Nutrient inversion and hyperspectral feature extraction of sea rice at different growth stages

Shuwen Wang[1],Ronghua Wen[1],Ming Li[1],Xiping Lu[2]

1 School of Electronics and Electrical Engineering, Lingnan Normal University, Zhanjiang 524048, China

2 Guangdong HUACO Electrical Appliance Group Co., Ltd, Lianjiang 524400, China

Abstract: Nitrogen is a large amount of essential elements for the growth and development of sea rice. Monitoring the nitrogen nutrition status of sea rice timely and accurately, and rational fertilization of sea rice is of great significance for increasing yield, optimizing quality and reducing water pollution. The remote sensing diagnosis technology of sea rice nutrition has the characteristics of simple, non-destructive and rapid, and has been widely studied and applied by experts in various countries. In this experiment, the sea red rice varieties were taken as an example. Through field experiment, the leaves of sea rice in four growth stages were collected by using chlorophyll analyzer and near infrared spectrometer, and the chlorophyll value and spectral reflectance of sea rice leaves were determined. The results showed that the spectral reflectance of sea rice leaves in different growth stages had obvious changes. The sensitive band of sea rice leaves was further found by combining the spectral curve, which laid the foundation for the future nitrogen nutrition diagnosis of sea rice.

Key words: sea rice; Nutrient; Hyperspectral; Spectral reflectance; Sensitive bands

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1. Introduction

China has 1.5 billion mu of saline-alkali land and over 35 million mu of coastal beaches, of which about 15 percent can be transformed and utilized. The developed and utilized area is about 200 million mu, accounting for 10 percent of the country's total arable land. Sea rice can grow naturally under the conditions of certain salinity seawater irrigation, and achieve a grain yield of about 300-500 kg per mu. At the same time, sea rice also has important functions such as drought resistance and insect resistance, ecological restoration, and has greater ecological utility and market promotion value. Once the sea rice is fully promoted and planted, it will effectively reduce the saline-alkali land area in China and carry out ecological restoration, and also effectively alleviate the food security problem in China, which has important economic value and social significance.

Nitrogen is a large number of essential elements for the growth and development of sea rice, timely and accurately monitoring the nitrogen nutrition status of sea rice, and rational fertilization of sea rice is of great significance for increasing production, optimizing quality and reducing water pollution. However, due to the difference in nitrogen management level of farmers, the phenomenon of over-fertilization and under-fertilization coexist, and the problems such as unreasonable fertilization period are prominent, resulting in serious nitrogen loss and low nitrogen utilization rate in farmland. How to determine the reasonable fertilizer amount and fertilization period to make the fertilizer supply consistent with the law of sea rice fertilizer requirement is the key to improve the nitrogen utilization rate, and then improve the yield and quality of sea rice. Remote sensing diagnosis technology of crop nitrogen nutrition status has been widely studied and applied by agronomists in various countries because of its simple, non-destructive, rapid, and can improve nitrogen utilization rate and save tillage cost. This experiment took sea red rice varieties as the research object, and found the sensitive band of leaves suitable for sea red rice varieties, which provided the basis for establishing nutritional diagnosis model in the future.

2. The experimental part

(1) Experimental design

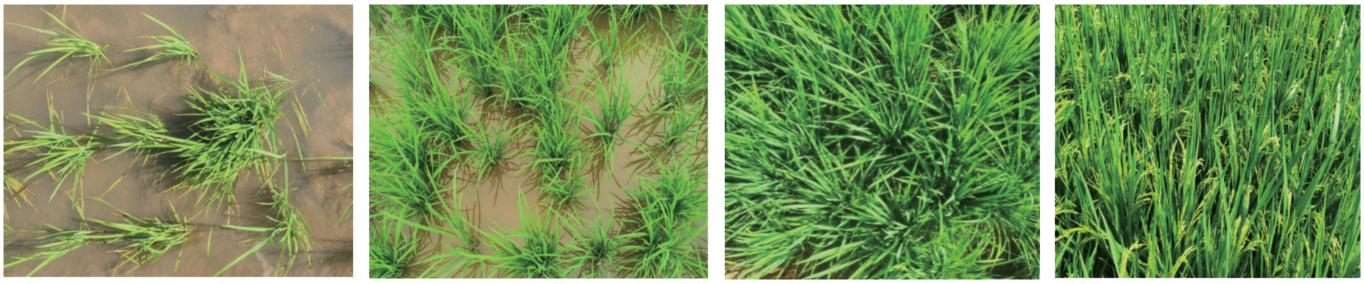
The experiment was conducted at the saline-alkali tolerant rice variety testing and display base of Buchao Village, Jianxin Town, Suixi County, Zhanjiang City, Guangdong Province, with Haihong 11 as the experimental research object. The base fertilizer used 15 kg of urea, 40 kg of superphosphate and 7.5 kg of potassium chloride per mu. 7 kg urea per mu is applied 7-10 days after transplanting, and 7 kg potassium chloride per mu is applied 15 days after transplanting. The experiment was carried out during the replanting period from April 2 to April 6, the tillering period from April 25 to April 29, the jointing period from May 19 to May 23, and the filling period from June 17 to June 21.

(2) Sea rice leaf collection

The sea rice leaves were collected in the field at the regreening stage, tillering stage, jointing stage and heading stage respectively. The pictures of sea rice at different stages are shown in FIG. 1.

(3) Determination of chlorophyll in sea rice leaves

In the field, sea rice leaf chlorophyll was determined by using a chlorophyll analyzer, and 100 leaves were collected from different growth periods for determination. The scatter diagram of sea rice leaf chlorophyll value in different growth periods is shown in Figure 2.



(a) Regreening stage **(b) tillering stage** **(c) jointing period** **(d) grouting period**

FIG. 1 Sea rice canopy at different growth stages

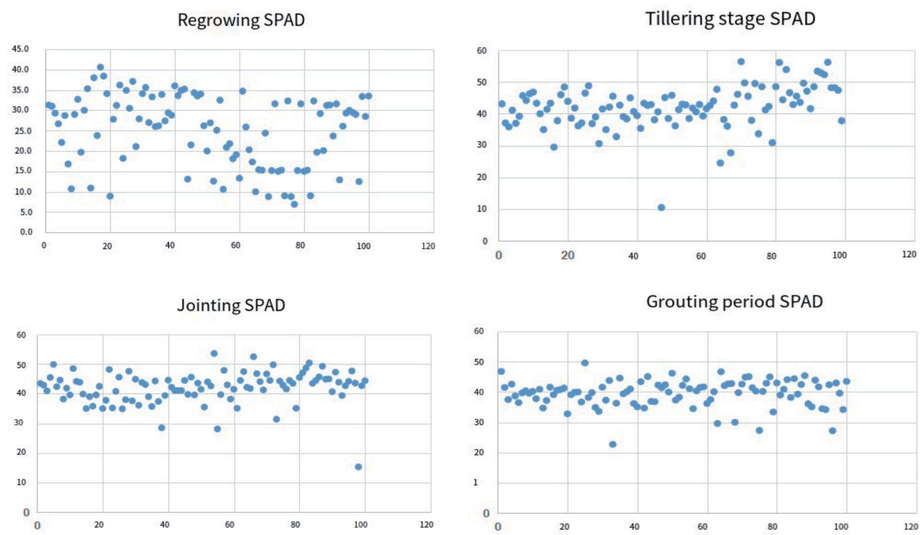


FIG. 2 Scatter plots of chlorophyll of sea rice leaves at different growth stages

(4) Spectral reflectance extraction of sea rice leaves

Sea rice leaves of different growth stages of sea rice were collected, stored in an incubator, and brought back to the laboratory for hyperspectral reflectance extraction. Near-infrared spectroscopy was used to extract the spectral information of sea rice leaves. The spectrum acquisition system consists of SW2520-050-NIRA (Taiwan, China) NIR spectrometer, optical fiber, halogen light source, computer and adjustable displacement platform. The collection range and optical resolution of the spectrometer are 950-1700nm and 6.5nm respectively. The spectral data was obtained in reflection mode and included 114 wavelengths. To reduce noise, black and white corrections were made beforehand.

The spectral reflectance of 100 sea rice leaves at different growth stages was extracted, and the reflectance curve was shown in Figure 3:

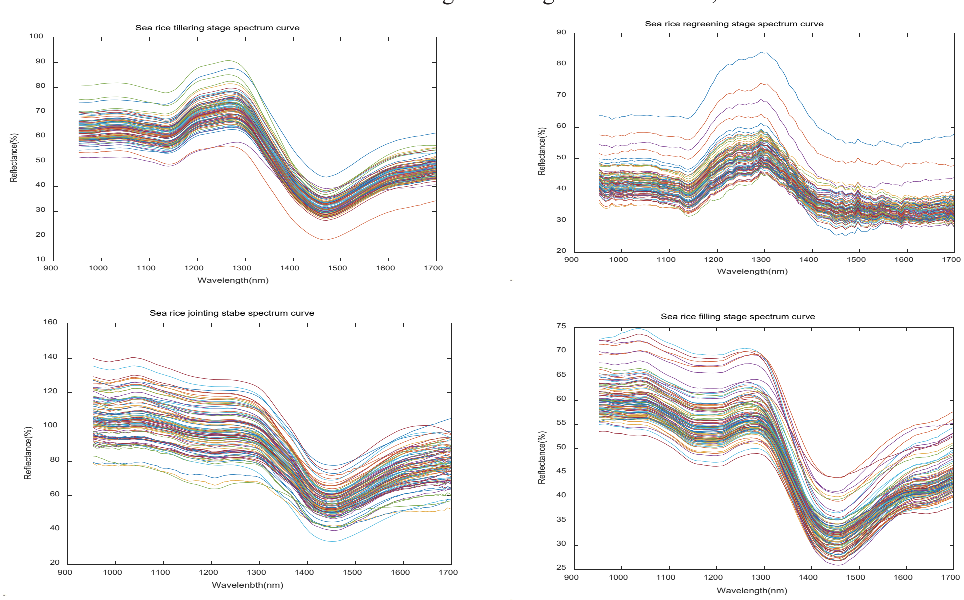


FIG. 3 Spectral reflectance curves of sea rice leaves at different growth stages

3. Results and Analysis

(1) Leaf chlorophyll analysis of Haihong 11 at different growth periods

The chlorophyll value unit of the chlorophyll meter is SPAD, SPAD value is a measure of the relative content of a plant chlorophyll or a parameter representing the green degree of the plant, SPAD value has a specific proportional relationship with the nitrogen content, nitrogen fertilizer is the main fertilizer of the plant, so if the SPAD value is high, then the nitrogen fertilizer is sufficient, no need to fertilize; And if the SPAD value is relatively low, it means that the nitrogen fertilizer content is low, and timely fertilization is needed.

From FIG. 2, it can be seen that the SPAD value at tillering stage was the highest compared with other growth stages, the SPAD value at greening stage was generally low, and the SPAD value at jointing stage and filling stage tended to be similar. In the case of normal fertilization, the precise monitoring of SPAD changes in different growth stages can indirectly understand the nutritional conditions of sea rice in different growth stages, and then combine with the final yield measurement, so as to determine the amount of fertilization and fertilizer in different growth stages in the next year.

(2) Hyperspectral reflectance curve analysis of Haihong No. 11 in different growth periods

The hyperspectral reflectance curves of replanting stage, tillering stage and filling stage had a plateau zone before 960-1100nm, a trough zone between 1100-1200nm, a trough zone between 1200-1350nm, a trough zone between 1400-1600nm, and a plateau zone between 1600-1700nm. The hyperspectral reflectance curve at jointing stage has a plateau zone between 960 and 1300nm, a trough zone between 1300 and 1600nm, and a plateau zone between 1600 and 1700nm. The characteristic wavelength of sea rice in different growth stages can be determined by sensitive wavelength analysis method, and the chlorophyll inversion model of sea rice in different growth stages can be established according to the leaf chlorophyll value in different growth stages, so as to accurately judge the nutritional state of sea rice in different growth stages, further accurately guide fertilization, and ensure the increase and quality of sea rice.

4. Conclusion

Through the above test and analysis, the following conclusions can be drawn:

(1) There are differences in leaf chlorophyll of Haihongdao11 in different growth stages, indicating that the nutritional status of crops in different growth stages is different. After a long time of practice, the nutrient profit and loss situation in different growth stages can be determined to guide precise fertilization.

(2) The change law of hyperspectral curve of Haihongdao11 in different growth periods is basically the same, but the chlorophyll spectral reflectance value in different growth periods is also different. The difference of chlorophyll can be retrieved through the change of spectral reflectance in different growth periods, so as to reflect the nitrogen nutrition status in different growth periods.

(3) According to the hyperspectral reflectance curve of sea rice, the sensitive band of sea rice can be determined, which provides the basis for establishing the nutrient diagnostic model of sea rice in the following days.

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About the author: Wang Shuwen (1975-), male, Han, born in Zhaodong City, Heilongjiang Province, graduate student, Professor, School of Electronics and Electrical Engineering, Lingnan Normal University; Research direction: Application of intelligent measurement and control technology.