



Identification of candidate genes related to seedling vigor under cold conditions in rice (*Oryza sativa* L.)

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Objectives

In order to identify the genes involved in seedling vigor under cold conditions, comprehensive gene expression analysis was performed with recombinant inbred lines (RILs) derived from a cross between cultivars with high seedling vigor and low seedling vigor. Genes for which expression correlated with seedling vigor under cold conditions were identified.

Results

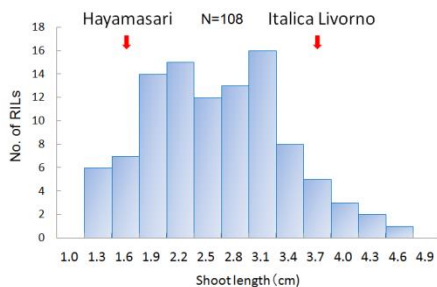


Fig. 1 Shoot length of 108 RILs derived from a cross between cultivars with high seedling vigor and low seedling vigor under cold conditions.

Seedling vigor under cold conditions of 108 RILs derived from a cross between 'Italica Livorno' (high seedling vigor) and 'Hayamasari' (low seedling vigor) was evaluated after growth at 17°C for 9 days. Thirty-one RILs were found to be significantly more vigorous than 'Hayamasari', and 33 RILs were significantly less vigorous than 'Italica Livorno'. Forty-four RILs showed seedling vigor between those of 'Italica Livorno' and 'Hayamasari'.

| Common name | ProbeName | Description | IL/HM |
|--------------|--------------|---|-------|
| AK120243 | Os10g0130500 | Transposase | 9.82 |
| Os12g0535600 | Os12g0535600 | Ribosome-inactivating protein family protein. | 4.50 |
| AF515482 | Os06g0133000 | Granule-bound starch synthase 1, chloroplast precursor (EC 2.4.1.21) | 3.66 |
| AK061449 | Os03g0856500 | Plastid-specific 30S ribosomal protein 1, chloroplast precursor (CS- S5) (CS5) (S22) (Ribosomal protein 1) (PSRP-1) | 3.32 |
| AK064635 | Os10g0529700 | Glutathione-S-transferase 2 | 2.71 |
| CIS14969 | Os04g0529600 | Lanthionine synthetase C-like family protein | 2.42 |
| AK107816 | Os03g0371400 | Cytochrome P450 family protein | 2.32 |

Table 1 List of genes expressed at higher levels in the highly vigorous RILs and the cultivar than in those with low vigor.

Microarray analysis was performed with RNAs isolated from shoots of 'Italica Livorno', 'Hayamasari', two highly vigorous RILs and two RILs with low vigor grown at 17°C for 9 days. Seven genes were expressed at higher levels in the highly vigorous RILs and the cultivar than in those with low vigor.

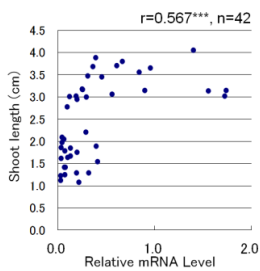


Fig. 2 Correlation between mRNA levels of AK107816 and shoot length under cold conditions.

The expression levels of the 7 genes shown in Table 1 were analyzed by quantitative real-time PCR with 22 highly vigorous RILs and 20 RILs with low vigor. The expression level of 1 of the 7 genes, a cytochrome P450 gene, was significantly correlated with seedling vigor under cold conditions.

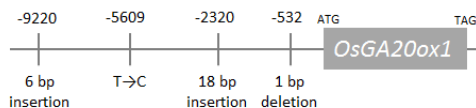


Fig. 3 Sequence polymorphisms in the promoter region of the gibberellin oxidase 1 gene (*OsGA20ox1*) between 'Hayamasari' and 'Italica Livorno'. The CAPS marker was developed based on the T-C mutation at -5609 in the promoter region of *OsGA20ox1* for genotyping RILs.

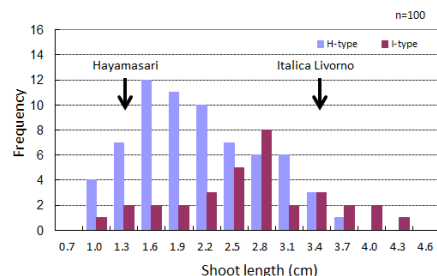


Fig. 4 Comparison of shoot length in RILs with the Hayamasari-type and Italica Livorno-type promoter sequences of *OsGA20ox1*. The means of shoot length are significantly different at 0.1% level between H-type and I-type.

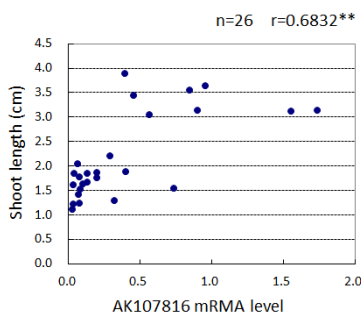


Fig. 5 Correlation between mRNA levels of AK107816 and shoot length under cold conditions in RILs with the Hayamasari-type promoter sequence.

Conclusion

AK107816, which codes for cytochrome P450, was identified as a gene for which expression correlated with seedling vigor under cold conditions. The polymorphism in the promoter region of *OsGA20ox1* is also associated with seedling vigor under cold conditions.