Critical temperature and duration for high temperature-induced sterility in indica rice

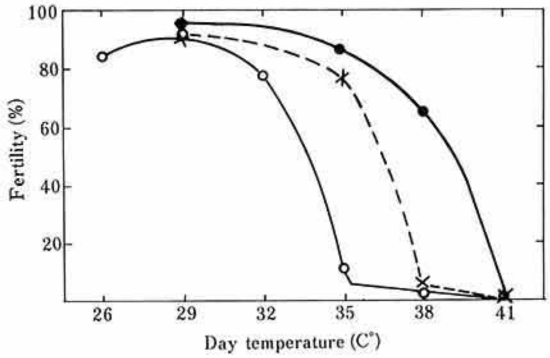
With the dry season crop of rice in some areas of Thailand, Osada (1972) observed an occurrence of empty grains attributable to the high temperature damage when daily maximum temperature exceeded 34 or 35°C at flowering time. High percentage of sterility also occurs at similar temperatures when rice is grown in growth cabinets. The present paper reports critical temperature and duration for the occurrence of such heat-induced sterility. The experiments were conducted in the IRRI phytotoron.

Throughout the experiments three varieties or selections, which had been identified as tolerant, moderately tolerant or susceptible by other screening tests, were used: N22, an upland variety from India and heat tolerant; IR747B2-6, a lowland selection from IRRI and moderately heat tolerant; BKN 6624-46-2, a lowland selection from Thailand and heat susceptible.

Plants were grown in the glasshouse room at 29°/21°C in the same way as described in the previous paper (Satake and Yoshida, 1977). At flowering, the plants were exposed to different temperatures (26, 29, 32, 35, 38 41°C) and to different durations (2, 4, 8 hrs) for five consecutive days. The temperature treatment was started at 9:00 a.m. for the 4 or 8 hrs treatments but it was started at 10:00 a.m. for the 2 hrs treatment. Spikelets flowered during the treatments were examined for fertility.

As shown in Fig. 1, with the duration of temperature treatment of 8 hrs a day, percent fertility was more decreased by higher temperature, and clear varietal differences were observed among the varieties used. For a convenience in comparison, the temperature at which percent fertility begins to decrease below 80% is referred to CT (80) and the temperature at which percent fertility becomes 50% is referred to CT (50).

It is estimated from Fig. 1 that CT (80) is 36.5°C for N22, 35°C for IR747B2-6 and



Day temperature was kept for 8 hrs, and night temperature was fixed at 21°C in each treatment.

Fig. 1. Relation between temperature at flowering and fertility of spikelets

32°C for BKN 6624-46-2. Thus, the difference in CT (80) between a heat tolerant variety N22 and a heat susceptible selection BKN 6624-46-2 is more than 4°C. Likewise, CT (50) is estimated to be 39°C for N22, 36.5°C for IR747B2-6, and 33.5°C for BKN 6624-46-2. At 41°C, percent fertility was zero with all the varieties.

In Fig. 2, the duration of temperature treatment varies from 2 to 8 hrs a day. The estimated CT (80) is 38°C – 4 hrs for N22. It is 38°C – 2 hrs and 35°C – 8 hrs for IR747B2-6, and 38°C – 2 hrs and 35°C – 4 hrs for BKN 6624-46-2. At 41°C, even 2 hrs treatment induced very high percentages of sterility in all the varieties so that the critical duration was difficult to estimate.

Judging from Figs. 1 and 2, it is considered that 35°C be used for eliminating susceptible varieties in the routine screening work, and 38°C, for selecting tolerant varieties. In the above two experiments, night temperature was kept at 21°C. To test the effect of night temperature on the occurrence of sterility, night temperature (16 hrs, 17:00–9:00) was varied from 21°C to 33°C with a constant day temperature of 35°C. It was shown that night temperatures from 21 to 30°C did not affect percent fertility,

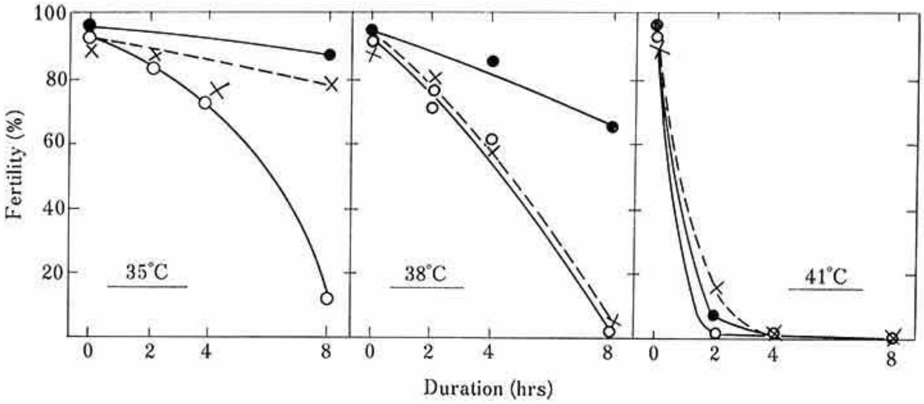


Fig. 2. Fertility of spikelets as related to temperature and its duration at the flowering stage

but a considerable decrease of percent fertility occurred at 33°C.

Under natural environments, it is quite unlikely that a night temperature of 33°C lasts for 16 hrs a day. Therefore, the sterility might not be caused by the night temperature in fields. On the contrary, it is common to have maximum day temperatures from 35 to 41°C or even higher in semi-arid regions and in hot months of tropical Asia. In these areas heat susceptible varieties may suffer from the high percentage of sterility induced by high day temperature.

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