How and why to use low temperature treatment in the rice breeding?

Árpád SZÉKELY[1] – Tímea SZALÓKI[1] – Beáta VITÁNYI[1] – Mihály JANCSÓ[1] – János PAUK[2] – Csaba LANTOS[2]

1: National Agricultural Research and Innovation Centre, Research Institute of Irrigation of Water Management; Anna liget u.35, H-5540, Szarvas, Hungary E-mail: szekely.arpad@ovki.naik.hu

2: Cereal Research Non-profit Ltd., Alsó kikötő sor 9, H-6726, Szeged, Hungary; E-mail: csaba.lantos@gabonakutato.hu

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Introduction

One of the most important traits is low temperature germinability (LTG) in seedling establishment in direct-sowing of rice. An important breeding aim is to develop varieties, which are tolerant to low temperatures at critical growth stages (Nakagahra et al., 1997). In generally, the breeding programmes include screening for chilling sensitivity of different rice genotypes under field conditions (Andaya and Mackill 2003). However, selection of cold tolerant varieties in field condition is difficult, because of the unpredicted intensity and duration of the cold periods. Nanculao et al. (2013) and Cruz and Milach (2004) mentioned that the coleoptiles length is suitable to find differences among rice genotypes under 13°C. Hungarian researchers found a minimum temperature at 12°C for the germination (Gombos and Simon-Kiss 2008). Double haploid lines (DH) serve an opportunity to shorten the breeding time. And in our breeding programme, hundreds of unique DH plants have been produced annually. But evaluation of these materials is hard. Our goal was to develop a fast, repeatable and early screening method to evaluate cold tolerance of new rice lines.

Materials and methods

The germination parameters (germination percentage - GP, median germination time - E50, germination speed - R50 and the lag period) were described in our earlier paper (Székely 2016). These parameters were calculated for 14 rice cultivars and DH lines at 12°C. The 12 DH lines originated from one crossing of Nembo and Köröstáj 333. The germination experiment at 12°C lasts for 25 days.

Results and discussion

In the first experiment the germination was failure, there was no noticeable germination process neither breeding lines nor released varieties. Under chilling stress, all varieties showed lower GP, longer lag period, lower R50 and lower E50 than in control condition. Because of the very slow and fragmented germination process at 12°C, we could not calculate adequately the E50 and R50 values in all lines. Accordingly, we use GP and lag period to find differences among the varieties. Based on Szalóki's data (Szalóki et al. 2018) the increasing lag period resulted in decreasing GP. The correlation was linear. We found the same correlation in case of released varieties. However, DH lines did not show this correlation. The shortest lag periods were found in 42.IV (11.17±0.76) and 42.I. (11.50±0.00) among the DH lines although these lines had longer lag period as compared with parents'values (Table 1). In case of GP, there were two genotypes (5.I. and 42.IV.),

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which reached the parental values. Based on the examined parameters there were two lines (22.II. and 9.I) which had the least germination process.

Table 1: The germination parameters of the 12 DH lines and two released variety

Genotype	LAG	Genotype	LAG	Genotype	GP	Genotype	GP
Nembo	9.5±1.73	5.I.	12.83±0.58	Köröstáj 333	83.33±5.77	9.II.	50.83±8.04
Köröstáj 333	10.67±1.04	9.III.	13.67±1.04	5.I.	82.50±5.00	11.I.	43.33±2.89
42.IV	11.17±0.76	10.I.	13.67±0.29	42.IV.	80.00±4.33	5.II	42.50±10.00
42.I.	11.50±0.00	11.I	13.67±0.76	Nembo	73.33±3.82	9.III.	39.17±9.46
5.II.	11.75±0.35	9.II.	13.83±0.29	22.III.	72.50±8.66	10.I.	36.67±3.82
42.II.	12.50±0.87	9.I.	14.50±0.87	42.II.	68.33±1.44	22.II.	19.17±10.41
22.III.	12.67±1.53	22.II.	15.00±1.32	42.I.	62.50±6.61	9.I.	7.50±4.33

Conclusions

According to results, the screening methods at 12°C is suitable for finding differences among the varieties. This method is a simple way to determine GP and lag period time. Based on our data (20th day of the experiment), we can evaluate the degree of cold tolerance of different basic breeding materials. 5.I. and 42.IV are suitable for further testing and 22.II and 9.I. lines were sensitive the cold temperature.

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