

# Study On the Application of Nitro-Compound Fertilizer to Improve Saline-Alkali Soil

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**Abstract.** The deterioration of soil quality in saline-alkali land has always been a major problem restricting the development of agriculture in China. Therefore, this study studied the application effect of nitro-compound fertilizer through experiments, aiming to explore the application prospect and popularization value of nitro-compound fertilizer in saline-alkali land agriculture. The experimental results showed that nitro-compound fertilizer could significantly improve the soil quality and increase the yield and growth of crops in saline-alkali soil. The addition amount of 2.5-10 kg/ mu is more suitable, and the addition of 10 kg/ mu of nitro-compound fertilizer can increase the yield of corn by 217%. In addition, the addition of nitro-compound fertilizer can not only significantly reduce the soil salt content, the reduction can reach 37.5%, but also significantly improve the soil alkalinity. pH value decreased from the original 9.4 to 7.12, a decrease of 2.28. This showed that the application of nitro-compound fertilizer had a remarkable improvement effect in regulating soil alkalinity. Therefore, the application of nitro-compound fertilizer has wide application prospect and popularization value in saline-alkali land agriculture.

**Keywords:** Saline-alkali land improvement; Nitro-compound fertilizer; Crop yield; Soil salinity.

## 1. Introduction

Saline-alkali soil refers to soil containing too much salt and alkaline substances, resulting in soil pH imbalance, nutrient deficiency and ecosystem imbalance, thus affecting agricultural production and ecological environment [1-2]. At present, China has a large number of saline-alkali land, accounting for about 17% of the country's arable land, which has seriously affected China's food production and sustainable agricultural development. Therefore, the improvement of saline-alkali land has become an important issue for agricultural production and ecological environment protection in the world. As an important plant nutrient supply source, water-soluble nitrogen fertilizer plays an important role in agricultural production. However, when water-soluble nitrogen fertilizers are applied to saline-alkali soils, those traditional nitrogen fertilizers may lead to a further increase in soil salinity [3-4]. Therefore, for the restoration and improvement of saline-alkali soil, it is necessary to research and develop a new type of fertilizer that can adapt to saline-alkali soil [5].

The yield, quality and nitrogen use efficiency of maize were affected by gradient application of nitrogen fertilizer in saline soil. Yan Y found that the appropriate application of nitrogen fertilizer can promote the growth and development of maize and increase its yield. Nitrogen is a key component of plant protein, chlorophyll, nucleic acid and other important nutrients, and it plays an important role in regulating plant growth and photosynthesis. Therefore, in order to maximize the yield and quality of corn and ensure the efficiency of nitrogen fertilizer use, appropriate nitrogen fertilizer application must be carried out. In addition, the growth of corn in saline-alkali soil is also affected by salt, so the special properties of saline-alkali soil must be considered when applying fertilizer [6]. Different nitrate and ammonium ratios affected the growth and nitrogen metabolism of soybean seedlings under salt-alkali stress. Li X found that under salt and alkali stress, appropriate nitrate can improve the growth and nitrogen metabolism capacity of soybean seedlings, reduce the accumulation of nitrogen metabolic waste, and promote nitrogen use efficiency. In contrast, high ammonium ratios may lead to nitrogen accumulation within the plant, thus affecting the growth and nitrogen metabolism of soybean seedlings. Therefore, under salt-alkali stress, increasing the supply ratio of nitrate and

reducing the supply of ammonium are beneficial to improve the efficiency of nitrogen utilization and the adaptability of soybean seedlings to salt-alkali stress. In addition, it is also necessary to consider the soil pH value and the supply of other fertilizer elements, so as to comprehensively consider the nutritional requirements and environmental conditions of plants and achieve the best growth effect [7].

Under salt and alkali stress, nitrogen application can reduce the inhibitory effect of exogenous betaine on soybean growth. Yang D found that the application of appropriate nitrogen fertilizer can increase the growth of soybean seedlings and reduce the growth restriction caused by saline-alkali stress. At the same time, the increase of exogenous betaine content will inhibit the growth of soybean, but the application of a certain amount of nitrogen fertilizer can alleviate the inhibitory effect and increase the growth rate of soybean. Therefore, the application of nitrogen fertilizer can reduce the inhibitory effect of exogenous betaine on soybean growth under salt-alkali stress and improve the adaptability of soybean.

It should be noted that the application of nitrogen fertilizer can not exceed the amount, excessive nitrogen fertilizer will not only waste resources, but also increase nitrogen emissions in the atmosphere, causing a negative impact on the environment. Therefore, appropriate amount of nitrogen fertilizer should be applied and the amount of nitrogen fertilizer should be strictly controlled to improve nitrogen utilization efficiency and avoid negative impact on the environment [8].

In this context, this paper will study and discuss the application effect and mechanism of a new type of fertilizer - nitro compound fertilizer in improving saline-alkali soil, aiming at providing practical solutions for the restoration and agricultural development of saline-alkali soil in China.

## **2. Relevant research**

### **2.1. Overview of nitro-compound fertilizer**

Nitro-compound fertilizer is a fertilizer composed of two or more types of nitrogen fertilizer or other fertilizers mixed in proportion. Its main forms are ammonium nitrogen and nitrate nitrogen, which can provide relatively complete nutrients for plants [9-10]. Among them, ammonium nitrogen is easily absorbed and transferred in plants, so it is considered as the absorbable nitrogen source of plants. Nitrate nitrogen plays an important role in the growth of tillers, leaves, flowers and fruits. The advantage of nitro-compound fertilizer is that it can meet the nutrient needs of a variety of crops (such as rice, wheat, corn, cotton, watermelon, tomatoes, peppers, etc.), while pure fertilizer can often only be used on specific crops. At the same time, the application of nitro-compound fertilizer is also more convenient than that of traditional pure fertilizer, and through reasonable application, it can also improve the absorption efficiency of nutrients by plants.

### **2.2. Saline-alkali land formation and problems**

Saline-alkali land is caused by the concentration of water-soluble salt in soil, which generally occurs under the factors of drought and water shortage, poor soil drainage and improper greening construction. In addition to the impact on the natural environment, the formation of saline-alkali land also brings many challenges to economic, social and ecological issues [11-12]. With the accumulation of salt in saline soil, soil porosity will also decrease, resulting in an increase in soil moisture and a decrease in aeration, thus impeding plant growth. In addition, the salt in saline-alkali land will also have a toxic effect on plant roots, inhibit the growth and development of plants and nutrient absorption. Saline-alkali land improvement refers to changing the soil structure and chemical properties of saline-alkali land by certain methods, so as to restore or improve the production function of saline-alkali soil. Saline-alkali land improvement is one of the key technologies to achieve sustainable agricultural development [13-14].

### 2.3. Theoretical basis of nitro-compound fertilizer improvement of saline-alkali land

Nitro-compound fertilizer has important theoretical basis and practical significance for improving saline-alkali land. The main function of nitro-compound fertilizer is that the nitrate ions produced in the process of nitrification in the soil can reduce the soil pH value and increase the soil volume ratio, so as to improve the environmental conditions of saline-alkali soil. During nitrification, nitrate ions can be plasma-combined with sodium and potassium to form salt, thereby reducing the chance of collision between non-salt ions in saline-alkali soil, thereby reducing soil conductivity and water tension, promoting plant root growth and nutrient absorption, and thus enhancing plant salt tolerance [15]. In addition, nitro-compound fertilizer can improve soil organic matter content and microbial activity, improve soil quality and ecological environment, maintain soil water and nutrients, ensure soil fertility and increase nutrient utilization efficiency, so as to improve the yield and quality of plants on saline-alkali land. As shown in Figure 1:

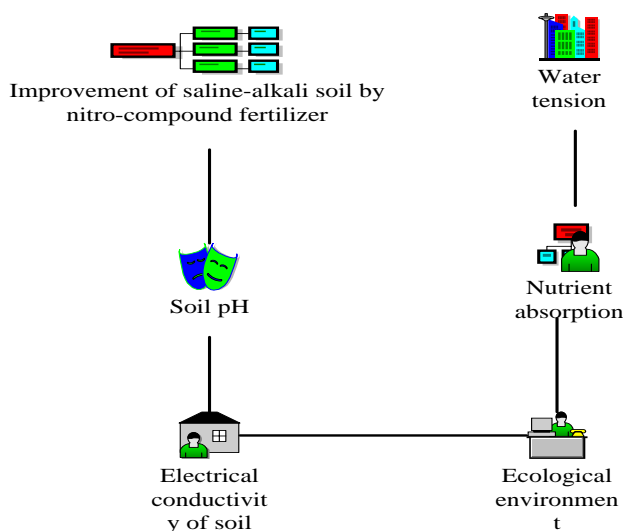


Figure 1. Flow chart of the improvement of saline-alkali soil by nitro-compound fertilizer

## 3. Experimental study on the improvement effect of nitro-compound fertilizer on saline-alkali land

### 3.1. Experimental purpose

The purpose of this experiment is to study the application effect of nitro-compound fertilizer in saline-alkali land improvement, compare the plant growth and soil chemical property changes of nitro-compound fertilizer treatment and untreated saline-alkali land, further explore the improvement effect of nitro-compound fertilizer on saline-alkali land, and provide practical and theoretical support for the treatment of saline-alkali land.

### 3.2. Analysis

In the experiment, we selected a saline-alkali soil to carry out the experiment, the soil was treated with 0, 75, 150, 225 and 300 kg/hm<sup>2</sup> nitro-compound fertilizer, and the control group was set up, and the continuous observation was carried out for 120 days to quantify the growth of corn and the change of soil chemical properties. The results are shown in Table 1:

**Table 1:** Plant growth and soil chemical properties in treated and untreated saline soils

Option	Average plant height (cm)	Average ground dry weight (g/m <sup>2</sup> )	pH value	Total nitrogen content (g/kg)	Soil organic matter content (g/kg)
Control group	19.43	7.82	9.40	0.64	4.11
Treatment 1	32.87	10.64	7.84	1.02	7.98
Treatment 2	35.62	12.18	7.42	1.16	9.32
Treatment 3	37.69	12.97	7.26	1.36	10.42
Treatment 4	39.04	13.54	7.12	1.57	11.73

As can be seen from Table 1, in the control group without nitro-compound fertilizer application, the average plant height was 19.43 cm, the average above-ground dry weight was 7.82 g/m<sup>2</sup>, and the pH value was 9.40. After nitro-compound fertilizer was applied, the height and dry weight of the plant increased significantly, while the pH value decreased significantly. At the same time, the content of total nitrogen and organic matter in the soil treated with nitro-compound fertilizer was also higher than that in the untreated control group. For example, the total nitrogen content and organic matter content in the treatment 4 group were 1.57 g/kg and 11.73 g/kg, respectively, which were significantly higher than those in the control group (0.64 g/kg and 4.11 g/kg). These data show that the application of nitro-compound fertilizer can improve the growth of plants and the chemical properties of soil, so as to promote the improvement of saline-alkali land.

### 3.3. Results

Nitro-compound fertilizer treatment significantly improves plant growth conditions and soil chemistry, because nitro-compound fertilizer contains high concentrations of nutrients and organic matter, which may be insufficient in saline-alkali soil, and treatment can effectively replenish missing nutrients and organic matter. In addition, nitro-compound fertilizers may regulate the ion balance in the soil, making the soil more suitable for plant growth. In summary, nitro-compound fertilizer has important application value in saline-alkali land improvement. In actual operation, the appropriate application amount and application period should be selected according to the specific situation to achieve better results.

## 4. Application results and discussion of nitro-compound fertilizer to improve saline-alkali land

### 4.1. Introduction

Saline-alkali land is one of the most extensive land types in the world, and molecular level fertilization can improve the efficiency of soil fertility use. In this paper, we studied the application of nitro-compound fertilizer in improving saline-alkali land, analyzed its effect on soil improvement, and discussed its application strategy.

### 4.2. Analysis and results

For common maize in saline-alkali land, nitro-compound fertilizer was used to increase crop yield and improve the quality of saline-alkali land. Different amounts of nitro-compound fertilizer were used in the experiment, specifically the base fertilizer: 18-18-9, 40kg per mu; The amount of pressed salt and alkali before seedling stage: 26.5-11.5-0, 5kg applied per mu; 4-5 leaf stage: 26.5-11.5-0,

10kg applied per mu; 11-12 leaf stage: 26.5-11.5-0, 25kg applied per mu; Granular fertilizer: 22-8-10, 10kg per mu. The control group received no added fertilizer.

The experimental process is as follows:

(1) Preparation: Select suitable saline-alkali land plots, and divide the plots into experimental group and control group.

(2) Application of base fertilizer: Before sowing, the nitro compound fertilizer base fertilizer is evenly spread in the plot at the ratio of 18-18-9, and 40kg is applied per mu.

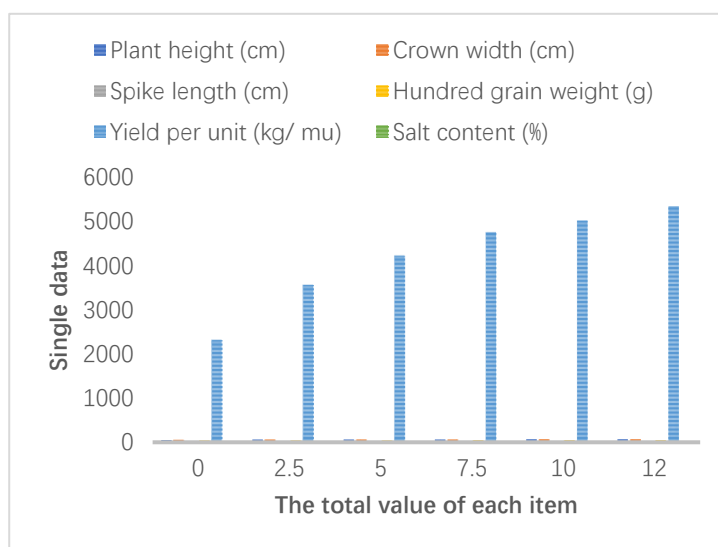
(3) Application of pressure salt and alkali fertilizer: Before crop emergence, the nitro-compound fertilizer pressure salt and alkali fertilizer is evenly spread in the plot at a ratio of 26.5-11.5-0, and 5kg is applied per mu.

(4) Application of 4-5 leaf stage fertilizer: When the crop grows to 4-5 leaf stage, the nitrate compound fertilizer 4-5 leaf stage fertilizer is evenly spread in the plot at a ratio of 26.5-11.5-0, and 10kg is applied per mu.

(5) Application of 11-12 leaf stage fertilizer: When the crop grows to 11-12 leaf stage, the nitro compound fertilizer 11-12 leaf stage fertilizer is evenly spread in the plot at a ratio of 26.5-11.5-0, and 25kg is applied per mu.

(6) Application of tapping fertilizer: Before the crop heading stage, the nitro compound fertilizer tapping fertilizer is evenly spread in the plot at a ratio of 22-8-10, and 10kg is applied per mu.

(7) Analysis records: the growth conditions of crops in the experimental group and the control group were observed and the output was recorded. In addition, soil quality is analyzed and assessed. As shown in Figure 2:



**Figure. 2.** Effects of different amounts of nitro-compound fertilizer on growth, yield and soil quality of common wheat

As shown in Figure 2, when nitro-compound fertilizer was applied, the growth condition and yield of maize were significantly improved with the increase of the added amount. At the same time, nitro-compound fertilizer also has the effect of reducing soil salt content and soil alkalinity (pH). Specifically, when 2.5kg nitro-compound fertilizer was added, corn yield (per unit yield) could be increased by 53% (2313.33 kg/ mu in the control group and 3560.00 kg/ mu in the 2.5kg nitro-compound fertilizer). In the case of adding 10kg nitro-compound fertilizer, the yield showed the highest peak (5013.33 kg/ mu). In addition, the addition of nitro-compound fertilizer also significantly reduced the soil salt content, from 0.80% in the control group to 0.5% after adding 10kg nitro-compound fertilizer, a reduction of 37.5%. Therefore, the application of suitable amount of nitro-compound fertilizer can effectively improve the quality of saline-alkali land and increase the yield of crops.

### 4.3. Policies

The main strategy of nitro-compound fertilizer to improve saline-alkali land is to increase nutrients under the condition of poor soil quality, so as to improve crop growth and yield. In practical application, it is necessary to determine the appropriate fertilizer amount according to the characteristics of the area. As can be seen from the experimental data, the addition amount between 2.5-10kg/ mu is more appropriate, too much or too little will affect the growth of too much or too little will have a negative impact on the growth of crops. If too much nitro-compound fertilizer is applied, it will lead to too high concentration of nitrogen fertilizer in the soil, but it will affect the absorption and utilization efficiency of plants, and may cause soil acidification, resulting in a decline in soil quality. Conversely, if too little nitro-compound fertilizer is applied, it can not meet the nutrients required for plant growth, and it will also affect factors such as yield and quality. Therefore, in specific practice, the amount of fertilizer should be scientifically determined according to geographical location, soil properties, crop characteristics and fertilization costs and other factors to achieve the best effect.

In addition, the application time of nitro-compound fertilizer will also affect its fertilization effect. In general, topdressing during the growing season of plants will produce better results, especially in crops with a longer growth period. Therefore, in the process of practical application of nitro-compound fertilizer, the principle of scientific, standardized and long-term fertilization should be followed, and the reasonable application of fertilization can not only make full use of nutrients, but also ensure the production efficiency and sustainable development of saline-alkali land agriculture.

## 5. Conclusion

The application of nitro-compound fertilizer can significantly improve the soil quality and increase the yield and growth of crops in saline-alkali land. The addition amount of 2.5-10 kg/ mu is more suitable, too much or too little will affect the growth effect, adding 5-10 kg/ mu of nitro-compound fertilizer has the most significant effect on the improvement of corn yield, and adding 10 kg/ mu of nitro-compound fertilizer can increase its yield by 217%. The addition of nitro-compound fertilizer can not only significantly improve the growth condition and yield of maize, but also significantly reduce the salt content of saline-alkali soil, and has the effect of reducing soil alkalinity (pH). Therefore, the application of nitro-compound fertilizer has wide application prospect and popularization value in saline-alkali land agriculture, and also provides an effective way for the sustainable development of agriculture.

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