to 100 mL of tap water and left under a continuous stirring for 10 min using a magnetic stirrer. Then, 1 mL of acetic acid was added to the chitosan-water mixture in a dropwise. The solution was left under continuous stirring at room temperature for 3 h to ensure a uniform chitosan solution was obtained.

2.3. Examination

Synthetic fertilizers were used in this study for both eggplant and pepper. Soil moisture and electrical conductivity were measured using a sensor test meter that been used for regular check of the plants' soil effects. The soil moisture meter will indicate whether the soil is dry, moist, or wet. The electrical conductivity test is a rapid and affordable method for figuring out how much salt is in a solution. It offers gardeners a trustworthy way to check fertilizer levels.

2.4. Implementation

This study was conducted to examine the influence of spraying chitosan solution on the synthetic fertilizer soils of eggplant and pepper plants. Plants were evaluated using two mechanisms: (1) watered with an approximate quantity of 400 mL of water per day, and (2) with the use of chitosan solution. A similar procedure was followed for method #1, where in this experiment, water was added only once the soil moisture was reduced to 40%, which is the minimum recommended agricultural soil moisture. Chitosan solution was sprayed with an approximate quantity of 40 mL each time.

Soil moisture level and electrical conductivity were measured once a day and the next day before water irrigation.

3. Results and Discussion

Figure 1 displays the moisture content of pepper and eggplant soil's plants for 30 days of continuous evaluation. In this study, the moisture content was tested prior to the irrigation for the next day. According to moisture analysis results, daily watering was required for both pepper and eggplant plants in order to achieve the minimum water requirements for plants to grow healthy, 40% moisture content. On the other hand, soils with chitosan solutions have survived for an average period of 4 days before reaching 40% moisture content. During the period of 4 days, the chitosan solution was sprayed only once, followed by water irrigation, where no water was added for the rest of the days. Once the soil's moisture content approached 40%, another batch of chitosan solution and water irrigation were used. From this, a significant reduction in water consumption of soils with chitosan solution implantation can be seen. It can also be noticed from the presented data that eggplant soil was almost constant, 40%, during the entire period of evaluation, whereas a slight reduction and fluctuation was observed in the pepper's soil.

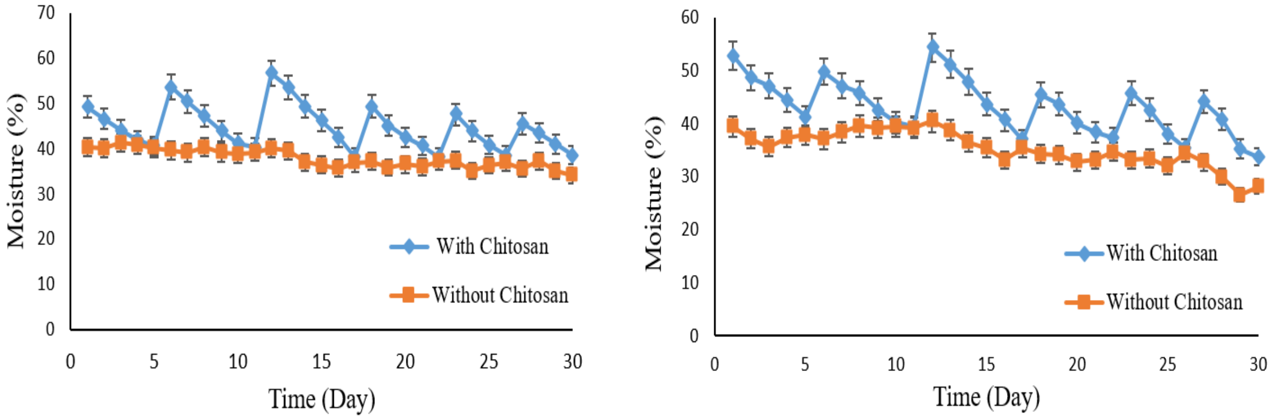

Figure 1. Measured moisture content of Pepper (**Right**) and Eggplant (**Left**) soil's plants.

A continuous 30-day evaluation of the electrical conductivity of pepper and eggplant soil's plants is presented in Figure 2. It was observed that soils with chitosan solutions have slightly higher electrical conductivity as compared to water-based irrigation ones. In addition, no notable difference was noticed in the electrical conductivity between eggplant and pepper soils. What is more interesting is that it was clearly observable that the next day of chitosan solution addition, the electrical conductivity increased significantly, then decreased gradually. For instance, the electrical conductivity of day one for soils with chitosan solution is nearly 360–380 ppm, whereas soils with water-based irrigation are about 310 ppm. The most captivating part here is that the electrical conductivity increased slightly with time, specifically for soils treated with the chitosan solution. For example, in the first few days the electrical conductivity ranges between 300 and 400 ppm; however, in the last ten days of evaluation period, the range of electrical conductivity was 400–500 ppm. Thus, perhaps due to the fact of chitosan biodegradation nature and/or because of the effectiveness of its preservation of soil salts.

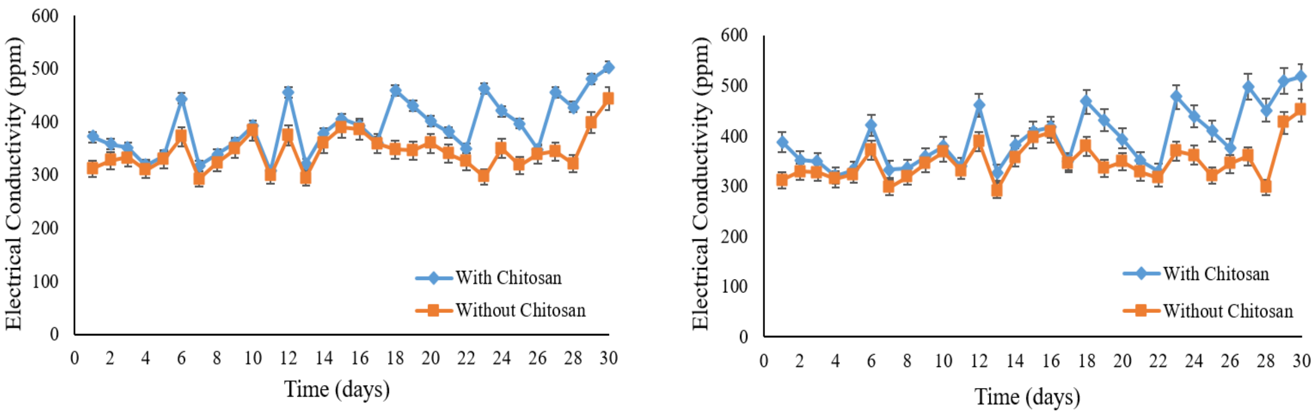

Figure 2. Measured electrical conductivity of Pepper (**Right**) and Eggplant (**Left**) soil's plants.

Figure 3 shows the virtual observational comparison of pepper and eggplant plants using soil with water irrigation and treated soil with the chitosan solution prepared in this study. Plants grew normally, as expected, for both irrigation mechanisms. The interesting observation at this point is that soil treated with chitosan solution resulted in a healthier plants and greener leaves. For the eggplant, treated soil with the chitosan solution resulted in complete and multi-leaf leaves, but untreated soil lost most of its leaves.

Figure 3. Observational comparison on the plant with the use of chitosan solution (**Left**) and without it (**Right**).

4. Conclusions

This study examined the effect of using a biopolymer chitosan solution on the growth of eggplant and pepper plants, besides soil moisture content and electrical conductivity. Results showed that soils treated with the chitosan solution increased the moisture level in the soil and reduced water consumption by nearly 170%. Soils treated with chitosan solution resulted in healthier and greener plants as compared to untreated soils. By the end of this study, it is highly recommended to examine the influence of chitosan solution on numerous types of plants for a longer duration.

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