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Growth Characteristics of Bell Pepper and Tomato Hydroponically Cultivated in Growth Media Containing Different NaCl Concentrations in Raw Water on Reclaimed Lands

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Abstract

Reclaimed land used as arable land can improve low food self-sufficiency or export competitiveness through large-scale controlled-environment agriculture. However, high salinity in reclaimed land can cause diseases and decrease yields during crop cultivation. This study was conducted to understand the growth characteristics of bell pepper and tomato hydroponically cultivated in rockwool and coir media reflecting changes in electrical conductivity (EC) and NaCl concentrations in the raw water of reclaimed lands. For bell pepper, Machai varieties (*C. annuum* L. cv. Machai) were used. For tomatoes, TY TRUST varieties (*S. lycopersicum* L. cv. TY TRUST) were used. NaCl was supplemented into the nutrient solution once a week to construct a treatment group based on EC. For bell pepper and tomato, NaCl was supplied at the following levels: none (CON), EC 4.0 (T1), EC 4.5 (T2), EC 5.0 (T3), and EC 5.5 $dS \cdot m^{-1}$ (T4). The plant height, leaf area, leaf fresh weight, leaf dry weight, stem fresh weight, stem dry weight, and fruit yield of bell pepper and tomato were investigated as indicators of growth characteristics of crops. For bell peppers, the growth index decreased with an increase in the stage as the NaCl concentration was increased, regardless of the type of media used. The use of coir media could secure bell pepper production yields without a significant effect of the NaCl concentration at the levels used in this study. However, for tomatoes, the leaf area was significantly decreased when NaCl concentrations were applied compared to that of the control group. Also, most other growth indicators were significantly decreased at NaCl concentrations above T2. The effects of the NaCl concentration were reduced when tomatoes were cultivated in coir media instead of rockwool media. Therefore, for hydroponically cultivated bell peppers and tomatoes, if raw water containing NaCl is supplied, it may be possible to maintain the crop yield if coir media are used.

Additional key words: cocopeat, coir, electrical conductivity, rockwool, sodium chloride

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Competing Interests
The authors have no conflicts of interest relevant to this study to disclose.

Introduction

Land reclamation projects are carried out to address land demand issues due to population growth and industrialization in countries with limited land. Generally, reclaimed land is created for the purpose of siting industrial complexes, airports, or as land use for cultivation (Lee and Yoon, 2014). In Korea, an amount of 135,000 ha of land has been reclaimed over the past 100 years, and about 6,000 ha of land is under consideration for horticultural complex use (Lee et al., 2021a, 2021b). Reclaimed land used as arable land can improve low food self-sufficiency or export competitiveness through large-scale controlled-environment agriculture (Seo, 2019; Son et al., 2020). Currently, the largest area of reclaimed land, Saemangeum, where construction started in 1991, has new farmland of 293 km^2 that has been improved over 30 years with a freshwater lake 118 km^2 in size (Jang et al., 2014). However, on reclaimed land, the groundwater level fluctuates due to precipitation and the salinity underground rises, approaching the topsoil (Jung et al., 2021). Therefore, reclaimed soil is classified as a typical type of salt accumulation soil. The salt content in such soil, i.e., NaCl, increases due to the existence of nearby seawater (Bae et al., 2015).

High salinity on reclaimed land can cause several diseases during crop cultivation. Crops damaged by salinity generally exhibit inhibited photosynthesis and growth, decreased chlorophyll contents, imbalanced effects, and accelerated aging (Muuns and Termaat, 1986; Zeng et al., 2001; Lee et al., 2008; Orosco-Alcalá et al., 2021). The accumulation of salt in the soil can reduce pore spaces, which can in turn reduce the air and moisture available for the roots of plants. Salt also lowers the water potential, which limits the absorption of water and nutrients, thus reducing the productivity of crops due to the toxic effects of salt ions (Ryu et al., 2010; Jo et al., 2018). For crop cultivation on reclaimed land, salt-tolerant crops such as cotton, barley, spinach, beets, and sugar beets can be selected for cultivation (Greenway and Muuns, 1980; Lim et al., 2010). To cultivate crops on reclaimed land, soil addition, subsoil reversal, and desalination irrigation strategies are utilized (Koo et al., 1998; Lee et al., 2021c). However, difficulties arise when applying soil desalination techniques because fruits and vegetables are mostly cultivated via hydroponics to achieve increased productivity. Therefore, it is important to secure a suitable water source for hydroponics. If the water secured for reclaimed land contains salt, it is necessary to study changes in crop growth and productivity due to water salinity.

Bell pepper (*Capsicum annuum* L.) is mainly cultivated for export in South Korea. The amount of bell pepper produced in South Korea in 2019 amounted to 80,000 tons (Yeo et al., 2021). Tomato (*Solanum lycopersicum* L.) is an important crop, with 160 million tons produced worldwide yearly and 390,000 tons produced in South Korea in 2019 (Zhang et al., 2016; Cho et al., 2021). Approximately 12% of domestic controlled-environment agriculture area in Korea is used to grow crops hydroponically. Bell pepper and tomato are mostly cultivated in coir, perlite, and rockwool media (Lee et al., 2019; An and Shin, 2021). The pH and the electrical conductivity of the media are important to ensure the provision of a suitable rhizosphere environment for crops cultivated hydroponically. The characteristics of coir (an organic medium) and rockwool (an inorganic medium) differ greatly. Rockwool is advantageous for nutrient control, though its disposal is difficult (Benoit and Ceustermans, 1995). Coir is stable due to its large buffering capacity. However, its physicochemical properties can differ depending on the feedstock (Evans et al., 1996). Although rockwool or coir media are widely used, only crop cultivation using perlite media in hydroponics containing salts such as NaCl has been studied and reported (Rhee et al., 2001; Rhee et al., 2002). Therefore, this study was conducted to understand the growth characteristics of bell pepper and tomato hydroponically cultivated in rockwool or coir media according to changes in the electrical conductivity levels and NaCl concentrations in raw water on reclaimed land.

Materials and Methods

Crop Cultivation and Growth Conditions

The bell pepper and tomatoes used in the experiment here were cultivated in a greenhouse located on reclaimed land in Saemangeum (35.77°N, 126.67°E), Gwanghwal-myeon, Gimje-si, Jeollabuk-do, South Korea. The greenhouse was a Venlo-type glass greenhouse with an area of 1,000 m^2. The air temperature and relative humidity in the greenhouse were controlled in the ranges of 15−30°C and 50−90%, respectively. For bell pepper, Machai varieties (*C. annuum* L. cv. Machai) were used. For tomatoes, TY TRUST varieties (*S. lycopersicum* L. cv. TY TRUST) were used. Bell pepper and tomato seedlings (41-days-old) were used in the experiment. These seedlings were planted in a rockwool slab (Grodan, Roermond, Netherlands) and a coir slab (chip : dust = 5 : 5, Kokobio, Naju, Korea) with five bell pepper and four tomato plants per slab. Both bell pepper and tomato were cultivated for eight months from October 5, 2021 to May 22, 2022. The tomato nutrient solution used consisted of N = 21.86 kg, P = 10.4 kg, K = 39.46 kg, S = 12.59 kg, Ca = 29.15 kg, Mg = 8.8 kg, Fe = 83.59 g, Mn = 42.75 g, Zn = 25.6 g, B = 87.5 g, and Mo = 4.2 g in every 1,000 L for vegetative growth and N = 21.61 kg, P = 10.4 kg, K = 45.9 kg, S = 12.45 kg, Ca = 26.5 kg, Mg = 7.84 kg, Fe = 83.59 g, Mn = 42.75 g, Zn = 25.6 g, B = 87.5 g, and Mo = 4.2 g in every 1,000 L for reproductive growth. The bell pepper nutrient solution consisted of N = 27.70 kg, P = 12.48 kg, K = 37.6 kg, S = 5.59 kg, Ca = 23.75 kg, Mg = 6.88 kg, Fe = 122.72 g, Mn = 42.75 g, Zn = 25.6 g, B = 87.5 g, and Mo = 4.2 g in every 1,000 L for vegetative growth and N = 25.45 kg, P = 11.96 kg, K = 38.64 kg, S = 5.59 kg, Ca = 28.62 kg, Mg = 6.88 kg, Fe = 83.59 g, Mn = 42.75 g, Zn = 25.6 g, B = 87.5 g, and Mo = 4.2 g in every 1,000 L for reproductive growth, with electrical conductivity EC = 2.7 $dS \cdot m^{-1}$ applied during reproductive growth and EC = 2.5 $dS \cdot m^{-1}$ applied during the vegetative growth stages. These nutrient solutions were supplied by determining the amount of irrigation in proportion to the level of solar irradiance. To study the growth responses of crops according to the NaCl concentration, NaCl was supplemented into the nutrient solution once a week to construct a treatment group based on the EC. For bell pepper and tomato, the following NaCl levels were used: none (CON), EC 4.0 (T1), EC 4.5 (T2), EC 5.0 (T3), and EC 5.5 $dS \cdot m^{-1}$ (T4).

Measurements of Crop Growth Characteristics

Plant height, leaf area, leaf fresh weight, leaf dry weight, stem fresh weight, stem dry weight, and fruit yield of bell pepper and tomato were investigated as characteristic growth indicators. The growth characteristics were measured monthly. Five bell pepper and four tomato plants were randomly selected for destructive measurements. The plant height was measured along the curve of the stem using a tape measure. Leaf area was measured in each case using an LI-3100 area meter (LI-COR, Lincoln, NE, USA). The fresh weights of the leaf and stem and the fruit yield were measured immediately after harvest. The dry weights of the leaf and stem were measured after oven-drying at 70°C for 38 h.

Statistical Analysis

All statistical analyses of the bell pepper and tomato growth characteristics were performed using the SPSS statistical program (IBM, Armonk, NY, USA). Statistical significance was determined using a one-way analysis of variance (ANOVA). Mean separation treatments were analyzed by Duncan's multiple test (DMRT) at $p < 0.05$.

Results and Discussion

Growth Characteristics of Bell Pepper and Tomato Without a NaCl Treatment

The growth characteristics of bell pepper plants cultivated for eight months mostly showed an increasing trend (Fig. 1). Plant heights, leaf and stem fresh weights, and leaf and stem dry weights showed few differences between plants cultivated in both rockwool and in coir media, with maximum measurements of 250 cm, 384.88 g, and 68.24 g, respectively (Fig. 1A, 1E, and 1F). Although the leaf fresh and dry weights differed depending on the growth stage, such differences were not statistically significant (Fig. 1C and 1D). Meanwhile, from the third to the fifth month after planting, the leaf area was greater for plants cultivated in the coir media than for those cultivated in the rockwool media (Fig. 1B). However, after the sixth month, the difference between plants cultivated in the rockwool media and coir media decreased,

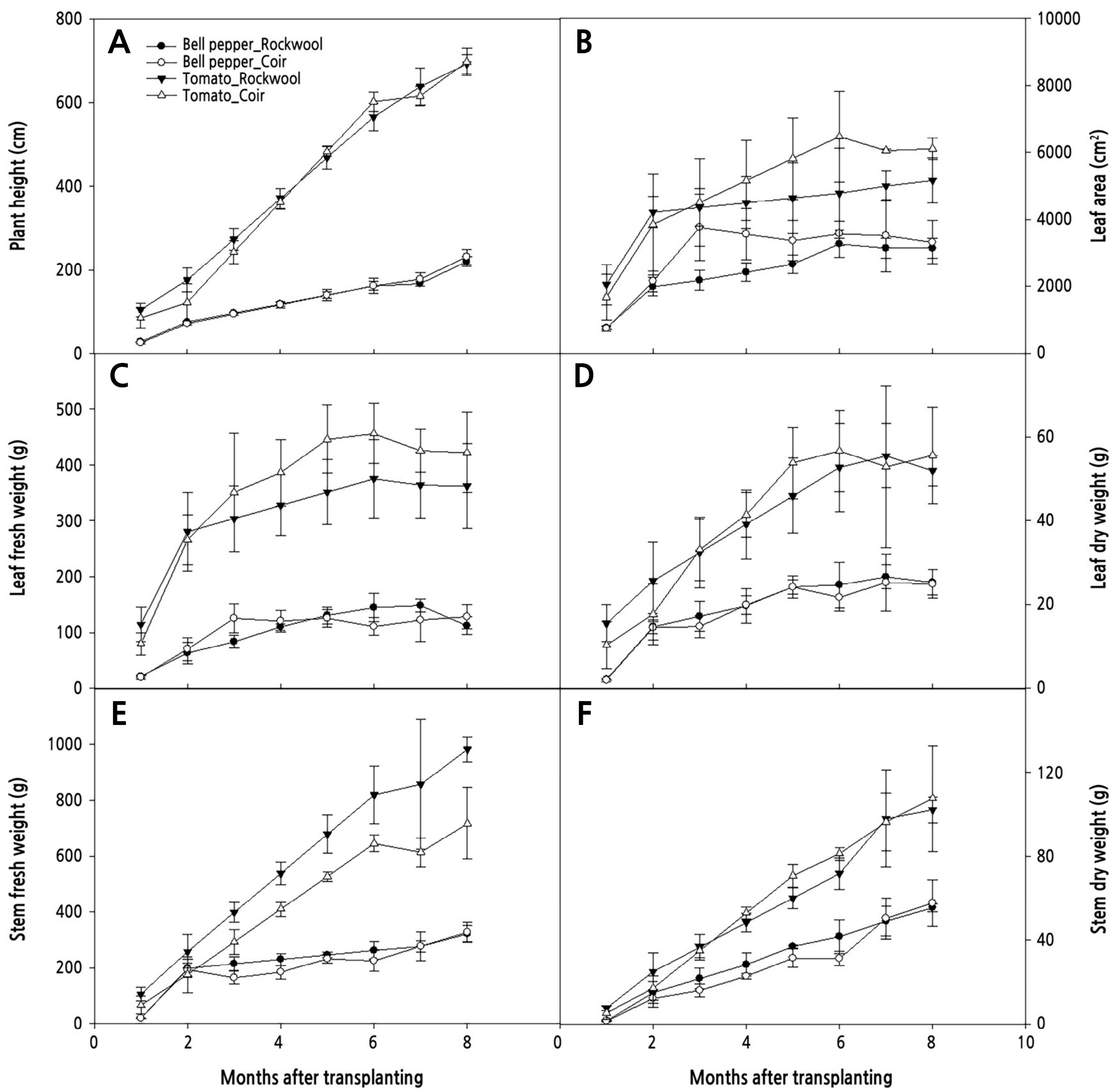

Fig. 1. Growth characteristics of hydroponically grown bell pepper (circle) and tomato (triangle) using rockwool (black) and coir (white) media during eight months. (A) to (F) mean plant height, leaf area, leaf fresh weight, leaf dry weight, stem fresh weight, and stem dry weight, respectively. Bars represent the mean ± standard deviation (bell pepper: $n = 5$ and tomato: $n = 4$).

with the maximum leaf area being 4,100 cm^2.

Most growth characteristics of tomato plants measured during eight months of cultivation showed an increasing trend as well, although many characteristics showed different trends compared to those of bell peppers (Fig. 1). Plant height, leaf dry weight, and stem dry weight showed scant differences between plants cultivated in rockwool and those cultivated in coir media, with maximum measurements of 730 cm, 73.51 g, and 136.95 g, respectively (Fig. 1A, 1D, and 1F). At three months after planting, the leaf area and leaf fresh weight were higher for plants cultivated in the coir media than for those cultivated in the rockwool media (Fig. 1B and 1C). The stem fresh weight was higher when plants were continuously cultivated in the rockwool media compared to those in the coir media (Fig. 1E).

The Veyron and Cupra varieties of bell peppers cultivated in soil, rockwool, and coir media can grow up to 130, 170, and 121 cm, respectively, two to three months after planting (An et al., 2011; Kim et al., 2013; Rhee et al., 2013). As the bell pepper Machai cultivar cultivated without a NaCl treatment in this study exhibited a plant height of around 100 cm regardless of the type of media used two months after planting, the growth was judged to be slower than those of the Veyron and Cupra varieties. In a study of the tomato cultivar “Dotaerang” cultivated in rockwool and coir media for two months after planting, plant heights were 240 and 230 cm, respectively (An and Shin, 2021). In the present study, the TY TRUST tomato cultivar cultivated in rockwool and coir media for two months after planting without a NaCl treatment showed plant heights of 180 and 110 cm, respectively. Thus, this cultivar showed slower growth than the “Dotaerang” cultivar. However, those varieties used for the comparison were not cultivated on reclaimed land. Therefore, the slow plant growth in the present study can be explained by the location of the reclaimed land, which is located on the coast with strong winds and fog, providing an unsuitable weather environment for crop growth (Nam and Shin, 2017).

Growth Characteristics of Bell Pepper and Tomato Plants According to the NaCl Concentration

The growth characteristics of bell pepper plants were different when different NaCl concentrations in raw water were supplied (Figs. 2 and 3). For bell peppers cultivated in the rockwool media, decreasing trends in the plant heights and leaf fresh weights were noted in T2, T3 and T4 and in the leaf dry weight only in T4 until the fifth month. After eight months, the plant heights, leaf fresh weights, and leaf dry weights were decreased significantly in the T2 or higher treatment groups compared to those of the control group (Fig. 2A, 2C, and 2D). The leaf area was decreased only in T4 until the fifth month compared to that of the control group. It was decreased in T3 or higher treatments at the eighth month compared to that of the control group (Fig. 2B). Stem fresh weights did not differ significantly between the treatment groups until the fifth month. At the eighth month, these weights were only significantly reduced in T4 compared to that of the control group (Fig. 2E). Stem dry weights were decreased significantly in T2 or higher treatment groups until the fifth month compared to that of the control group. However, at the eighth month, they were decreased significantly compared to that of the control group only at T4, showing a tendency to recover over time (Fig. 2F). For bell peppers cultivated in the coir media, plant heights were significantly decreased in all treatment groups compared to that of the control group (Fig. 3A). The leaf area was highest in T1 until the fifth month. It was the lowest in T4 (Fig. 3B). Leaf fresh and dry weights were significantly decreased in the T2 or higher treatment groups compared to those of the control group (Fig. 3C and 3D). Stem fresh weights were significantly decreased compared to that of the control group only in T4 until the fifth month. At the eighth month, these values were significantly decreased in the T3 or higher treatment groups compared to that of the control group (Fig. 3E). The stem dry weight was decreased significantly in the T2 or higher treatment groups as well compared to that of the control group until the fifth month. However, at the eighth month, these values were decreased significantly only in T4, tending to recover over time (Fig. 3F).

As a result of supplying raw water containing NaCl for tomato cultivation, the growth characteristics of tomatoes differed according to the NaCl concentration (Figs. 4 and 5). Plant heights of tomatoes cultivated in rockwool media were decreased significantly at the fifth month in T2 and T4 compared to those of the control group. However, at the eighth month, the T4 or higher treatment groups showed significant decreases in the plant height compared to the control group (Fig. 4A). The leaf area was significantly decreased in T2 and T4 compared to that in the control group until the fifth month. At the eighth month, this factor was significantly decreased in all treatment groups compared to that in the control group (Fig. 4B). The leaf fresh and dry leaf weights were both significantly decreased in T2 and T4 compared to those of

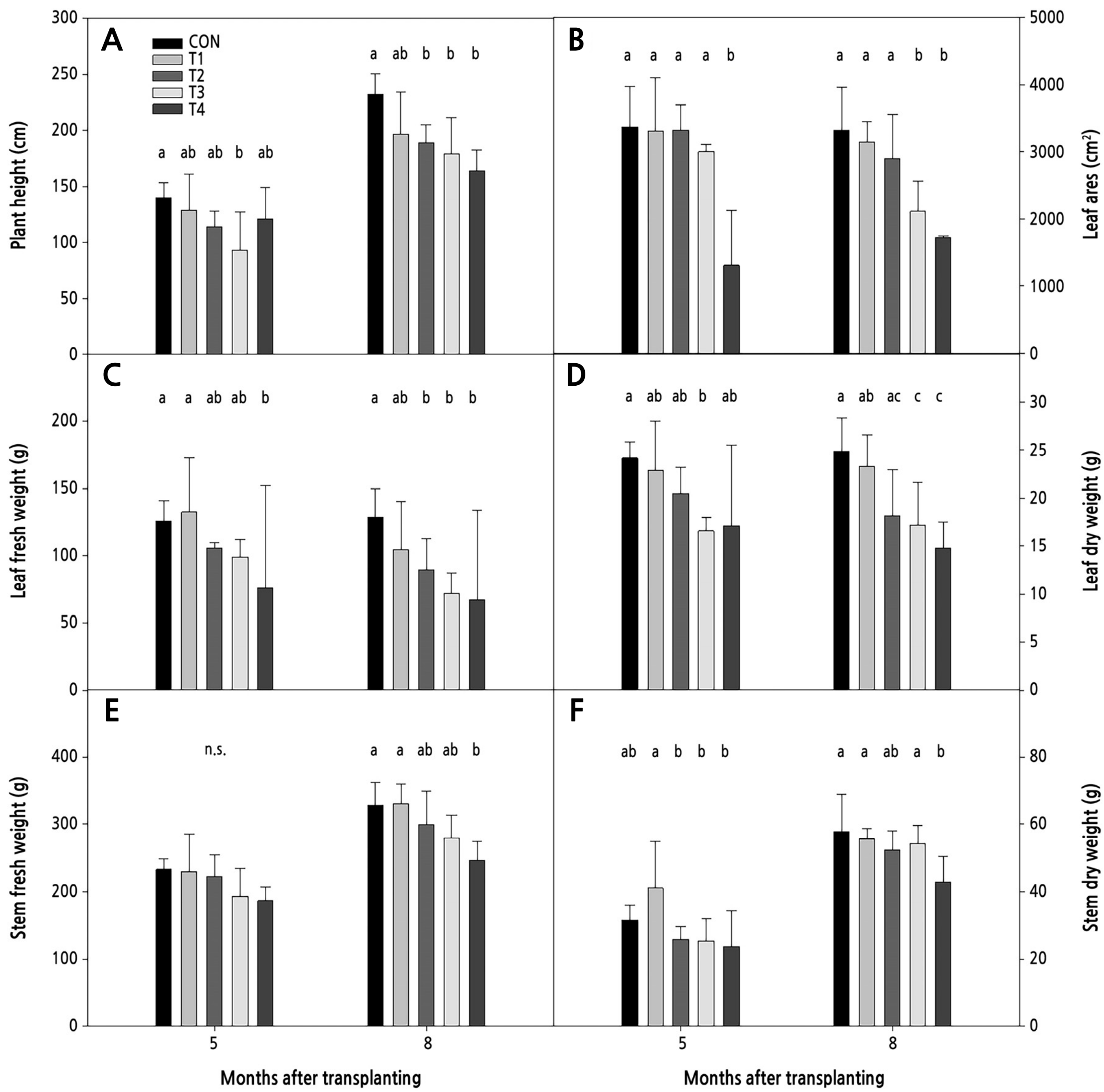

Fig. 2. Growth characteristics of hydroponically grown bell pepper using rockwool media at five and eight months according to different NaCl concentrations. (A) to (F) mean plant height, leaf area, leaf fresh weight, leaf dry weight, stem fresh weight, and stem dry weight, respectively. Bars represent the mean ± standard deviation ($n = 5$). Identical letters are not significantly different according to Duncan's multiple range test at $p < 0.05$.

the control group until the fifth month. They were decreased significantly in the T2 or higher treatment groups compared to those of the control group at the eighth month (Fig. 4C and 4D). Stem fresh weights showed significant decreases in all treatment groups compared to that of the control group (Fig. 4E). Stem dry weights were also decreased significantly, though only in T4 until the fifth month compared to that of the control group. This factor was decreased significantly in the T3 or higher treatment groups at the eighth month compared to that in the control group (Fig. 4F). Plant heights and fresh weights of tomatoes cultivated in coir media were decreased only in T2 until the fifth month compared to those in the control group. However, they did not show a significant difference between the treatment groups at the eighth month (Fig. 5A and 5E). Leaf area was decreased significantly in the T2 or higher treatment groups compared to that in the control group until the fifth month. At the eighth month, all treatment groups showed significantly decreased leaf area outcomes

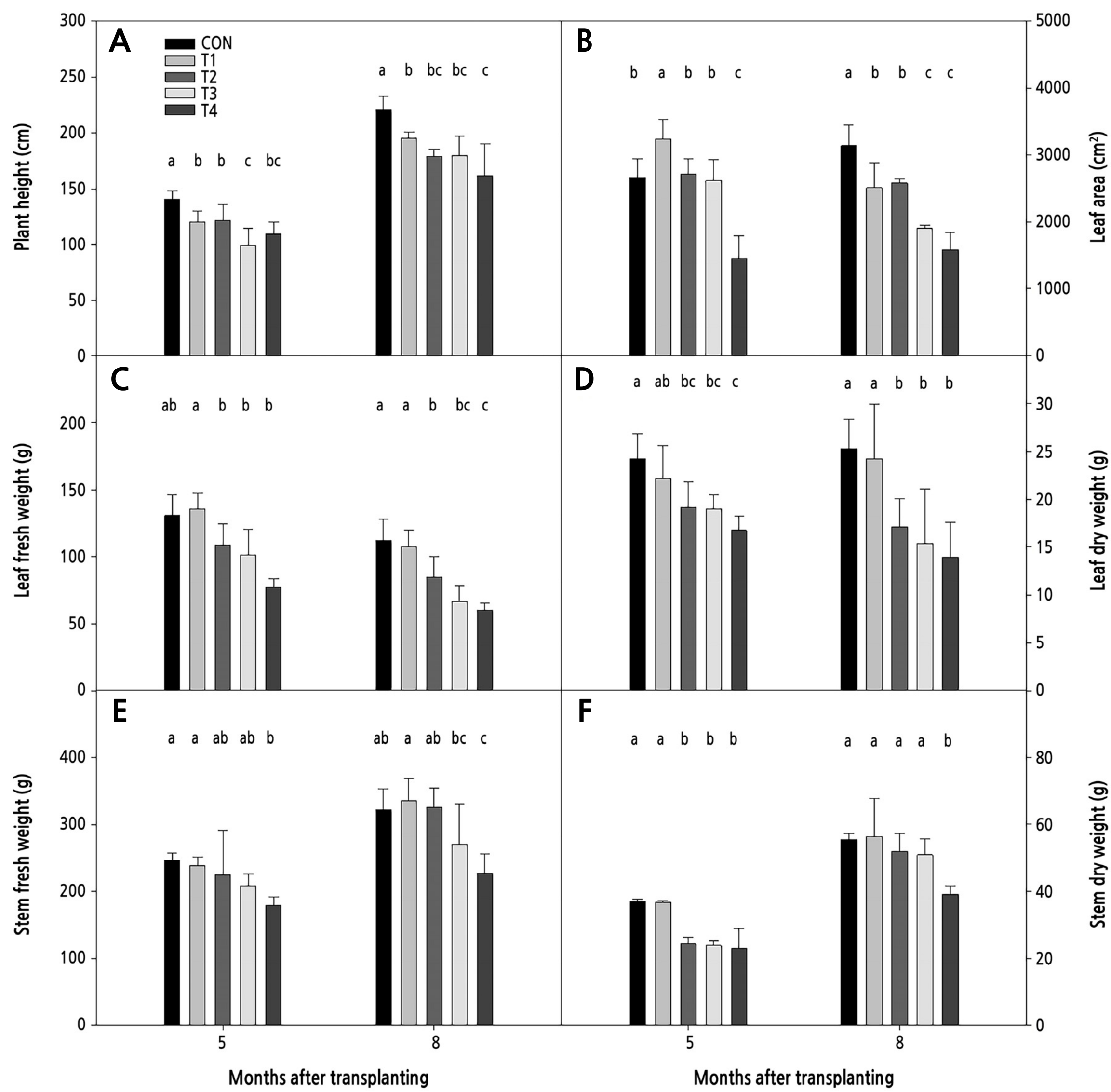

Fig. 3. Growth characteristics of hydroponically grown bell pepper using coir media at five and eight months according to different NaCl concentrations. (A) to (F) mean plant height, leaf area, leaf fresh weight, leaf dry weight, stem fresh weight, and stem dry weight, respectively. Bars represent the mean ± standard deviation ($n = 5$). Identical letters are not significantly different according to Duncan's multiple range test at $p < 0.05$.

compared to the control group (Fig. 5B). Both leaf fresh and dry weights were significantly decreased in the T2 or higher treatment groups compared to those of the control group (Fig. 5C and 5D). The stem dry weight was highest in T1 until the fifth month. At the eighth month, it was significantly decreased in the T3 or higher treatment groups compared to that in the control group (Fig. 5F).

For the bell pepper plants, the growth index decreased by stage as the NaCl concentration was increased, regardless of the type of the media used. The bell pepper growth index did not rapidly decrease when the NaCl concertation was low. However, in the treatment group T4 with a high NaCl concentration, various growth indices, such as the leaf area and leaf fresh weight, showed a decreasing tendency by almost half compared to that of the control group. Despite the limited studies of the effects of the NaCl concentration on bell peppers, studies of lettuce have shown that the growth index

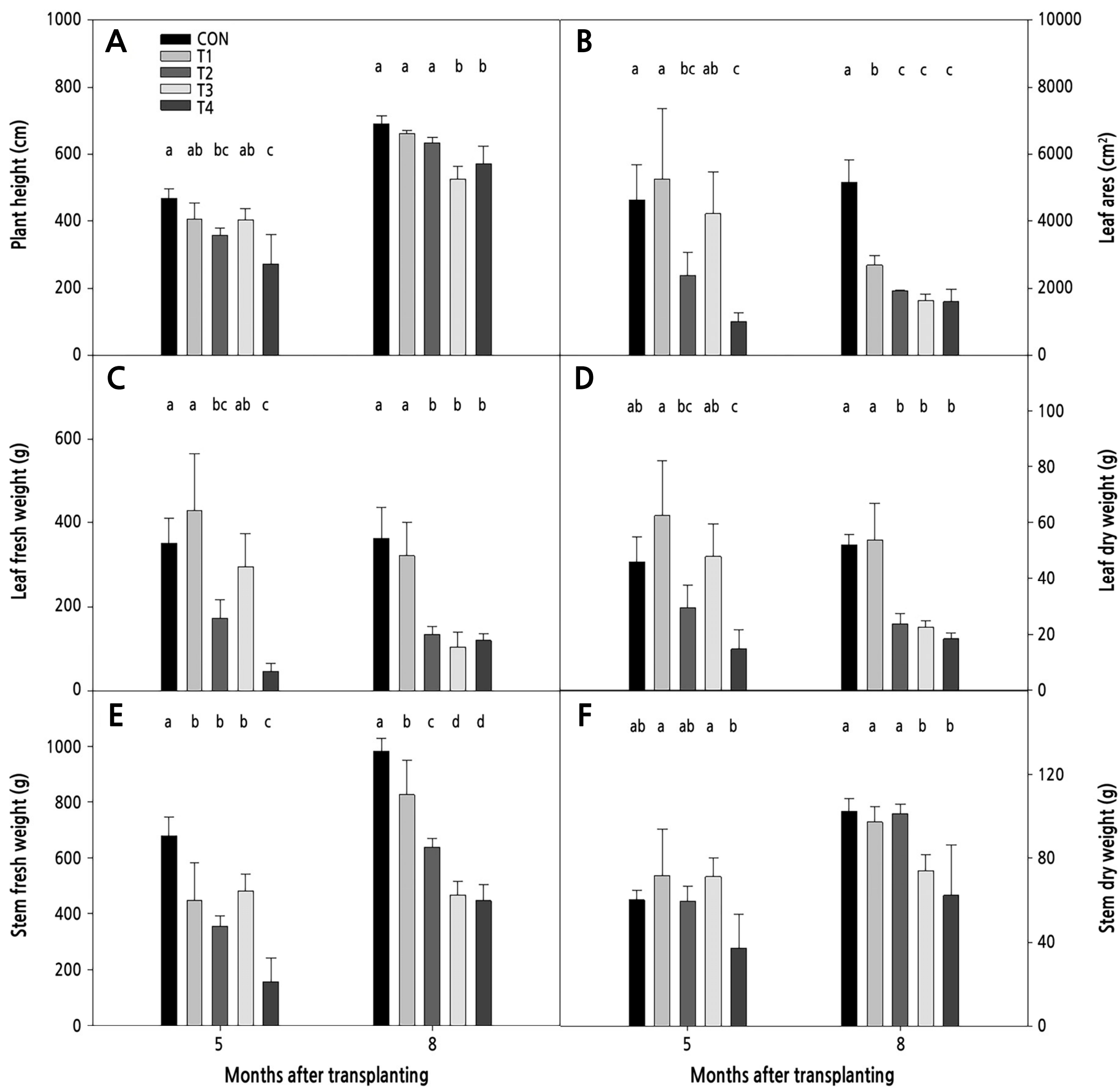

Fig. 4. Growth characteristics of hydroponically grown tomato using rockwool media at five and eight months according to different NaCl concentrations. (A) to (F) mean plant height, leaf area, leaf fresh weight, leaf dry weight, stem fresh weight, and stem dry weight, respectively. Bars represent the mean ± standard deviation ($n = 4$). Identical letters are not significantly different according to Duncan's multiple range test at $p < 0.05$.

gradually decreases when the NaCl concentration is 100 mM or higher (Shin et al., 2020), similar to results for bell pepper in the present study. From the fifth month to the eighth month, both the stem fresh and dry weights tended to recover by adapting to the treatment with a high NaCl concentration. Therefore, bell peppers showed a gradual response to NaCl. They did not show extreme changes in the growth indicators when they were cultivated in rockwool or coir media. For the tomato plants, their leaf areas were significantly decreased when they were treated with NaCl compared to those of the control group. Most other growth indicators were also significantly decreased at NaCl concentrations above T2, consistent with a previous study on the growth of "Momotaro" cultivar tomatoes, which showed that growth indicators were significantly decreased at NaCl concentrations of 20 mM or higher when "Momotaro" cultivar tomatoes were cultivated in bed soil mixed with peat moss and perlite at a 1:1 ratio (Rhee et al., 2002). However, for tomatoes cultivated

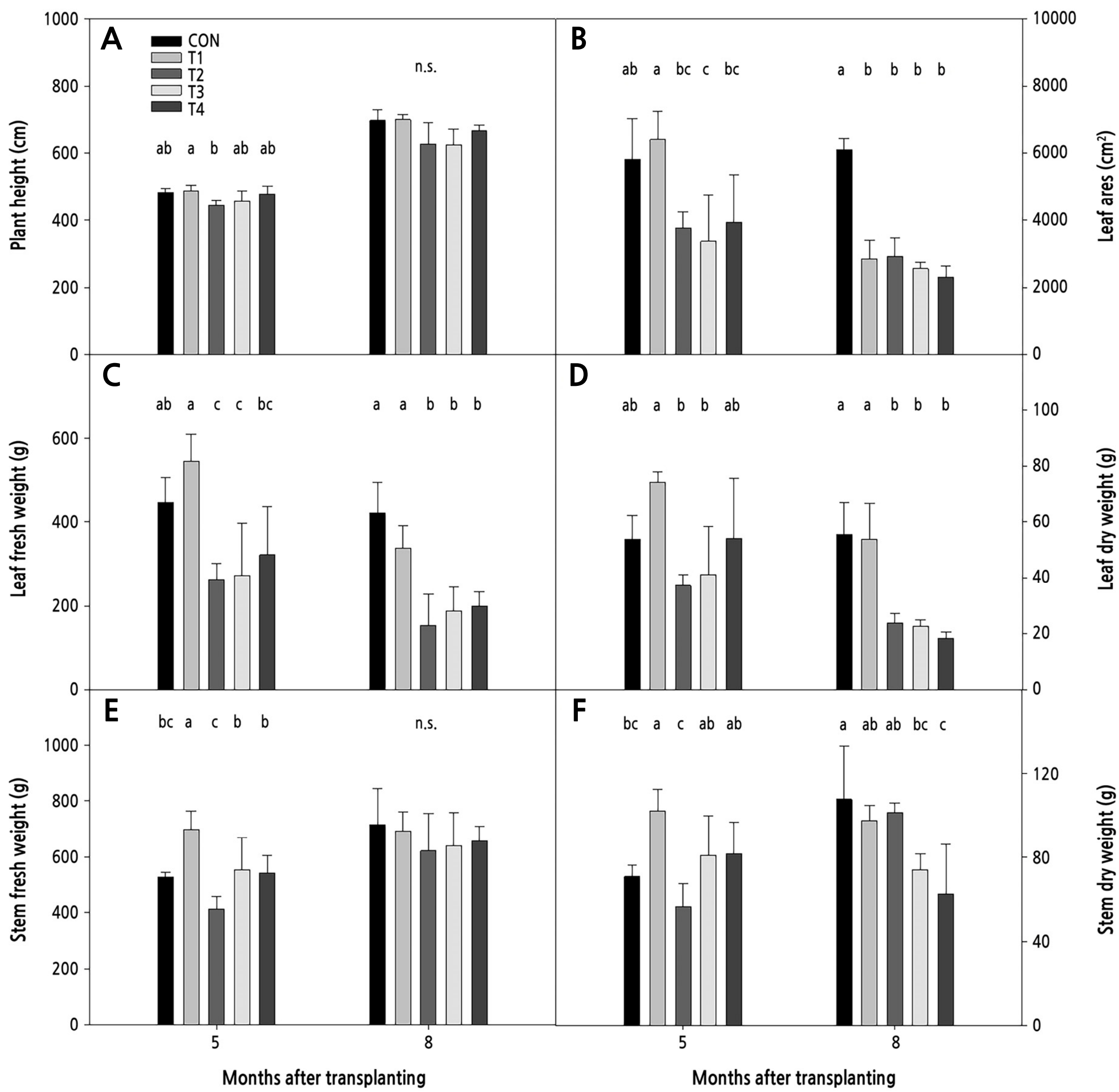

Fig. 5. Growth characteristics of hydroponically grown tomatoes using coir media at five and eight months according to different NaCl concentrations. (A) to (F) mean plant height, leaf area, leaf fresh weight, leaf dry weight, stem fresh weight, and stem dry weight, respectively. Bars represent the mean ± standard deviation ($n = 4$). Identical letters are not significantly different according to Duncan's multiple range test at $p < 0.05$.

in the coir media, plant heights and stem fresh weights did not decrease compared to those of the control group, even when the NaCl concentration was increased. Therefore, coir media can be considered as a suitable medium that can partially offset the NaCl-sensitive characteristics of tomatoes.

Yield of Bell Pepper and Tomato Plants According to the NaCl Concentration

As a result of supplying raw water containing NaCl to bell pepper and tomato plants during their cultivation, the production levels differed for each concentration (Table 1). Bell pepper production from the control group was 14.7 kg per slab when these plants were cultivated in rockwool media and was 16.2 kg per slab when cultivation took place in coir media, corresponding to 2.94 and 3.24 kg per crop, respectively. The production of bell peppers cultivated in Jinju has been reported to be 4.3 kg per crop (Choi et al., 2013). The national average production is 3.3 kg per crop according to the Ministry of Agriculture, Food and Rural Affairs (MAFRA, 2012). Tomato production from the control group was 23.4 kg per slab when these plants were cultivated in rockwool media and 19.8 kg per slab when cultivated in coir media, corresponding to 5.85 and 4.95 kg per crop, respectively. The production of tomato cultivated in Sacheon is reportedly 16.2 kg per crop (Choi et al., 2013). The national average production is 3.2 kg per crop according to the Ministry of Agriculture, Food and Rural Affairs. In this study, the production of bell pepper appeared to have a low yield due to

Table 1. Harvested fruit fresh weights of bell pepper and tomato using rockwool and coir growing media according to different NaCl concentrations

Crop	Medium	NaCl treatment^z	Harvested fruit fresh weight (kg/slab)
Bell pepper	Rockwool	CON	14.7 ± 3.05^y a^x
		T1	14.3 ± 3.23 a
		T2	12.0 ± 3.24 ab
		T3	9.6 ± 3.81 bc
		T4	8.7 ± 2.76 c
	Coir	CON	16.2 ± 6.44 a
		T1	15.7 ± 6.14 a
		T2	13.8 ± 8.34 a
		T3	11.8 ± 6.79 a
		T4	11.1 ± 7.25 a
Tomato	Rockwool	CON	23.4 ± 16.86 a
		T1	22.5 ± 13.01 ab
		T2	17.1 ± 6.59 abc
		T3	11.6 ± 4.66 bc
		T4	10.0 ± 3.99 c
	Coir	CON	19.8 ± 11.77 a
		T1	19.3 ± 6.03 a
		T2	15.3 ± 6.83 ab
		T3	12.1 ± 6.32 ab
		T4	10.4 ± 5.07 b

^{z}CON: control, T1: 4.0dS·m^{-1} NaCl, T2: 4.5dS·m^{-1} NaCl, T3: 5.0dS·m^{-1} NaCl, T4: 5.5dS·m^{-1} NaCl.

^{y}Each value is presented as the mean of three replications ± standard deviation (bell pepper: $n = 5$ and tomato: $n = 4$).

^{x}Values in a column followed by the same letter are not significantly different according to Duncan's multiple range test at $p < 0.05$.

environmental factors, specifically the use of reclaimed land in this study. Although tomato production in the present study exceeded the national average, it was lower than those of leading farms.

For bell pepper plants cultivated in rockwool media with a NaCl concentration treatment, the production per slab tended to decrease in the T3 or higher treatments. Such gradual decreases in production were similar to results obtained when Orlando cultivar bell pepper was cultivated in perlite media with increasing NaCl concentrations (Navarro et al., 2010). However, for the bell peppers cultivated in coir media here, no significant difference was observed between the treatment groups and the control group. The average production was higher for bell pepper cultivated in coir media than in rockwool media. For bell pepper plants, the use of coir media can secure the bell pepper production yield without significant effects of the NaCl concentration at the levels assessed in this study.

For tomato plants cultivated in rockwool media with a NaCl concentration treatment, the production per slab was significantly decreased in the T3 or higher treatments compared to that of the control group. However, when cultivated in the coir media, the production per slab was significantly decreased only in T4 compared to that in the control group. Growth indicators of tomatoes were more sensitive to a NaCl treatment than those of bell peppers. Thus, tomato is considered to be a crop sensitive to the NaCl concentration, as tomatoes of the Momotaro cultivar cultivated in soil mixed with peat moss and perlite at a 1:1 ratio have reportedly showed reduced production levels when the NaCl concentration was 20 mM or higher (Rhee et al., 2002). The growth index of lettuce also decreases when the NaCl concentration is 100 mM or higher (Shin et al., 2020). The production of tomatoes has been found to be higher when they are cultivated in coir media than in rockwool media when cultivated in both types of media using the Yamazaki tomato nutrient solution (An and Shin, 2021). This result appears to be in conflict with results of the present study. However, the trend would be different because it was the result of the Dotaerang cultivar in Andong without a NaCl treatment. Therefore, even for tomatoes, the NaCl concentration effects can be reduced when they are cultivated in coir media as compared to rockwool media.

In comparison with rockwool media, coir media can lead to greater weights, density levels, maximum saturation capacities, and porosity levels because the coir medium has low water holding capacity and rehydration capacity levels (Shin and Son, 2015). However, better water retention and drainage properties have been reported in coir media compared to peat moss and perlite for strawberry cultivation, leading to in increased productivity (Lee et al., 2018). Coir media can also accumulate Na ions better by eight to thirteen times compared to rockwool media (Lee et al., 2018). Therefore, for hydroponically cultivated bell pepper and tomato plants, if raw water containing NaCl is supplied, it may be possible to maintain crop yields using coir media.

Despite the different trends that arose depending on the types of crops and substrates, overall, when NaCl was included in the supply water, there was a decrease in the growth and quantity of crops. These results mean that countermeasures must be taken in reclaimed land agriculture, which uses water from underground sources or nearby rivers with high concentrations of NaCl as the main agricultural water. Therefore, for reclamation agriculture, the establishment of a foundation for a stable agricultural water supply, such as rainwater reuse technology, superior drainage technology, and the expansion of water supply facilities, is necessary to ensure worthwhile yields.

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