Climate Change Adaptation for Rice in Japan

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Rice is a staple crop in Japan. Yearly production is around 8.3 million ton from 1.6 million ha of paddy field. Cultivated area distributes from Okinawa (24°N) to Hokkaido (43°N). Therefore there have been several natural constraints for the rice production, such as low temperature, typhoon, insect and diseases. In addition to those problems, heat damage caused by high temperatures in the summer has been a serious problem of the rice production since the end of the 20th century, when a tendency of temperature rise has been remarkable since 1990s in Japan. In the summer of 2010, air temperature in August was highest since 1898, and the severe heat evets caused a considerable decrease in the rice grain quality.

High temperatures during ripening stage of rice plant increase the occurrences of chalky grain (rice grain turned white), immature thin grain, and cracked grain [2]. These damages lowered the rice grade and therefore price. Chalky grains are classified into some types, depending on the locations of the chalks in the grain. They include milky white (whole endosperm becomes chalky), white-ridge, and white-base. Occurrence of milky white grains increases under the condition of high temperature with low solar radiation, and large sink size (excess number of spikelets), whereas the number of white-ridge and white-base grains increase under high temperature, and low nitrogen concentration of grain. Countermeasures are needed to reduce losses in both quality and yield of rice under high temperature. Adjustments of nitrogen application management, water management, and planting and /or harvesting time are reported to possible adaptation measures.

Detailed weather forecasting data is important for the decision making of these countermeasures. NARO has been developing the 'Agro-Meteorological Grid Square Data System' which divides the whole country into 1km grid and delivers weather data of each grid, such as daily temperature, humidity, precipitation, solar radiation and so on [5]. This system includes prediction weather data from the present to approximately four weeks. Thus, NARO has also been developing the application system which combine the management technology with the weather forecasting data for reducing high temperature damage on rice [4].

In addition to the management practices, development of heat tolerant cultivars plays a major role in development of adaptation technology. In fact, some new rice cultivars tolerant to heat damage on ripening stage have been released recently. Morita and Nakano (2011) reported that one of those cultivars, named 'Nikomaru' has high amount of non-structural carbohydrates in the stem at full heading stage and this character contributes to stabilize the yield and grain filling under high temperature condition [3]. The planting area of tolerant cultivar has reached 65,000 ha in 2013 and has been increasing every year by 10,000 ha.

Matsui (2009) described that the floret sterility was induced by high temperature at flowering time [1]. Such floret sterility has not yet been widely reported as the reason of yield decline in Japan. However, projected climate change may increase the occurrences of this type of damage and decrease rice yield. Cultivar breeding for improved heat tolerance for heat-induced sterility is essential in order to prevent the increases in sterilized grain under high temperature condition.

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