Evaluation of cold damage in a Hungarian rice variety collection

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Introduction

Rice is sensitive to chilling temperature that is usually a limiting factor in temperate and subtropical zones as well as in high-elevation areas. Seedling stage is one of the most critical periods during development. In Hungary, cold periods may occur in May and June when rice has 3-4 leaves. Cold stress causes various seedling injuries. The most common symptom is chlorosis, the leaves become yellow due to chlorophyll degradation (Jiang et al. 1986). Numerous publications described that SPAD meter's values correlates nitrogen- and chlorophyll content of leaves (Wang et al.2014, Jiang et al. 1986). Stunted growth and decreasing tillering ability are also remarkable indications of cold damage (Cruz et al. 2013). In this study, we determined the effect of a 5-day long cooling period on 140 rice varieties based on visible damages.

Materials and methods

In this work, we used 140 rice varieties from the NAIK ÖVKI Rice Variety Collection. We applied direct seeding in 1.5 m rows (2 replicates). Cooling period (8.0 °C - 13.4 °C) existed for five days when plants had 3-4 leaves (Table 1.)

Table 1: The daily minimum temperatures, June 2018, Szarvas.

Date	Minimum temperature (°C)	Date	Minimum temperature (°C)
22.06.2018	13.4	27.06.2018	14.6
23.06.2018	9.0	28.06.2018	16.1
24.06.2018	8.0	29.06.2018	18.2
25.06.2018	10.2	30.06.2018	18.7
26.06.2018	12.1	01.07.2018	13.2

The chlorophyll content was estimated using Minolta SPAD-502 chlorophyll meter. SPAD readings (5 reps.) were taken at three parts of the third fully expanded leaves: (1) leaf base, (2) middle of the leaf, (3) top of the leaf. We collected data before predicted cooling (06.21), after the 5-day long period (06.26) and ten days later (07.05).

Results and discussion

Our results showed that low temperature resulted in significant decrease of SPAD values. In case of 45 varieties, more than one SPAD value decrease was observed on the 5th day, i.e. 32 % of the studied varieties were sensitive to cold. However, we found 19 lines among these susceptible varieties, which could regenerate to the 10th day. Compared to pre-stress conditions, lower SPAD values were recorded on 26 cultivars after ten days

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regeneration. An advanced breeding line, 'IR74371-70-1-1' showed the highest decrease. Szalóki (2018) reported that serious yellow leaf symptom was obsedved on 'IR74371-70-1-1' (TP 30580) after a cold period in aerobic rice system too. The best varieties with increasing SPAD values were 'Balilla x Rizotto' and 'Kitashali' on the 5th and 10th days. On the other hand, 'UKR5' and 'Vosztok' had also higher SPAD on the 10th day, but first chlorophyll content was decreased (Table 2)

Jiang and Vergara (1986) described that SPAD value of cold susceptible 'IR8' decreased from 30.0 to 27.1 after 4-day cold water treatment (12°C), while there was no noticeable change in cold-tolerant 'Fujisaka 5'. According to those results, 3 unit SPAD reduction were considered sensitive reaction. Similar reduction were observed in case of our 22 entries on the 5th day, of which 3 lines remained suppressed on the 10th day.

Table 2: Average SPAD values of six rice varieties at pre-stress condition and the changes after a 5-day cooling period and at the 10th day of experiment

Cultivars	Before the cooling	5. day	10. day	Cultivars	Before the cooling	5. day	10. day
	SPAD	Change	Change		SPAD	Change	Change
BalillaxRizotto	33.70±0.97	4.45	6.80	UKR 5	43.07±1.80	-1.37	4.08
IR74371-70-1-1	32.70±3.67	-0.65	-12.00	PSB RC 94	33.40±1.54	-4.75	-1.35
Kitashali	35.43±0.55	4.23	4.63	Vosztok	36.93±0.99	-1.47	4.48

Conclusions

We found that among the studied genotypes the most tolerant varieties were 'Balilla x Rizotto' and 'Kitashali'. They had no SPAD value decrease despite of low night temperatures. 'UKR 5' and 'Vosztok' suffered chlorophyll degradation, but they could regenerate after 10 days. Most sensitive genotype was 'IR74371-70-1-1'. These results also highlight the importance of cold tolerance traits for temperate rice breeding.

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