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Advances in Research on Effects of Water Stress on Growth and Development of Mung Bean

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Abstract

Water plays a vital role in the life of mung beans. Different water stresses have different effects on the growth and quality of mung beans. This article summarizes the water requirement of mung beans and summarizes the effects of different water treatments on photosynthetic characteristics, nutrient absorption and utilization, physiological characteristics, and yield and quality of mung beans. With a view to providing a theoretical basis for the efficient use of water resources in drylands and the study of mung bean drought resistance.

Keywords

Mung bean, Water stress, Research progress.

1. Introduction

China is a country with severe water shortage. The per capita water resource is only 2300 cubic meters, which is only 1/4 of the world average. The total water consumption of the country is 601.55 billion m3, of which agricultural water is 369.31 billion m3 and 61.4% of the total water consumption[1]. The shortage of water resources has become the main factor restricting the development of China's agriculture, and it is also the primary problem facing agricultural production in the arid regions of northern China. Mung beans, also known as green adzuki beans, belong to the genus Vigna in the Fabaceae of the Leguminosae butterfly family [2]. Mung bean is a short-day sunshine and temperature-loving crop with short growth period, high flexibility during sowing period, strong adaptability, resistance to drought and barrenness, and has the function of nitrogen fixation and nourishment, and has the role of nitrogen fixation and nourishment. Mung bean is rich in nutrients, high in use value, and good food supplement. It has a very big advantage compared with other cereals and beans. At the same time, it is the preferred stubble for intercropping, intercropping and mixed crops of grasses, potatoes and other crops [3]. Drought conditions limit the growth of crops and are not conducive to agricultural development. The selection of drought-resistant and high-yielding varieties and reasonable irrigation methods are an economic and effective measure to increase the output of mung beans.

2. Water demand of mung beans

The water demand of mung bean is affected by many factors such as variety, climate, soil, nutritional conditions, length of growing season and other agricultural measures, and the water demand of mung bean is different in different growth periods. Shipeng Liu et al [4] conducted artificial water stress treatment on mung bean seeds germination, and found that with the increase of stress, the germination rate, germination potential, germination index, vigor index of mung bean all showed a downward trend; mung bean seeds were under 25% stress The absence of germination in the solution indicates that the critical water stress value for mung bean seed germination is less than 25%; the growth of the

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hypocotyl and radicle after germination is also affected by water stress, and the ratio of hypocotyl / radicle decreases with the increase of the intensity of water stress , Indicating that mung bean seeds have a strong adaptability to water stress after germination. For the mung bean seedling stage, Yanqiu Geng et al [5] studied the effect of different water supply on the photosynthetic physiological characteristics of mung bean seedling stage, and then determined the appropriate water supply quantity in the bean seedling stage is 250 ~ 350mm. Lihua Zhang et al [6] found that the total water consumption during the growth period of mung beans is only 1/2 of the precipitation during the same period. With the delay of the growth period, the water consumption of mung beans of different varieties and moisture treatments showed a decreasing-up-down trend Among them, the water consumption in the seedling stage and the pod growing period is relatively large, and the relative daily water consumption intensity of mung bean basically shows the trend of first increasing and then decreasing, in which the pod pod growing period is the largest.

3. Effect of water stress on mung bean photosynthetic characteristics

3.1 Photosynthesis

Photosynthesis is the physiological basis for crop growth and yield formation, and it is also the decisive factor for crop productivity. The photosynthetic performance of crops is the key to determining crop yield formation. In recent years, there has been some research on mung bean photosynthesis. Xiaoli Gao et al [7] studied the photosynthetic performance of four different genotype mung bean leaves, and pointed out that during the flowering and pod formation of mung bean, maintaining a high chlorophyll content and photosynthetic productivity of functional leaves, Delaying leaf senescence has an important role in the formation of grain yield. It was found that after mung bean flowering, with the senescence of the leaves, the net photosynthetic rate (Pn), transpiration rate (Tr), stomatal conductance (Gs), chlorophyll content, and soluble protein content of each functional leaf gradually decreased, and the leaf weight showed a decrease— With the increase-decrease trend, the photosynthetic performance of leaves at different flowering nodes gradually decreased from top to bottom during the same period. Comprehensive analysis shows that during the flowering and pod formation of mung beans, maintaining a high chlorophyll content and photosynthetic productivity of functional leaves, delaying leaf senescence, plays an important role in the formation of grain yield. Yingying Wang et al [8] studied the comparison and cluster analysis of photosynthetic characteristics of different mung bean varieties combining grain and fertilizer, and pointed out that there are significant differences in photosynthetic traits such as photosynthetic rate among mung bean varieties.

3.2 The effect mechanism of water stress on photosynthetic characteristics

Water participates in the plant's metabolic process. After water stress is applied to the plant, the chlorophyll content is reduced and the stomata are closed. The plant's absorption of CO2 is restricted, and the chloroplast lamellar membrane system mechanism is changed. The decreased enzyme activity leads to a slower photosynthesis, which in turn inhibits the accumulation of photosynthetic products [9]. Climate drought and soil water stress will restrict crop photosynthesis and biological productivity to a certain extent [10], and photosynthesis is the most important physiological process of crops. During this process, crops synthesize large amounts of organic matter and produce biomass. Therefore, the photosynthesis of crops Soil moisture is very important. The study found that [11], water stress treatment at different growth stages can reduce the photosynthetic rate, stomatal conductance and transpiration rate of the crop leaves, and with the increase of the degree of water stress, the degree of decrease decreased. Studies by Lili Fan [5] and other studies showed that Pn, Tr and Gs of mung bean treated with different water supply volumes were extremely significantly positively correlated ($P < 0.01$), indicating that with the change of water supply, various physiological indicators of plant photosynthesis changed accordingly and influenced each other. And the correlation is high.

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3.3 Effect of water stress on chlorophyll content

Chlorophyll is an important substance for photosynthesis. The content of chlorophyll reflects the intensity and ability of photosynthesis of plants to a certain extent, thereby affecting the growth of plants. Water stress also has a certain effect on chlorophyll content. Juanyun Cao [4] et al. Conducted water stress treatment on mung bean seedlings with different concentrations (10%, 15%, 20%, 25%) of PEG-6000. The study found that the chlorophyll content increased at 10% PEG stress compared with the control , Malondialdehyde, and protein decreased slightly; at 15%, 20%, and 25%, as the water stress intensified, the chlorophyll content continued to decline, and the osmotic adjustment substance gradually increased. Many studies have shown that [12] [13], water stress leads to a decrease in chlorophyll content, and the resistance crops have a smaller decrease in chlorophyll content. The research results of Huifang Shen [14] and others also proved this view, but the chlorophyll content of different varieties in different growth stages differed in different extents. For example, among the three mutants, 172-3, the high-resistance variety, had the largest decline in the filling period, while It is the smallest in the other two periods, indicating that the changes of the same physiological and biochemical indicators of the same variety in different growth periods are also different.

4. Effect of water stress on nutrient absorption and utilization of mung bean

Mung bean can change its growth by inoculating different root fungi. Different water stress has little effect on its inoculation. Honggang Wang [15] believes that the water required to make 1 gram of dry matter from mung beans inoculated with mycorrhizal is about half the water required for uninoculated control plants, which greatly improves the water use efficiency. Yuefeng Li [16] believed that water stress severely inhibited the growth of plants, but had little effect on the growth and infection of arbuscular mycorrhizal fungi (AMF). Inoculation of AMF is not only beneficial to the absorption of nitrogen and phosphorus by the plant, it improves the water condition of the plant, increases the accumulation of soluble sugar, reduces the content of proline, and reduces the degree of inhibition of plant growth under water stress. Xueli He [17] believed that water stress severely inhibited the growth of plants, but had little effect on the infectivity of VA mycorrhizal fungi Glomus mosseae, G.sp. and G. caledonium. Inoculation of VA mycorrhizal fungi not only helps plants absorb phosphorus and nitrogen in the soil, but also significantly improves the water condition of the plant, reduces the proline content of the plant leaves, increases the photosynthetic efficiency of the inoculated leaves, and significantly increases the plants The quality of dry matter enhances the drought resistance or drought tolerance of mung beans.

5. Effect of water stress on mung bean physiological characteristics, yield and quality

5.1 Effect of water stress on mung bean physiological characteristics

Water plays a vital role in the growth and development of crops. Water stress will destroy the normal metabolism of plants, not conducive to protein synthesis, reduce enzyme activity, and affect carbon and nitrogen metabolism. A study [18] found that with the intensification of water stress, the chlorophyll content of mutants with strong drought resistance decreased by a small amount, and SOD activity, POD activity and NR activity were significantly higher than those with low resistance. With the intensification of water stress, the accumulation of proline (Pro) of mutants with strong drought resistance increased, the degree of membrane permeability damage became smaller, and the increase of MDA content was smaller. Shipeng Liu et al [19] conducted water stress experiments on different varieties of mung beans at seedling stage. The study found that when 10% -20% PEG-6000 treatment, as the degree of water stress increased, the chlorophyll content continued to decline, SOD, CAT, The change trend of POD activity and the content of proline, soluble sugar, soluble protein, MDA gradually increased. Yizhong Duan et al [20] conducted a comprehensive evaluation of the drought

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resistance of 21 mung bean germplasm resources. The study concluded that the chlorophyll content, MDA content, and proline content are closely related to the drought resistance of mung bean.

In addition, water stress will also have a series of effects on the normal growth of plants. Water is the main component of plant cell protoplasts. If the water content is reduced, the protoplasm will change from a sol state to a gel state, and life activities will be greatly reduced. If the cells lose too much water, it may cause protoplasm destruction and lead to cell death. And water is the solvent for plants to absorb and transport substances. Generally speaking, plants can only absorb solid inorganic and organic substances dissolved in water. Similarly, various substances can be transported in plants only when dissolved in water. In addition, water can maintain the inherent state of the plant body. The cells contain a lot of water, which can maintain the tension (ie, swelling) of the cells, make the branches and leaves of the plant stand upright, which is convenient for fully receiving light and exchanging gas, and also opens the flowers, which is beneficial to pollination. Water is the environment in which life occurs and the condition for life development. Once the water metabolism of the plant is out of balance, it will disrupt the normal physiological activities of the plant body and, in severe cases, cause the plant body to die. Yizhong Duan et al[21] found that under drought stress, the germination rate and germination potential of mung bean both decreased significantly, and inhibited the growth of germ and radicle. Zhongxiao Guo et al [22] found that under water stress conditions, the plant height, stem diameter and leaf area of mung bean drought-resistant varieties were significantly higher than those of ordinary varieties.

5.2 Effect of water stress on mung bean yield and quality

Different water stresses have a great influence on the yield and quality of mung beans. Among them, the growth state of mung bean seedling stage has a great relationship with the final yield and quality of mung bean. Jing Chai et al [23] studied the impact of different water supply on the biological output of mung bean seedling stage and obtained an appropriate increase in water supply. The amount is conducive to the growth at the seedling stage, comprehensive growth and biomass, the precipitation of mung bean in the growing season is 350 mm is more suitable, the growth of mung bean aboveground and belowground is coordinated, the material distribution of each organ is reasonable, for mungbean further branching, pod formation and other reproductive growth Lay the foundation for increasing economic output. Water shortage has always been a huge problem restricting agricultural development in the arid and semi-arid areas of northwest China. Mung bean has different requirements for water in different growth periods [24]. Therefore, it is the main direction of the research on mung beans to effectively increase the yield by storing and using water resources through supplementary irrigation at a reasonable growth stage. Rain-collecting supplementary irrigation technology collects excess natural precipitation through engineering measures and supplements irrigation during the dry season. Xiaoling Ji et al [25] concluded that the supplementary irrigation of mung beans in the Loess Hilly and Gully Region of northern Shaanxi can reduce the ground temperature and increase the soil water content. Complementary irrigation at the branching stage can promote the growth and growth of mung bean plants, which is beneficial to the number of pods The increase in the number of pods and grains can increase the output of mung bean

6. Conclusion

At present, flood irrigation and border irrigation are the main methods of field mung bean irrigation. This is not a great waste of water resources, and it cannot guarantee the high yield and quality of mung bean. The low water use efficiency seriously affects the sustainable development of mung beans. Water treatment can improve the resistance of mung bean plants to bad environment to a certain extent, maintain the normal operation of metabolism in the body, promote the good operation of various physiological indicators, and ultimately promote the formation of yield quality. However, at present, there are few comprehensive studies on water stress on mung bean water use efficiency and the construction of corresponding models. Therefore, on this basis, further research in this area needs to be further strengthened.

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