Effect of chemical modifiers on the growth of beet in saline soil

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Abstract. The effects of different combinations of three modifiers on the growth of beet on saline soil were studied. The results showed that the combination of calcium sulfate and ammonium sulfate in the four improved combinations of saline soil promoted the growth of beet. SPAD was 120.85% higher than the control group, the chlorophyll content was more than double that of the control group. The photosynthesis was strong, which played an important role in improving the quality of beet.

1. Introduction

In the 21st century, promoting agricultural development has become a focus of widespread concern in various countries in the world [1]. While China is vigorously developing its agricultural economy, an increasingly serious problem has gradually emerged-soil salinization [2–3]. Soil salinization will seriously affect the physical properties of the soil, reduce soil permeability, surface soils tend to shrink and agglomerate when dry, and expand muddy soil when wet, reducing soil fertility, and due to the high concentration of salt separator, it will also seriously affect The growth of crops thereon reduces yield[4]. According to the data from the second national soil census, there are about 3.69×10\textsuperscript{7} hm\textsuperscript{2} of saline soil in China, of which the salinized area of cultivated land is 9.21×10\textsuperscript{6} hm\textsuperscript{2}[5], accounting for 6.62% of the total cultivated land area in China.

A lot of research work has been done on the improvement and utilization of saline soil. Studies have shown that the use of underground drainage can reduce the critical depth of groundwater, and the desalination rate can reach more than 85% [6–8]; in areas with drought and lack of rainfall and insufficient water sources, sprinkler irrigation or drip irrigation can be used to inhibit soil salt return Prevent groundwater levels from rising [9–10]. Domestic scholars have studied the use of chemical measures such as biological waste, bio-organic fertilizer, biochemical fulvic acid, gypsum, and aluminum sulfate to improve saline soils [11–12]. No studies have been reported in the literature.

In this study, beet [13], a salt-tolerant crop, was selected as the research object. By applying modifier A (the main chemical component of which is calcium sulfate), modifier B (the main chemical

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component of which is ammonium sulfate), and modifier C to the soil (The main component is humus). The plant height and chlorophyll of sugar beet were analyzed in order to make a scientific evaluation of the soil improvement effect of saline soil improved fertilizer.

2. Materials and methods

2.1. Test materials
According to the occurrence conditions of salinized soil, loamy soil is the most prone to secondary salinization. To this end, the local loessy loess in Fuping, Shaanxi was selected as the test soil. For precise research, the common NaCl salinization For soil, the concentration is set to 0.4% NaCl, which is the level of moderate salinization. A 20 cm diameter plastic pot with a height of 16 cm and a bulk density of 1.3 g / cm³ was used. The test soil passed a 5 mm sieve, and each pot contained about 3.64 kg.

2.2. Test method
A total of 4 modifiers were set and mixed with NaCl-type saline soils respectively. Using saline soils as a control, there were 5 treatments, and each treatment was designed with 3 replicates.

| Type     | Number | Modifier ratios       |
|----------|--------|-----------------------|
| Saline soil | CK     | CK                    |
|          | S1     | 1%A+1%B               |
|          | S2     | 1%A+10%C              |
|          | S3     | 1%B+10%C              |
|          | S4     | 1%A+1%B+10%C          |

All pots are fertilized at one time. After the fertilizer and soil are mixed well, they are put into plastic pots. The fertilization amount of each pot is: N-P₂O₅-K₂O: 5-3-3g. After the first irrigation is completed, the water is poured to the field water holding capacity. In the later period, to ensure that the water content of each treated soil is maintained at 100% to 60% of the field water holding capacity, which is lower than 60% of the field water holding capacity, irrigation is started. It is 40% of the water holding capacity in the field.

The pots are placed in random blocks, and the positions are exchanged regularly to eliminate the impact of environmental differences.

2.3. Detection indicators and data processing
Beet plant height was measured with a steel ruler; chlorophyll was measured with a chlorophyll meter.

The test data was analyzed and plotted using Excel2010.

3. Results and analysis

3.1. Effect of different modifier combinations on sugar beet plant height
The change of beet plant height with time on saline soil is shown in Figure 1. The beet plant height of each treatment increased with time, and the beet plant height of S3 treatment in each period showed the lowest among treatments. The beet plant height in February was S2>S1>CK>S4>S3. The beet plant height of each treatment was 11.30cm in the control treatment; S1 was 8.23% higher than CK; the beet plant height in S2 was the highest at 13.87cm, which was CK is 22.74% higher; the beet plant height of S3 is the lowest at 6.17cm, which is 45.40% lower than CK; S4 is 29.20% lower than CK. The beet plant height in March was S1>S4>CK>S2>S3. The beet plant height of each treatment was 18.32cm in the control treatment; the beet plant height of S1 was the highest at 19.90cm, which was 8.62% higher than the CK; CK is 2.13% lower; the beet plant height of S3 is the lowest at 13.77cm,
which is 24.84% lower than CK; S4 is 2.78% higher than CK. The beet plant height in April was S1>CK>S2>S4>S3. The beet plant height of each treatment was 23.97cm in the control treatment. The beet plant height of S1 was the highest at 25.57cm, which was 6.68% higher than CK. CK was 0.17% lower; the beet plant height of S3 was the lowest at 21.83 cm, which was 8.93% lower than CK; S4 was 0.71% lower than CK.

As shown in the figure, in the early stage of beet growth, the proportion of modifiers treated by S1 and S2 promoted the growth of sugar beet better, while the treatment of S3 and S4 was worse. The difference between S4 and S4 is not large, and the improvement effect is not obvious. The beet plant height under the S3 treatment modifier ratio has always been lower than that of CK, which has a poor improvement effect on saline soil, and has an inhibitory effect on beet growth.

![Beet Plant Height](image)

**Figure 1.** Variation of beet plant height in different treatments

### 3.2. Effect of different modifier combinations on beet chlorophyll

The chlorophyll content of sugar beet in each treatment is shown in Figure 2. The chlorophyll content of beet in CK and S2 changed little with time, and the chlorophyll content of beet treated by S1, S3 and S4 increased with time, and photosynthesis increased. The beet chlorophyll content in February was S2> S1> CK> S3> S4. Among the beet chlorophyll content of each treatment, the SPAD of the control treatment CK was 34.07; S1 was 35.52% higher than CK; the beet chlorophyll content of S2 was the highest and SPAD was 53.97, Which is 58.41% higher than CK; S3 is 1.97% lower than CK; S4 has the lowest chlorophyll content, with SPAD of 14.43, which is 57.64% lower than CK. The beet chlorophyll content in March was S1> S2> S4> CK> S3. Among the beet chlorophyll content of each treatment, the SPAD of the control treatment CK was 33.83; the beet chlorophyll of S1 was the highest at 64.70, which was 91.25% higher than CK; CK was 76.26% higher; S3 had the lowest chlorophyll content, with SPAD of 33.70, which was 0.38% lower than CK; S4 was 6.80% higher than CK. The beet chlorophyll content in April showed S1> S2> S3> S4> CK. Among the beet chlorophylls of each treatment, the chlorophyll content of control CK was the lowest, SPAD was 37.07; the beet chlorophyll content of S1 was the highest, SPAD was 81.87, which was higher than CK. 120.85%; S2 is 52.68% higher than CK; S3 is 24.44% higher than CK; S4 is 18.15% higher than CK.

In the figure, the change of chlorophyll content in each treatment was similar to the change in plant height, but in the later stage of beet growth, the beet chlorophyll content in S3 exceeded the control treatment CK, which was inconsistent with plant height performance. The chlorophyll content of CK and S2 did not change much with time, indicating that the photosynthesis intensity of the two changes was small. However, the chlorophyll content of S2 was still higher than that of CK, S3 and S4 during the whole beet growth period, which was lower than that of beet growth S1 treatment showed that the photosynthesis of sugar beet treated by S2 was always stronger than that of CK, S3 and S4. The SPAD treated by S1 was 44.65% higher than the S2 treated at the end, and photosynthesis was the strongest.
4. Summary and discussion

The change of beet plant height and chlorophyll under different ratios of improvers in saline soil is about the same, but the effect of different treatments on chlorophyll is greater than the plant height. Get bigger. In each treatment, S1 and S2 performed better, and S3 and S4 performed worse. The results showed that the coupling effect of calcium sulfate and humus in the modifier on the improvement of saline soil was better in the early stage, and the plant height, chlorophyll content and photosynthesis of sugar beet performed best in the early stage of growth, and it was also good in the middle and late stages. The effect of the coupling of calcium sulfate and ammonium sulfate on the improvement of saline soil in the improver is obvious in the middle and late stages of sugar beet, especially the chlorophyll content, which is much higher than other treatments in the later stage, and has a better effect on improving sugar beet photosynthesis and sugar beet quality. However, the coupling effect of calcium sulfate and humus and calcium sulfate, ammonium sulfate and humus combined with the modifier on saline soil is not ideal. The inhibitory effect on sugar beet growth is even higher than that of unmodified saline soil. The performance is slightly better than the control treatment.

From the above, it can be judged that there may be a certain chemical reaction between ammonium sulfate and humus, and the substances produced will cause stress on the growth of sugar beet, and the combination of calcium sulfate and humus modifier in the early stage of beet growth is better; calcium sulfate and sulfuric acid Ammonium modifiers have a better promotion effect in the middle and late stages of beet growth, especially the effect of improving beet quality is more obvious. This article did not make in-depth research on the interaction mechanism between the modifiers and the effects of the modifiers on the nutrients of saline soils. It is suggested that further studies on the interactions between the modifiers and the effects of the modifiers on the nutrients of saline soils should be carried out in the future.

Acknowledgments

This work was financially supported by Internal Scientific Research Project of Shaanxi Land Engineering Construction Group fund (No. DJNY2019-14).

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