The effect of temperature on the time of flower opening in rice

Kazuhiro Kobayasi[1], Tsutomu Matsui[2], Mayumi Yoshimoto[3], Cailin Wang[4] and Toshihiro Hasegawa[3]

1 Faculty of Life and Environmental Science, Shimane University, 1060 Nishi-Kawatsu-Cho, Matsue, 690-8504 Japan
E-Mail address: kobayasi@life.shimane-u.ac.jp
2 Faculty of Applied Biological Science, Gifu University, 1-1 Yanagido, Gifu 501-1193, Japan
3 National Institute for Agro-Environmental Sciences, 3-1-3, Kannondai, Tsukuba, Ibaraki 305-8604, Japan
4 Institute of Food Crops, Jiangsu Academy of Agricultural Sciences, Xiaolingwei, Nanjing 210014, China

Introduction

Flower opening in the early morning is one of the important characteristics to avoid sterility caused by heat stress at anthesis of rice plants. Spikelet sensitivity to high temperatures decreases in the subsequent period to one hour after flowering (Satake and Yoshida, 1978). Even an hour advancement in flower opening may have a significant effect on sterility, because air temperature sometimes rises at a rate of 3 °C/hr or more around 10:00 h. Although **flower opening time (FOT)** is under strong genetic control, it is also strongly affected by weather, in particular, temperature. Most of experiments about FOT were, however, conducted under controlled environments and rice plants under a glass house or a growth chamber open flowers one or two hours later than those under an outdoor condition (Imaki et al., 1982). How the variation in temperature influences FOT of various genotypes remains unclear particularly under field conditions; this limits our ability to predict FOT that is highly influential on the temperature conditions at anthesis.

Objectives

We therefore attempted to determine the relationship between temperatures at various times before anthesis and FOT under field conditions in Nanjing, Jiangsu Province, China and in Matsue, Shimane Prefecture, Japan.

Materials and Methods

Rice plants were grown outdoors at two locations. By taking photos of panicles at 10-minute intervals, we determined FOT, which is defined as the time when 50% of the flowers which flowered on the day open. Air temperature was measured every 10 minutes.

Results

Experiment 1

Temperature from 00:00 to 06:00 h was most influential on FOT (Table 1).

Indica cultivars opened flowers one or a few hours earlier than japonica cultivars (Fig. 1). In particular, Xiaomazhan from China, an indica cultivar, flowered at around 9:00 h in the morning. The night temperature in Nanjing promoted FOT by about 20 to 30 minutes per 1 °C except Jiu 9304.

Table 1. Correlations between mean air temperatures during 18:00-06:00 h, 0:00-06:00 h, 03:00-0:900 h, 12 hours and 6 hours just before anthesis and flower opening time in six cultivars in Nanjin.

	18:00-06:00	00:00-06:00	03:00-09:00	12 h before	6 h before
Jiu9304	-0.115	-0.092	-0.069	-0.116	-0.097
Akitakomachi	-0.566	-0.289	-0.076	0.092	0.217
Milky Queen	-0.797	-0.715	-0.692	-0.642	-0.554
Xiaomazhan	-0.733	-0.717	-0.528	-0.607	-0.480
Hunanxian	-0.584	-0.584	-0.584	-0.584	-0.584
II You 084	-0.576	-0.254	-0.604	-0.532	-0.551

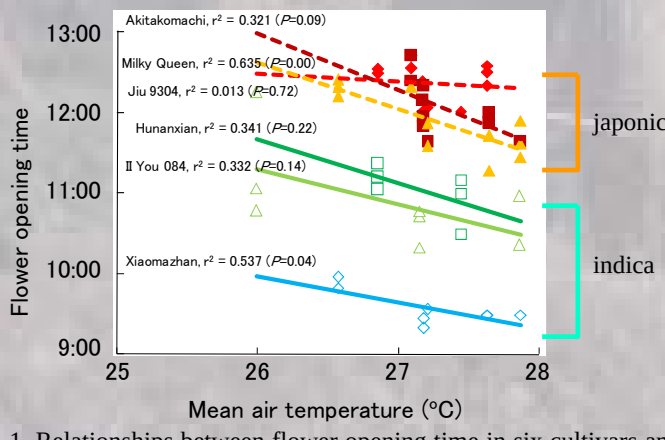

Fig. 1. Relationships between flower opening time in six cultivars and mean air temperature during 00:00-06:00h before anthesis in Nanjing.

Experiment 2

Temperature from 00:00 to 06:00 h was most influential on FOT, too (Fig. 2). Indica cultivars opened flowers one or two hours earlier than japonica cultivars. In indica cultivars, as the temperature was increased, FOT advanced. The night temperature promoted FOT by about 20 to 30 minutes per 1 °C in indica cultivars. In japonica rice, the relationship between the temperature and FOT was not significant.

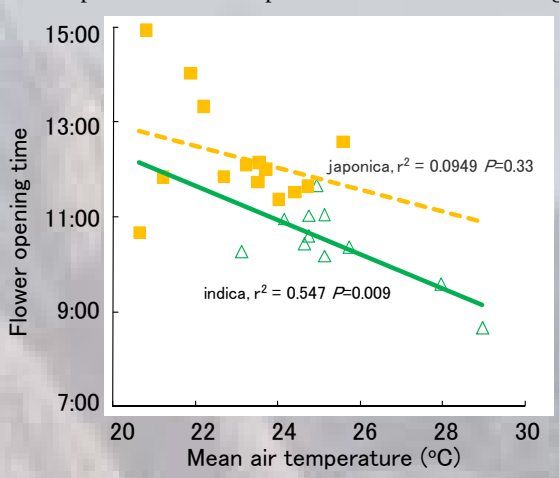

Fig. 2. Relationships between flower opening time in eight cultivars and mean air temperature during 00:00-06:00h before anthesis in Matsue. Open triangles show indica cultivars and closed squares show japonica cultivars.

Conclusion

In indica cultivars, night temperature from 00:00 h to 06:00 h promoted FOT by 20 or 30 minutes per 1 °C. In japonica rice, the relationship between the temperature and FOT was not obvious.

Acknowledgements
We acknowledge the scientific and technical support from Ms. Zhaoling and the staff of Institute of Food Crops, Jiangsu Academy of Agricultural Sciences.

References

Imaki, T., Jyokei, K. and Hara, K. 1982. Bull. Fac. Agr. Shimane Univ. 16:1-7.
Satake, T. and Yoshida, S. 1978. Jpn. J. Crop Sci. 47:6-17.