Mechanism of sterility caused by high temperature at flowering time in indica rice

High temperature appears to be a crucial physical constraint in rice grain production in areas such as Pakistan, Middle East and tropical Africa. Even in tropical Asia, several reports suggest that high temperature-induced sterility could be an important constraint in the dry season crop of rice.

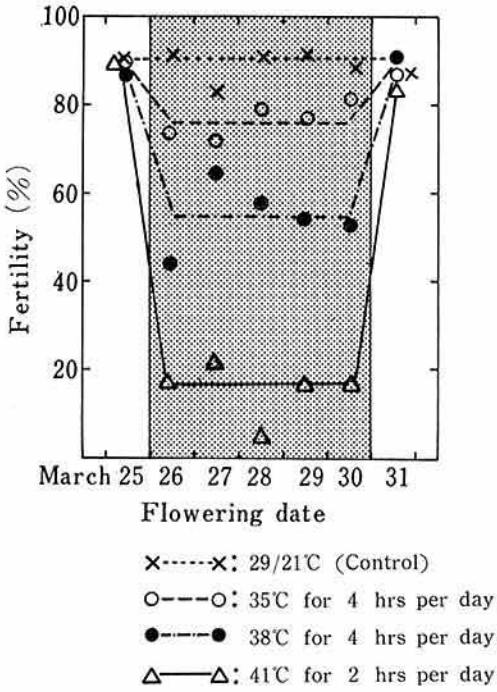
The present study was designed to identify the most sensitive stage of rice spikelets to high temperature and to investigate the mechanism of high temperature-induced sterility. Experiments herein reported were conducted in the IRRI phytotron.

Pregerminated seeds of a selection IR747B2-6 were sown in a circular pattern in 4-*l* plastic pots with 20 seeds per pot and the plants were grown in the glasshouse. The temperature was kept at 29°C between 0900 and 1700 hours and 21°C during the night while the relative humidity was maintained above 70%. Daylength was that of natural condition.

Tillers were removed once a week from 3 weeks after sowing to about 1 month before heading. This procedure facilitated to produce uniform main culms for the spikelet fertility test.

At flowering, plants were transferred to natural light growth cabinets maintained at 35, 38 and 41°C, and exposed to respective high temperatures for different lengths of time. After the high temperature treatment, the plants were transferred back to the glasshouse room maintained at 29°/21°C. Marks were given with different colors of magic pens on the surface of spikelet glumes to record flowering date or flowering time of the day. This technique made it possible to examine direct relationship between the high temperature treatment and fertility of the spikelets flowered during the treatment.

As shown clearly in Fig. 1, percent fertility decreased with the spikelets flowered during

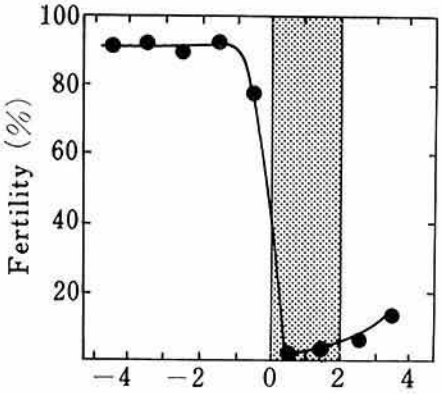


Variety : IR 747 B-2-6
Treatment : For each of 5 days from March 26 to March 30

Fig. 1. Effect of high temperature treatments on fertility of spikelets which flowered on the days before, during or after the treatments

the treatment but it was almost as high as that of normal plants with the spikelets flowered before or after the treatment. Thus, it can be concluded that sterility is induced by high temperature on the flowering day, whereas high temperature before or after the flowering day has little influence on fertilization of spikelets.

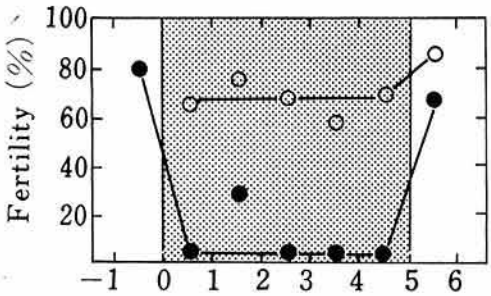
To examine further the most sensitive time to high temperature, plants were exposed to 41°C for 2 hrs at different time of the day (0900-1100, 1100-1300, 1300-1500, and 1500-1700 hours). The data thus obtained are summarized in terms of percent fertility as a function of a number of hours before or after the time of anthesis, irrespective of the time of the day of the treatment (Fig. 2). Percent fertility of spikelets flowered during the high temperature treatment was very low whereas that of those flowered one hour before the



Hours to flowering from the beginning of high temperature treatment

Variety: IR 747 B-2-6
Treatment: 41℃ for 2 hrs

Fig. 2. Effect of high temperature treatment on fertility of spikelets which flowered at the time before, during or after the treatment



Days to flowering from the beginning of high temperature treatment

●——● Not pollinated

○——○ Pollinated

Variety: IR 747 B-2-6
Treatment: 38℃ for 8 hrs for each of 5 test days

Fig. 3. Effect of artificial pollination on the fertility of spikelets exposed to high temperature during anthesis

treatment was not affected at all. Percent fertility of spikelets which flowered after the treatment remained low. These results indicate that the anthesis stage and also the subsequent stage of fertilization occurring within one hour after anthesis are most sensitive to high temperature.

In a separate experiment, the ability of pistil in the fertilization was examined by artificial pollination. Pollens taken from the spikelets which flowered at 29°C were given onto the stigmas of spikelets exposed to high temperature. As shown in Fig. 3, without the artificial pollination percent fertility of spikelets went down to about 3% when the plants were exposed to 38°C for 8 hrs. The percent fertility was, however, increased by artificial pollination to 65%. These observations indicate that high temperature largely affects process of pollination or viability of pollens but it does not disturb the ability of pistil in the fertilization. Microscopic observations of the pollens on stigmas revealed that the occurrence of unfertilized spikelets could be attributed to insufficient pollination or to decreased number of germinated pollens on stigmas or to both.

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