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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 chitosan based solution on eggplant and pepper growth, moisture content, and thermal conductivity. After 30 days 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 chitosan solution prepared in this study, water consumption 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 plant preserve high 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 biopolymer that has become popular 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 to 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 to 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) from Weifeng Kehai Ltd., China with a molecular weight of 471 kDa and a degree of deacetylation of 84% ± 2% [10]. Glacial acetic acid with a Grade ≥ 99.7%, was used.

2.2. Solution Preparation

A 2.5% chitosan solution was prepared by dissolution of 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 into 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 into 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 plant's 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 conducted to examine the influence of spraying chitosan solution on the synthetic fertilizer soils of Eggplants and Peppers 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. Similar procedure was of method#1 was followed, where in this experiment, water was added only once the soil moisture 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 before 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 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 solution have survived for an average period of 4 days before reaching the 40% moisture content. During the period of 4 days, the chitosan solution was sprayed only one time followed by water irrigation, where no water was added for the rest of days. Once the soil's moisture content approached to 40%, another batch of chitosan solution and water irrigation was used. Form this, it can be seen significant reduction in water consumption of soils with chitosan solution implantation. It can be also noticed form the presented data that eggplant soil was almost constant, 40%, during the entire period of evaluation, whereas slight reduction and fluctuation was observed of the pepper's soil.

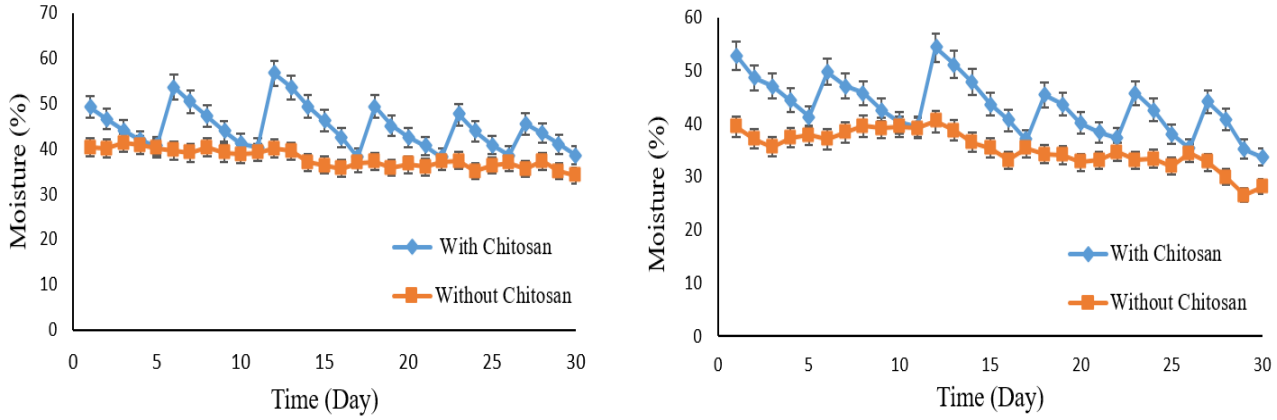

Figure 1. Measured moisture content of Pepper (**Right**) and Eggplant (**Left**) soil's plants.

A continuous 30 days evaluation of electrical conductivity of pepper and eggplant soil's plants are presented in Figure 2. It was observed that soils with chitosan solution have slightly higher electrical conductivity as compared to water-based irrigation ones. In addition, no notable difference was noticed for the electrical conductivity between eggplant and pepper soils. What is more interesting, 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 are nearly 360–380 ppm whereas soils with water-based irrigation 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, first few days the electrical conductivity ranges between 300–400 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.

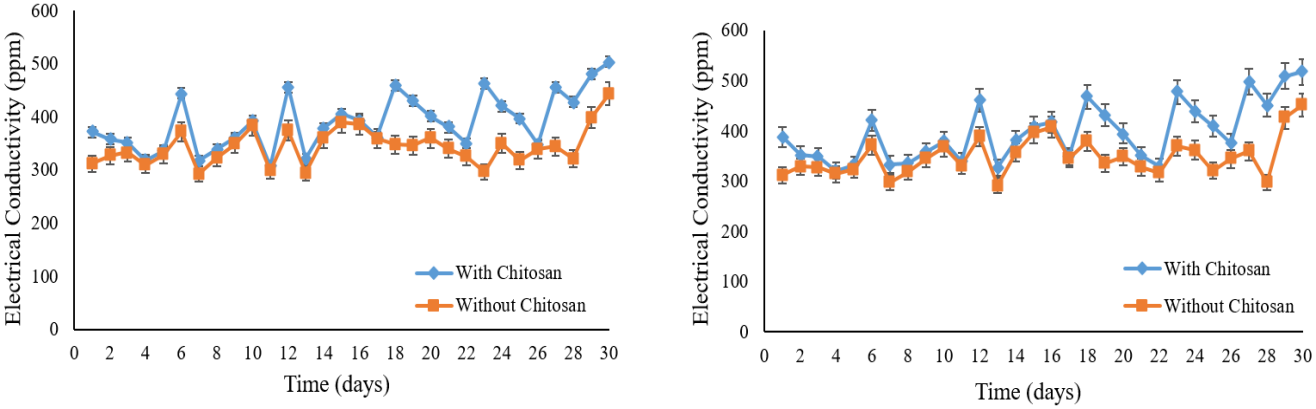

Figure 2. Measured electrical conductivity of Pepper (**Right**) and Eggplant (**Left**) soil's plants.

Figure 3 shows the virtual observational comparison of pepper and eggplant plants using soil with water irrigation and treated soil with chitosan solution prepared in this study. Plants were grow normally, as expected, for both irrigation mechanisms. The interesting observation at this point is that soil treated with chitosan solution resulted more healthy plant and greener leaves. For the eggplant, treated soil with the chitosan solution resulted complete and multi-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 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 heather 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 and for longer duration.

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