

Research status and countermeasures of rice barrier chilling injury in cold region of China

Xie Pengyuan¹, Lan Dongxue¹, Lv Yuguang² and Qi Xiaoli^{1,a}

¹College of Life Science, Jiamusi University, Jiamusi 154007, China

²College of Pharmacy, Jiamusi University, Jiamusi 154007, China

^a Corresponding author: qixiaoli3@tom.com

Abstract. In this paper, a large amount of research has been carried out on the effect of low temperature cold damage on rice planting in the cold region. Through literature research, the mechanism of low temperature cold damage on rice yield reduction in the dry region has been learned. This paper has the guiding significance for understanding the effects of chilling injury on rice planting in cold region and its defense.

1. Introduction

Chilling injury refers to the phenomenon of growth stagnation or growth barrier injury occurring in the range of temperature below the proper temperature and above the freezing point, which is one of the main factors affecting rice production in high latitude regions of China^[1-9]. There are three main types of cold damage in rice: delayed type, obstacle type and mixed type. In recent years, the main cold damage in the region is the barrier cold damage and delayed cold damage, which lead to the increase of rice empty rate, more green rice grains and significantly reduced 1000-grain weight, not only serious yield loss, but also poor rice quality. Under the condition of chilling injury, different rice varieties and seedling quality have different effects on yield. Heilongjiang is located in the high latitude area of China, with a low annual average temperature. It is the most northern region suitable for rice planting in China, so it is particularly important to select rice varieties. At present, the main problems of rice cultivation in cold land include poor quality of seedling, excessive planting density, unreasonable application amount and application period, water layer irrigation.

The main effects of obstruction-type cold injury are short-term abnormal low temperature during the reproductive growth period, which damages the physiological function of reproductive tissues and organs, resulting in a series of phenomena such as spikelets infertility, empty grains, decreased yield and decreased quality^[10]. The response of rice yield to sustained low temperature varies with the type of ripening period, critical period of low temperature encounter and low temperature intensity. Continuous low temperature at tillering stage can increase the yield of rice of each variety (ripening stage), and the increase amplitude varies with different ripening stage types^[11].

Please submit sources files directly to the conference organizer. If the conference editors chose to provide print-ready PDF documents to the publisher, you have to submit high-resolution PDF file with all fonts embedded (see PDF guidelines) instead of the sources files. In this case, please remember that no final corrections will be made by the publisher.



2. The influence of temperature on rice

Sustained low temperature will cause suffer delay rice root, slow growing, insufficient tillering, birth process lag, heading stage delayed, production declined dramatically. Rice 1000-grain weight decreased by 5% ~ 8% and bulk weight decreased, brown rice rate, white rice rate and whole rice rate decreased by an average of 10%, poor taste. Low temperature and less sunshine low temperature, rainy and wet, induced the spread of rice blast, resulting in rice yield reduction. After the ripening stage, the field dehydrated slowly and the harvest time was delayed. Some areas suffered snowstorms and failed to harvest^[12].

The yield of rice depends on varieties, environmental conditions, cultivation management and the interaction of the three. Under the situation of large population and small land and shortage of resources, it is particularly important to exert the production potential of existing rice varieties through cultivation management measures^[13].

Different varieties have different resistance to low temperature at the same temperature, so the yield performance varies greatly. When a variety is chosen, one should not introduce it blindly. Strong seedling is stronger than weak seedling and has more roots. After transplanting seedling, it has strong ability to absorb water and absorb fertilizer, and it returns to green quickly.

3. Defensive way

3.1 Choose low temperature resistance, early maturity, high yield varieties

Those varieties with strong resistance to low temperature, no sensitivity to temperature, good defensive effect on barrier cold damage, delaying cold damage, high yield and good quality should continue to be popularized. The research on the obstacle cold damage of rice in Heilongjiang province should be based on the identification of the cold resistance of resources, and create excellent rice varieties with strong cold resistance through hybrid breeding with the help of molecular AIDS^[14].

3.2 Early loose planting and breeding of strong seedling can effectively protect against cold damage

The rice seedlings with good quality have strong growth, well-developed vascular bundle of seedlings, more root systems, less water in the plants, high content of carbohydrates, sugar and phosphoric acid, and significant drought and cold resistance. Such rice seedlings can absorb water and absorb fertilizer at low temperature, promote tillering, early growth and rapid growth, improve photosynthesis and increase rice yield.

3.3 According to local conditions, reasonable fertilization is the key to protect against cold damage

Low temperature years, one should change phosphorus fertilizer and potash fertilizer, decrease potash fertilizer. Phosphate fertilizer and potash fertilizer are mainly used as basic fertilizers, phosphate fertilizer can increase the content of soluble sugar in the body of rice, so as to improve the ability of rice resistance to low temperature, at the same time, it still has some effect on promoting precocity in phosphorus. Potassium fertilizer can compensate what caused by insufficient light photosynthetic intensity drops, obvious effect on promoting precocious, can fill in the booting stage of rice potassium application. Nitrogen is a rice indispensable nutrient element, 30% of the nitrogen fertilizer is put as basal, 40% of the total nitrogen fertilizer for tillering, 20% of the total nitrogen fertilizer for earing fertilizer, and 10% of the total nitrogen fertilizer for promoting grain development.

In the low temperature years, earing fertilizer and fertilizer for promoting grain development can be used late or not. Because early paddy field temperature is lower and slower synthetic organic matter decomposition, the nitrogen utilization rate is low. The late young ear differentiation to before and after heading, the temperature is higher, microorganisms in the soil mass transformation is accelerated, the rice is gradually strengthening on utilization rate of nitrogen in the soil, so the nitrogen fertilizer should be used early, less, avoiding the rice plants within the free N is too high, plant dry matter storage capacity reduced, moderate growth, stem and leaf. As a result, low temperature will affect pollen abortion, infirmity, young panicle differentiation stage, nutrient delivery from stem and leaf to

ear is blocked, and the grout cannot mature normally. Therefore, it is very important for rice to apply fertilizer rationally according to local conditions to protect against low temperature and cold damage.

3.4 Water layer management is an important measure to prevent cold damage

Water layer management has an important influence on the growth and development of rice. Irrigation of rice should be shallow, dry and wet. The temperature was increased by shallow water in tillering stage to promote early growth and rapid development of tillers. In the later stage of tiller, the water was removed and the field was exposed to the sun, and the population structure and light conditions were improved. Spike development is most rice water requirement period, by its in meiosis, with 17 °C under chilling injury to fill the deep layer of 15 to 20 cm, which can reduce chilling damages. The rice can be filled water normally after low temperature, used intermittently fill water for 3-5 days before heading. The shallow water in flowering stage can improve soil temperature, promote rice heading and flowering stage. The rice was generally protected from low temperature by intermittent irrigation between 25 and 30 days after heading.

4. Summary

Defense low-temperature chilling injury is a complex technology, and it need the each individual defense technology integration to form a complete set, which is the cold chilling injury of rice, lack of systemic defense technology. Therefore, in the production, the best cultivation management system should be designed according to the meteorological conditions to select suitable rice varieties. Cultivating strong seedling and reasonable planting; Scientific fertilization forms; Scientific water, timely drying. The above measures can basically solve the harm caused by low temperature to rice since they are used in our land. However, due to different regions, climate differences, soil quality and environmental conditions, they are not uniform and unchanging, and should be applied rationally according to local conditions so as to truly achieve a bumper harvest of rice production.

Acknowledgments

Authors wishing to acknowledge financial support from the Key Programs of Jiamusi University (Sjz2012-19), Provincial Training Programs of Innovation and Entrepreneurship for Undergraduates (201710222055), Natural Science Foundation of Heilongjiang Province of China (No.B2017015).

References

- [1] Kuroki M, Saito K, Matsuba S, et al. A quantitative trait locus for cold tolerance at the booting stage on rice chromosome 8 [J]. Theoretical & Applied Genetics, 2007, **115**(5):593-600.
- [2] Cong Wanbiao. Identification of Cold Resistance of New Rice Varieties In Cold Ground [J]. Chinese Agronomy Bulletin, 2007, **23**(7):232-235.
- [3] Wang Shiqiang. Study on The Difference of Cold Tolerance and The Regulation of Exogenous Substances in The Booting Stage of Rice in Cold Regions [D]. Shenyang Agricultural University, 2016.
- [4] Wang Ping, Wang Guixia, Shi Jian, et al. An Overview of Agricultural Meteorological Disasters in Heilongjiang Province in 2002 [J]. Heilongjiang Meteorology, **2003**(3):24-25.
- [5] Wu Jiang, Xu Xianbin, Meng Ying. Research on Low Temperature Chilling Injury and Countermeasures of Rice in Heilongjiang Province [J]. China Agricultural Meteorology, 2004, **25**(2):26-28.
- [6] Lian-Min Wang, Li-Zhi Wang, Li Zengliang, Etc. The Chilling Injury of Rice Of Heilongjiang Province III Barrier Type Chilling Injury Sensitive Period The External Form of Diagnosis [J]. Journal Of Heilongjiang Agricultural Science, 2009 (3) : 13-15.
- [7] Jiang Lixia, Li Shuai, Yan Ping, et al. The Obstructive Cold Injury in The Booting Stage of Rice in Heilongjiang and Its Impact on Yield [J]. Chinese Agricultural Meteorology, 2009, **30**(3):463-468.

- [8] Jiang Lixia, Li Shuai, Shen Shuhe, et al. Almost 46a Heilongjiang Rice Barrier Chilling Injury and Its Relationship With Climatic Productivity [J]. Journal of Atmospheric Sciences, 2010, **33**(3):315-320.
- [9] Zeng Xianguo, Xiang Hongtao, Wang Zhizhi, et al. Effects of Different Low Temperatures at The Booting Stage on Rice Vacancy Rate [J]. Heilongjiang Agricultural Science, 2014(6):19-22.
- [10] Pessarakli M. Handbook Of Plant and Crop Stress, Second Edition[J]. Crc Press, 1999.
- [11] Wang Yanhua. Effects Of Continuous Low Temperature on Rice And Breeding Decisions In Shenyang [D]. Shenyang Agricultural University, 2013.
- [12] Xu Side. Effects Of Low Temperature Chilling Injury on Rice In Heilongjiang Province and Countermeasures [J]. Chinese Agronomy Bulletin, 2003, **19**(5):135-136.
- [13] Guo Liying, Geng Yanqiu, Jin Feng, et al. Development of Cultivation Techniques for Low Temperature Cold Damage Defense of Rice in Cold Regions [J]. Journal of Crops, 2017(4): 7-14.
- [14] Wang Tongtong, Wang Lian-Min. Research Progress on Obstacle Cold Damage of Rice In Cold Regions In China [J]. Journal of Natural Disasters, 2013, **22**(4):167-174.