Effects of Different Concentrations of Salt Stress on Growth and Physiological Indexes of Cucumber Seedlings

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Keywords: Cucumber; Salt stress; Growth indicators; Physiological indicators

Abstract: This test by strong salt resistance of cucumber varieties of spring at 39, tianjin, tianjin research 4 as the experimental material, studied the different concentrations (0.0%, 0.3%, 0.6%) NaCl treatment on the influence of different cucumber seedling growth and physiological indicators. In cucumber seedling growth to two leaves one to salt stress, five times after processing, the determination of different concentration of the survival rate of different varieties of cucumber seedlings under salt stress, such as plant height, stem diameter growth index and malondialdehyde content, soluble protein content and other physiological indicators. By analyzing the growth index data, found that in 0.3% NaCl concentration when spring 39 and tianjin, tianjin research 4 cucumber seedling growth situation, the best is superior to contrast and 0.6% NaCl concentration, through the analysis of physiological index data, find spring 39, tianjin, tianjin research 4 cucumber seedlings of soluble protein content, malondialdehyde content, plasma membrane permeability increased with the increase of NaCl concentration; The root activity decreased with the increase of NaCl concentration. Can be seen from the data, 0.3% NaCl treatment have less effect on cucumber seedling growth and physiological indexes, 0.6% NaCl treatment of cucumber seedling growth and physiological index affected by salt stress significantly, including tianjin research than 4 jin chun 39 significantly.

1. Introduction

Soil salinization refers to the process in which the salt of the soil or groundwater rises to the surface with the capillary water, and the water is evaporated to accumulate salt in the surface soil [1]. Soil salinization is currently the main limiting factor affecting crop growth and yield formation. This may be because salt stress affects photosynthesis and absorption of water and nutrients, which affects the synthesis of amino acids and proteins in the body, which hinders crop growth and development. Salt stress can cause the original salt damage, ionic stress and other original effects, as well as a series of secondary stresses such as nutrient deficit and oxidative stress, which cause plant metabolism disorder, increase the synthesis and accumulation of osmolality and maintain the energy consumption of osmotic potential. Ultimately, it accelerates the aging and death of plants [2]. The enzymatic protection in plants is enhanced by the activity of antioxidant enzymes such as SOD, POD and CAT to effectively remove excess reactive oxygen species in the cells, alleviate the membranous peroxidation of cells and reduce the damage caused by salt stress [3].

2. Materials and Methods

2.1 Experiment Materials.

The test material cucumber varieties are Jinchun No. 39 and Jinyan No. 4, respectively. Source of materials: purchased from Alar International Trade City Seed Shop. The materials and tools required for seedling are: 50-well seedling tray, seedling substrate, film, analytical pure sodium chloride, water bucket, watering can, measuring cylinder, etc., provided by the Tarim University Horticultural Experimental Station; Experimental instruments: vernier calipers, rulers, dryers, electronic balances, analytical balances, water baths, 25ML and 100ML volumetric flasks, spectrophotometers, refrigerated centrifuges, mortars, ultrasonic cleaners, conductivity meters,

  DOI: 10.25236/isafb.2019.029

scissors, test tubes, pipettes, filter paper, ear balls, etc., and these are provided by the 412 and 320 laboratories of the Southern Xinjiang Characteristic Fruit Research Center of Tarim University; Experimental reagents: concentrated sulfuric acid, Coomassie Brilliant Blue G-250, perchloric acid, trichloroacetic acid, sodium hydroxide, potassium dihydrogen phosphate, sodium dihydrogen phosphate, ethyl acetate and methanol, etc., provided by the Department of Medicine, Tarim University.

2.2 Experiment Design.

Sowing Seedling. This part of the experiment was completed in November 2017 at the Intelligent Greenhouse of the Horticultural Experimental Station of the University of Tarim. Seeds with full and uniform size were selected for soaking and germination. After the seeds were exposed to white, they were sown in a seedling tray containing the substrate. The seedling tray with a size of 50 holes was used. The seedling substrate was grass charcoal: vermiculite: perlite = 3:2:1. One seed was planted at each hole. After the seedlings grew to two leaves and one heart, salt stress treatment was carried out. Two gradients were set by NaCl treatment, and pure NaCl was analyzed to prepare a salt solution with a concentration of 0.3% and 0.6%, and distilled water was used as a control (CK). 10 strains were treated each time and repeated 3 times. The brine was poured once every 2 days for a total of 5 treatments. After the 14th day after the treatment, the seedling growth and physiological indicators were measured.

Index Measurement. Determination of appearance indicators: observe the emergence of seedlings every day after sowing, then take NaCl treatment every two days and record the number of seedlings in the seedlings until the 5th NaCl treatment is completely finished, and calculate the survival rate of the seedlings of the two cucumber varieties at different concentrations. On the 14^{th} day after the treatment, the seedling growth indicators were measured: plant height, stem diameter, and leaf area.

Determination of physiological indexes: The plasma membrane permeability was measured on the 15th day after the treatment; the soluble protein content and the malondialdehyde content were measured on the 16^{th} day after the treatment; the root activity was measured on the 18^{th} day after the treatment.

2.3 Experiment Methods.

Experiment Treatment. A salt solution having a concentration of 0.3% and 0.6% was prepared by analyzing pure sodium chloride, and distilled water was used as a control (CK). The number of seedlings in the seedlings was recorded on the penultimate day of the salt stress treatment of the seedlings, and then NaCl treatment was performed every two days and the number of seedlings in the seedlings was recorded until the NaCl treatment was completely completed. The survival rates of seedlings with different concentrations of two cucumber varieties were calculated.

Growth Index Determination. Survival rate = total seedling survival / total number of seeds × 100%.

The height of the seedling from the cotyledon to the growth point was measured and recorded as the plant height; the thickness of the cotyledonary node parallel to the direction in which the seedling and the cotyledon were developed was measured, and the stem diameter was recorded.

The plant height was measured by a ruler; the stem diameter was measured by a vernier caliper; the leaf area was measured by a leaf area meter.

2.4 Data Processing and Analysis.

Excel2010 software is sued for data statistics and mapping, DPS7.05 software is used to analyze the difference between different cucumber varieties and different concentrations.

3. Results and Analysis

3.1 Effects of Different Concentrations of NaCl on Growth Index of Cucumber Seedlings.

Effects of Different Concentrations of NaCl on the Survival Rate of Cucumber Seedlings. As shown in Figure 1, with the increase of NaCl concentration, the survival rate of Jinchun 39 and Jinyan No. 4 cucumber seedlings was lower than that of the control and the survival rate under 0.6% NaCl treatment was significantly lower than that of the control. With the increase of the number of NaCl treatments, the survival rate of cucumber seedlings under the treatment of 0.6% NaCl decreased significantly and the survival rate of Jinyan No. 4 decreased more significantly. In the middle of NaCl treatment, the survival rate of 0.3% NaCl and 0.6% NaCl in Jinchun 39 cucumber seedlings decreased by 3.63% and 13.46%, respectively. The survival rate of 0.3% NaCl and 0.6% NaCl in Jinyan No. 4 cucumber seedlings decreased by 10% and 16.33%, respectively. In the late stage of NaCl treatment, the survival rate of 0.3% NaCl and 0.6% NaC of Jinchun 39 cucumber seedlings decreased by 14.5% and 30.77%, respectively. The survival rate of 0.3% NaCl and 0.6% NaCl in Jinyan No. 4 cucumber seedlings was 20% and 34% lower than that of the control, respectively. The survival rate of Jinyan No. 39 and Jinyan No. 4 cucumber seedlings treated with 0.3% NaCl and 0.6% NaCl was high. This indicates that the cucumber variety Jinchun 39 is more resistant to salt stress than Jinjin No. 4.

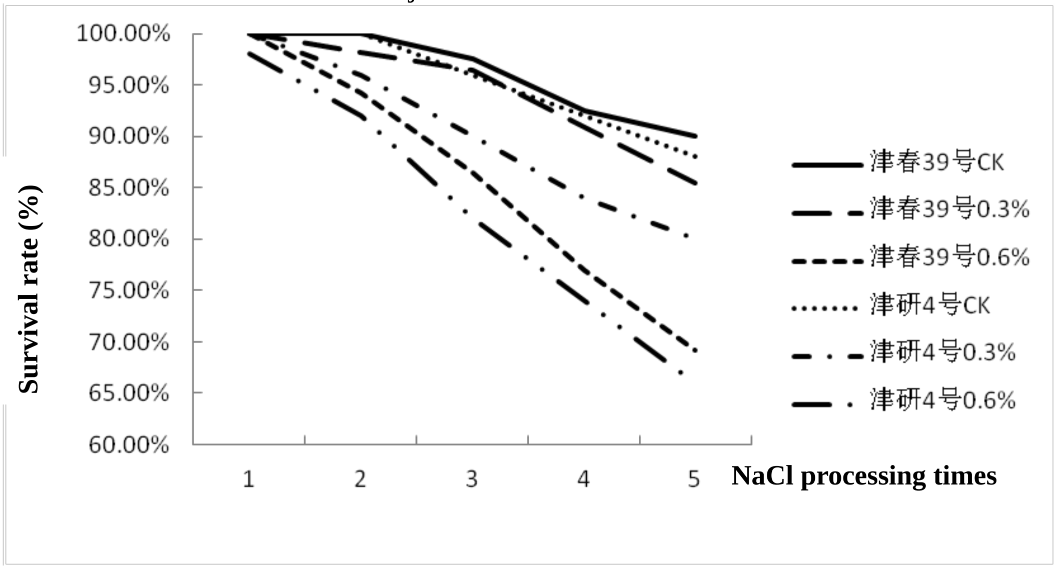

Figure. 1 Effects of Different Concentrations of NaCl on the Survival Rate of Cucumber Seedlings

Effects of Different Concentrations of NaCl on the Morphological Indexes of Cucumber Seedlings. As can be seen in Table 1, the plant height, stem diameter and leaf area of Jinchun 39 and Jinyan No. 4 all showed the maximum at 0.3% NaCl, indicating that the lower salt concentration promoted the growth of Jinchun No.39. The 0.3% NaCl plant height of Jinchun No.39 was 1.1 times that of the control, the 0.6% NaCl plant height was 6.4% lower than the control; the 0.3% NaCl stem diameter was 1.1 times that of the control, and the 0.6% NaCl stem diameter was 4.9% lower than the control; The leaf area of %NaCl was 1.5 times that of the control, and the area of 0.6% NaCl leaf was reduced by 12.0% compared with the control. The 0.3% NaCl treatment height of Jinyan No. 4 was 1.3 times that of the control, the 0.6% NaCl plant height was 18.1% lower than the control; the 0.3% NaCl plant height was 1.3 times that of the control, and the 0.6% NaCl plant height was 1.9% lower than the control group. The leaf area of 0.3% NaCl was 1.5 times that of the control, and the area of 0.6% NaCl leaf was reduced by 9.2% compared with the control.

It is concluded that with the increase of NaCl concentration, the increase and decrease of plant height of Jinyan No.4 seedlings are larger than that of Jinchun 39. The increase of stem diameter of Jinyan No.4 seedlings is larger than that of Jinchun No.39. The magnitude is smaller than Jinchun No.39; the increase in leaf area of Jinyan No. 4 seedlings was the same as that of Jinchun 39, and the decrease was smaller than that of Jinchun No.39. There was a significant difference in plant height between Jinchun No.39 and Jinyan No. 4, and there was no significant difference in stem diameter and leaf area. Compared with Jinchun No. 39, the low salt concentration has a great effect on the appearance index of Jinyan No.4 seedlings.

Table 1 Effects of Different Concentrations of NaCl on the Growth of Cucumber Seedlings

Indexes	Jinchun No.39			Jinyan No.4		
	CK	0.30%	0.6%	CK	0.30%	0.6%
Plant height (cm)	3.9c	4.73bc	3.63c	5.1b	6.8a	5.67b
Stem thickness (mm)	2.65b	2.98ab	2.49b	3.08ab	3.69a	3.18ab
Leaf area (cm^2)	7c	10.33ab	6.33c	8bc	13a	12a

Note: Different lowercase letters in the table indicate significant differences (P<0.05). The following figures and tables are the same.

3.2 Effects of Different Concentrations of NaCl on Physiological Indexes of Cucumber Seedlings.

Effects of Different Concentrations of NaCl on Membrane Permeability of Cucumber Seedlings. As shown in Figure 2, the relative conductivity of the leaves of Jinchun 39 and Jinyan No. 4 seedlings treated with NaCl at different concentrations increased with the increase of NaCl concentration. The relative electrical conductivity of cucumber seedlings treated with 0.3% 3% and 0.6% NaCl was 3.2 times and 3.8 times higher than that of the control. The relative electrical conductivity of cucumber seedlings treated with 0.3% 3% NaCl and 0.5% NaCl was 1.5 times and 2.4 times higher than that of the control. The relative conductivity of Jinchun No. 39 under the treatment of 0.3% NaCl suddenly increased sharply, indicating that the normal structure of the cell membrane was destroyed, and the intracellular material was extravasated, causing damage to plants; Ccompared with Jinchun 39, the relative conductivity of Jinyan No. 4 is relatively flat, but as the relative conductivity increases, the damage to plants is gradually increased [7].

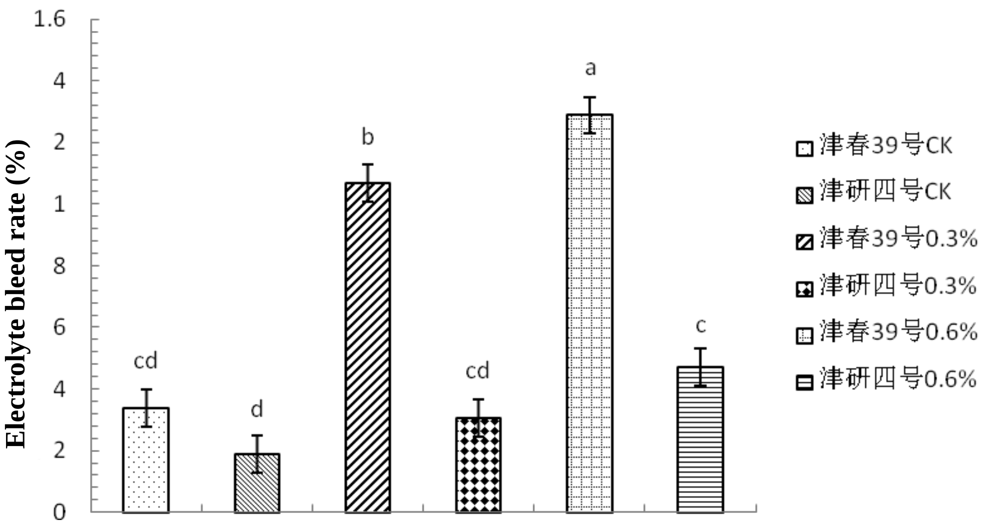

Figure. 2 Effects of Different Concentrations of NaCl on Plasma Membrane Permeability of Cucumber Seedlings

Effects of Different Concentrations of NaCl on Soluble Protein Content in Cucumber Seedlings. As shown in Figure 3, the soluble protein content of cucumber seedlings of Jinchun 39 and Jinyan No. 4 increased with the increase of NaCl concentration. This indicates that plants undergo synthesis of osmotic adjustment substances such as soluble proteins under salt stress to alleviate the damage caused by salt stress. At the salt concentration of 0.6%, the soluble protein content of the two cucumber varieties reached the maximum, which was 1920.523μg·g-^{1}FW and 1558.38μg·g-^{1}FW, respectively, and the lowest in the control (CK). The difference between Jinchun 39 control and 0.3% NaCl was significant, and the difference between 0.3% and 0.6% NaCl was not significant. The difference between the adjacent concentrations of Jinyan No. 4 was not significant, indicating that the plant metabolism was equal between the concentrations [8].

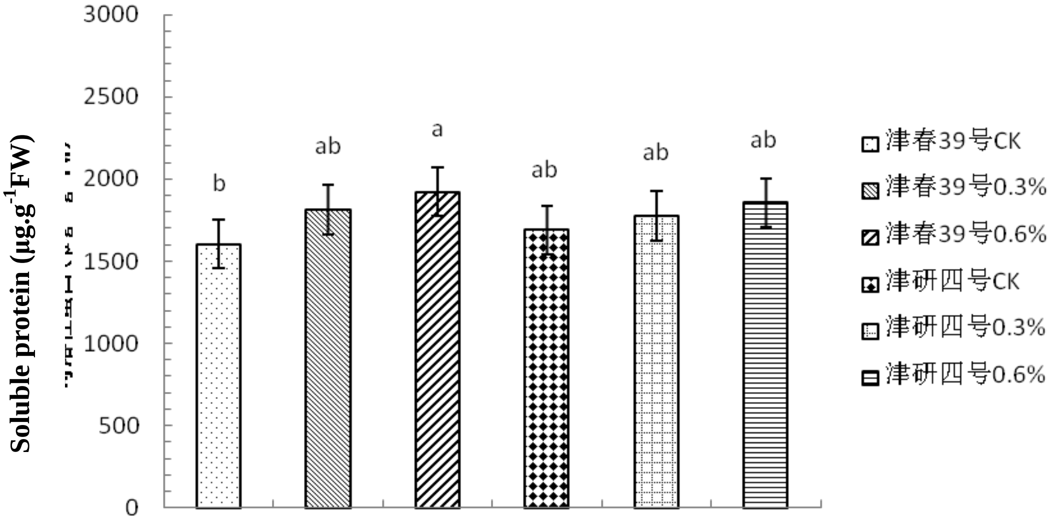

Figure. 3 Effects of NaCl Treatment at Different Concentrations on Soluble Protein Content in Cucumber Seedlings

Effects of Different Concentrations of NaCl on Root Activity of Cucumber Seedlings. Under salt stress, the roots of plant roots were the most directly affected by stress. As shown in Figure 4, with the increase of NaCl concentration, the root vigor of Jinchun No. 39 and Jinyan No. 4 cucumber seedlings gradually decreased. The root vigor of Jinchun No. 39 cucumber seedlings treated with 0.3% and 0.6% NaCl decreased by 31.7% and 40.7%, respectively. The root vigor of Jinyan No.4 cucumber seedlings decreased by 14.1% and 53.5%, respectively. The root vigor of Jinchun 39 and Jinyan No. 4 cucumber seedlings showed the maximum value at the control (CK), which were 6.487 μg TTF·g^{-1}FW·h^{-1} and 10.058 μg TTF·g^{-1}FW·h^{-1}, respectively. This shows that the former is more active than the latter; the root activity was the weakest at 0.6% concentration, which was 3.863 μg TTF·g^{-1}FW·h^{-1} and 4.806 μg TTF·g^{-1}FW·h^{-1}, respectively.

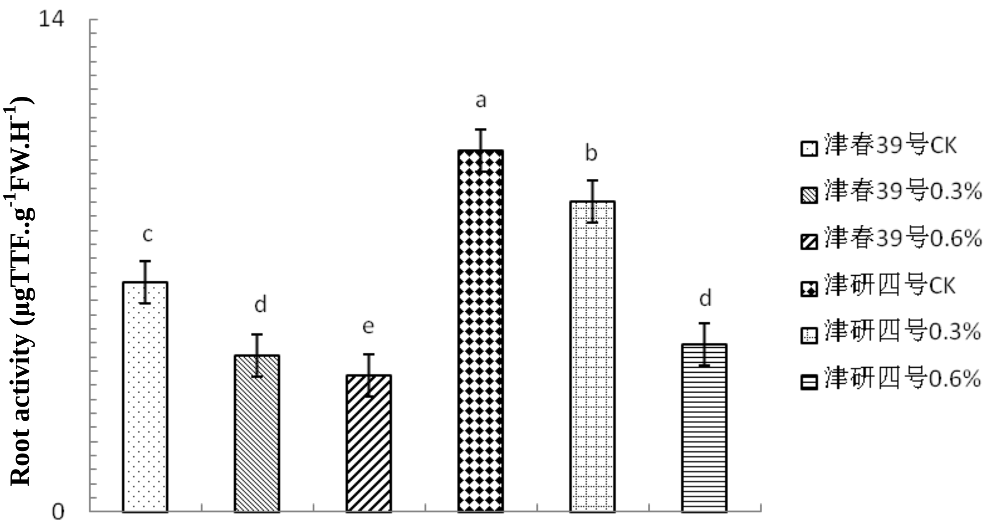

Figure. 4 Effects of Different Concentrations of NaCl on Root Activity of Cucumber Seedlings

Effects of Different Concentrations of NaCl on the Content of Malondialdehyde in Cucumber Seedlings. As can be seen from Figure 5, the MDA content of Jinchun 39 and Jinyan No. 4 cucumber seedlings increased gradually with the increase of NaCl concentration [10]. The malondialdehyde content of the cucumber seedlings of Jinchun No. 39 treated with 3% and 0.6% NaCl was 8.1 times and 10.7 times of that of the control, respectively; the malondialdehyde content of Jinyan No. 4 cucumber seedlings was 1.6 times and 1.8 times that of the control, respectively.

The MDA content of cucumber seedlings of Jinchun No. 39 and Jinyan No. 4 was the highest at 0.6% NaCl, and Jinchun No. 39 was larger than Jinyan No. 4. This shows that the degree of damage caused by salt stress on Jinchun No. 4 is greater than that of Jinyan No. 4. The highest malondialdehyde content of 0.6% in Jinchun No. 39 was 0.0393μmol·g -1FW, and the difference between the concentrations was significant. The highest malondialdehyde content of Jinyan No. 4 with a salt concentration of 0.3% was 0.00494μmol·g. -1FW, there was a significant difference between the control and 0.3% NaCl. With the increase of salt concentration, the content of malondialdehyde in cucumber seedlings of Jinchun 39 increased, and the degree of damage caused by salt stress increased.

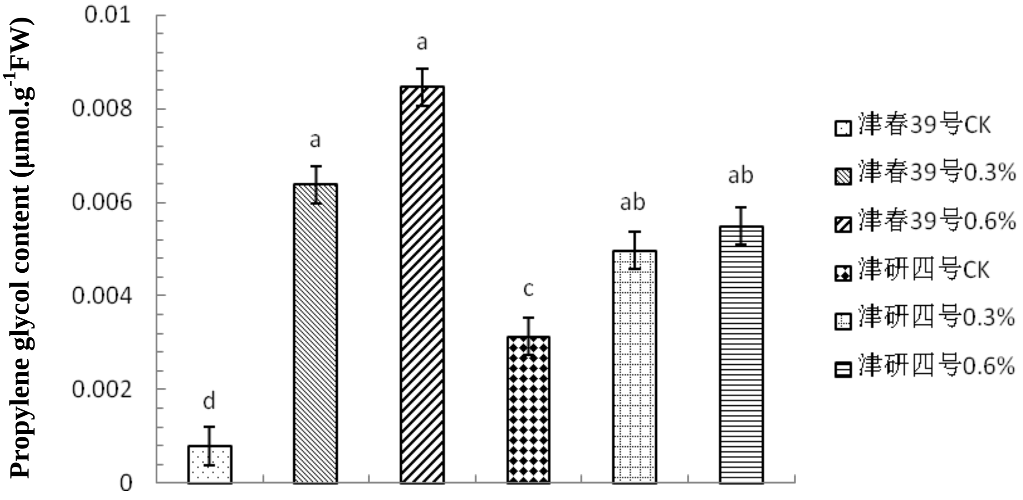

Figure. 5 Effects of NaCl Treatment at Different Concentrations on MDA Content in Cucumber Seedlings

4. Conclusion and Discussion

4.1 Conclusion.

The test materials were Jinchun No. 39 and Jinyan No. 4, and studied the effects of different salt concentrations on seedling growth and physiological indexes. The conclusions obtained in this experiment are as follows: with the increase of salt concentration, the survival rate decreases gradually and the growth of plants becomes smaller and smaller; the salt stress of appropriate low concentration (0.3% NaCl) affects the plant height and stem diameter of cucumber seedlings. Leaf area has the effect of promoting growth; but when the salt concentration is too high, the effect is reversed. Under salt stress, both cucumber seedlings showed increased soluble protein content and MDA content, which caused damage to the cell membrane and increased damage with increasing concentration. There was a significant difference in root activity between adjacent concentrations of the two varieties. Through comparison of the test data, it is concluded that Jinyan No. 4 is less salty than Jinchun No. 39. The experimental study period is the two-leaf and one-heart period of cucumber seedlings. Further research is needed to select the varieties with strong salt tolerance during the growth period of cucumber. After comprehensive comparison, it was found that the salt tolerance of Jinchun No. 39 was stronger than that of Jinyan No. 4.

4.2 Discussion.

Growth and Development of Cucumber Seedlings and Salt Stress. In Wang Suping and Guo Shirong et al., the effects of salt stress on root growth and water use of cucumber seedlings were studied. It was found that the earliest strains most directly affected by stress under salt stress were plant roots. Then the corresponding physiological reactions occur, and then affect the growth of the aboveground parts of the plants. Under the salt stress, the root growth of cucumber seedlings is significantly inhibited [11]. It can be seen from this experiment that the root activity of cucumber seedlings of Jinchun No. 39 gradually decreased with the increase of salt concentration, and the root activity of 0.3% NaCl and 0.6% NaCl was lower than that of the control. This indicates that root growth is significantly affected by high concentrations of salt stress.

Physiological and Salt Stress of Cucumber Seedlings. Studies have shown that [11-12] plants will synthesize osmotic adjustment substances such as soluble proteins to alleviate the damage caused by salt stress. In Zhou Qing's research [13], the materials were studied for Jinchun No. 2 and Jinyou No. 3 cucumber varieties, and it was found that the increase of NaCl concentration resulted in the decrease of soluble protein content in seedling leaves. However, the decrease of "Jinchun No.2" was greater than that of "Jinyou No.3", and the soluble protein content of "Jinchun No.2" decreased under continuous stress, while "Jinyou No.3" remained basically unchanged. This indicates that the plant membrane with strong salt tolerance is stable and the membrane permeability is less increased during the stress process. Maintaining high organic matter in salt-tolerant varieties under salt stress can reduce cell osmotic potential and adapt to saline environment, which may be one of the main reasons for salt tolerance of salt-tolerant varieties. However, the opposite conclusion appeared in the study of Han Bing. Under NaCl treatment, the soluble protein content in leaves and roots of cucumber seedlings was significantly increased, and the higher the concentration, the more obvious the increase of soluble protein content. The conclusions obtained in this experiment are consistent with Han Bing. Salt stress induces the production of soluble proteins and undergoes osmotic adjustment, thereby reducing cell water loss and reducing the damage caused by salt stress. The enhancement of plant resistance to salt stress is manifested by an increase in soluble protein content.

5. Conclusion

MDA is a membrane lipid peroxidation decomposition product, and its content can be used as one of the physiological indicators to identify the salt tolerance of cucumber seedlings to some extent [17]. Under salt stress treatment, the relative conductivity and MDA content of cucumber seedlings increased with the increase of salt stress concentration, indicating that salt stress caused cell membrane lipid peroxidation and destroyed the normal structure of cell membrane. The relative conductivity of the leaves of the plants increases, and the intracellular material is extravasated, causing damage to plants.

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