CRYPTIC USEFULNESS OF *ORYZA LONGISTAMINATA*, AFRICAN WILD SPECIES OF RICE

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Abstract

In the 21st century, several novel traits in crops should be possibly needed. Genetic resource is a jewel box for crop improvement. *Oryza longistaminata*, African wild species of rice is the most distantly related species from *O. sativa* within the Sativa group. Some characters of this species, long anther, large biomass and rhizomatous trait will be potentially useful in Next New Ideal Rice irrespective of high cross-incompatibility and hybrid sterility between two species. Long anther trait of *O. longistaminata* had been introduced into Shiokari, a variety in Hokkaido, Japan, through backcrossing. Segregants selected by long anther trait from *O. longistaminata* showed cool weather tolerance under cool summer condition, suggesting that long anther trait of *O. longistaminata* might be effective to cool weather injury at the booting stage. Large biomass trait was introgressed through selfing of selected lines derived from the cross between *O. longistaminata* and T-65. The selected lines showed stiff and long culm, large number of spikelets and relatively small number of panicles under non-fertilized conditions. Although global cultivars of rice are probably incompatible with *O. longistaminata,* some novel traits will be useful in the near future breeding program. Thus, these breeding materials derived from *O. longistaminata* are expected to be effective for new ideal rice.

Key word: *Oryza longistaminata*, *Oryza sativa*, anther length, cool weather tolerance, biomass

1.0 Introduction

In the 21st century, various new abiotic/biotic stresses potentially induced by increasing CO_2 concentration and global warming will attack various kinds of crops. It is urgently required to increase crop yield to feed increasing population in the world. High-input condition in modern agriculture have surely brought higher yields of crops by using short-statured varieties in "green revolution" in 1960s. However, these have induced various negative impact to environment; soil acidification, pollution of rivers, lakes and ground water and emission of global warming substances. In the 21st agriculture, it is important to gain high yield in sustainable conditions. For this, it is needed to maximize the crop-ability responsible for tolerances to various stresses. Wild relatives of crop is a jewel box for improvement of various traits. Wild relatives have not only visible usefulness but also cryptic usefulness. *Oryza longistaminata* Chev. et Roehr is a perennial species of rice in Africa, which is characterized by long anther, large stamen, rhizomatous trait and large biomass. Long anther and large stamen exerted long time of *O. longistaminata* are effective for outcrossing, suggesting that *O. longistaminata* is allogamous. Further, Khush *et al*., (1990) reported that *O. longistaminata* from Mali is tolerant to all races of bacterial blight in India. Although *O. longistaminata* carry the same AA genome as that of *O. sativa,* it is difficult to cross with *O. sativa* due to a crossing barrier (Chu and Oka, 1970) and hybrid sterility in F1 and F2 occurs. Further, it has been revealed that A genome of *O. longistaminata* is highly differentiated from that of *O. sativa*: *catalase* gene for antioxidant defense responds to environmental and physiological oxidative stress in *O. longistaminata* was found to have variation in number and sequence different from that of *O. sativa* (Iwamoto et al. 1998). Therefore, *O longistaminata* has not been utilized in breeding program so far. Single crossed seed between *O. longistaminata*, MwM from Kenya and a japonica varierty was obtained successfully. Using this F1 plant as a starting material, long anther trait of Mpunga wa majani (MwM) was introduced into japonica variety in Hokkaido, Japan, Shiokari by successive backcrossing. In segregating population, some tolerant plants to cool weather were found under natural cool conditions in Hokkaido, Japan. Further, large biomass trait of MwM was selected in selfed progeny derived from the F1 plant under non-fertilized conditions.

2.0 Materals and Methods

O. longistaminata, Mpunga wa Majani (MwM) collected at a valley 10km north from Mombasa, Kenya, was used in the study. MwM was crossed with japonica variety, Taichung 65 (T-65) and single crossed seed was obtained successfully. Any crossed seeds were not obtained when MwM was used as a pollen parent. As T-65 is a late-heading variety, an early heading plant selected in the F2 derived from the hybrid was crossed with Shiokari, a variety in Hokkaido, Japan. By successive backcrosses with Shiokari and selection with long anther and good fertility in greenhouse in winter, BC6F2 plants with Shiokari's background were produced. 10 BC6F2 populations were grown in 1992 and 1993. Especially, in 1993, many varieties of Hokkaido were attacked by cool summer and rice production in Hokkaido was severely decreased. As varietal differences to cool summer were observed, cool weather tolerances of the BC6F2 plants could be evaluated clearly under paddy field conditions in 1993.

Large biomass trait of MwM was selected in the selfed progeny derived from the cross between MwM and T-65 under non-fertilized paddy field of Institute of Plant Science and Resources, Okayama University. In order to maintain non-fertilized conditions, aero-parts of rice and wheat grown in winter were removed from the non-fertilized field and ground water was irrigated.

3.0 Results and Discussion

Frequency distributions of spikelet fertilities in 10 BC6F2 populations grown in 1992 and 1993 are shown in Fig.1. Although spikelet fertilities of Shiokari, a recurrent parent in 1992 and 1993 were low, segregations of spikelet fertilities in 1993 in 7 BC6F2 populations except #2, #4 and #5 populations were extremely different from those in 1992. Especially, in #7 and 9 populations, segregation patterns of spikelet fertility in 1993 were different from those in 1992. Since summer in 1993 was cool, it was surmised that cool weather tolerant gene (s) were segregated in #7 and #9 populations. On the other hand, difference of segregation patterns of spikelet fertility between 1992 and 1993 was not observed in #5 population, indicating that cool tolerant gene (s) of F2 plants #5 population were fixed. Further, F2 plants in #7 population in 1993 were clearly segregated into fertile and low fertile groups, suggesting that a few cool weather tolerant genes were segregated in #7 population. Although the relation between anther lengths and spikelet fertilities of #7 population was not examined, BC7F1 plants had longer anthers than those of Shiokari. This suggested that long anther trait from MwM might be partly responsible for cool weather tolerance. It has been reported that long anther trait is correlated with cool weather tolerance though the physiological mechanism for cool weather tolerance at the booting stage remains unclear (Suzuki 1981; Satake 1986; Takeda 1990).

Although in early generation, selfed progeny from the cross between MwM and T-65 showed various degrees of spikelet sterilities and shattering trait derived from MwM, good-fertile and non-shattering progeny were selected in advanced generation. Under non-fertilized conditions, plants with large biomass were selected. As shown in Fig.2, plants selected carried long and thick culms and long panicles with large number of spikelets compared with Norin18 which was selected as a promising variety under non-fertilized conditions. Further, the selected plants showed large rhizosphere. On the other hand, heading of the selected plants was very late and number of tillers was small, indicating that these plants did not produce any non-productive tillers. These traits are found to be important for high yield under low fertilized conditions. Indeed, Khush (1999) pointed out that these characteristics are required in the 21st century ideal rice. In order to transfer the large biomass trait into another varieties, it is needed to reveal QTL for large biomass using DNA marker and QTL analysis for large biomass trait is now ongoing.

4.0 Conclusions

Now, MwM//Shiokari backcrossed lines are maintained as recombinant inbred (RI) lines by successive selfing. Thus, various chromosomal fragments of MwM are possibly introduced in the RI lines. These materials bred are important as bridge materials to transfer useful traits of MwM into regional elite varieties. Next generation "green revolution" of rice is expected to be generated through introgression from wild relatives.

Referances

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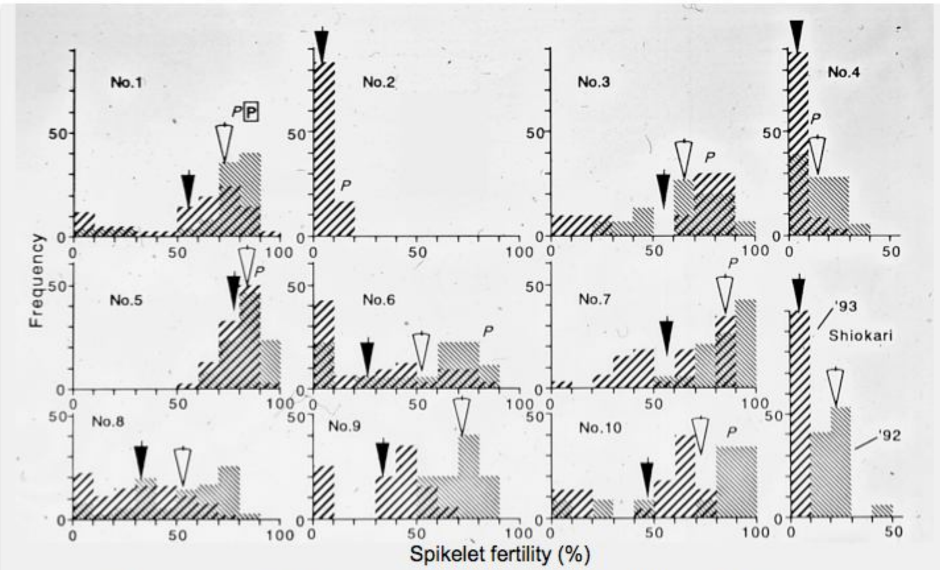

Fig.1. Frequency distributions of spikelet fertilities of MwM//Shiokari BC6F2 populations in 1992 and 1993.

P : *Spikelet fertility of BC5F1 plant in 1993. P : Spikelet fertility of BC6F1 plant in 1993.*

▽, ▼ : *Mean spikelet fertilities of BC6F2 plants in 1992 and 1993, respectively.*

F

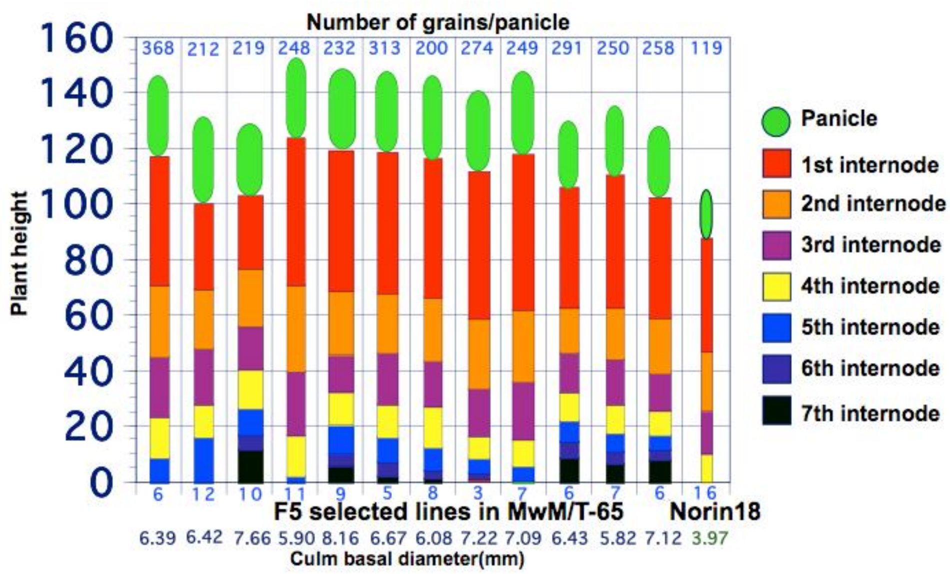

Figure 2: Illustrated agronomic traits of F5 lines selected from MwM/T-65 F2 in non-fertilized paddy field of IPSR

Norin 18; promising LIA variety selected in 300 varieties conserved at IPSR