



# HOKKAIDO UNIVERSITY

|                     |                                                                                                                                                              |
|---------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Title               | Identification of the gene for thermosensitivity associated with heading in Hokkaido rice varieties                                                          |
| Author(s)           | Hoque, Md. Imdadul                                                                                                                                           |
| Description         | この博士論文全文の閲覧方法については <a href="https://www.lib.hokudai.ac.jp/dissertations/copy-guides/">https://www.lib.hokudai.ac.jp/dissertations/copy-guides/</a> をご参照ください。 |
| Degree Grantor      | 北海道大学                                                                                                                                                        |
| Degree Name         | 博士(農学)                                                                                                                                                       |
| Dissertation Number | 甲第16590号                                                                                                                                                     |
| Issue Date          | 2025-09-25                                                                                                                                                   |
| DOI                 | <a href="https://doi.org/10.14943/doctoral.k16590">https://doi.org/10.14943/doctoral.k16590</a>                                                              |
| Doc URL             | <a href="https://hdl.handle.net/2115/98200">https://hdl.handle.net/2115/98200</a>                                                                            |
| Type                | doctoral thesis                                                                                                                                              |
| File Information    | HOQUE_Md_Imdadul_abstract.pdf, 論文内容の要旨 <a href="https://creativecommons.org/licenses/by/4.0/">https://creativecommons.org/licenses/by/4.0/</a>               |



## 学位論文内容の要旨

博士の専攻分野名称：博士（農学）

氏 名：HOQUE Md. Imdadul

### 学位論文題名

Identification of the gene for thermosensitivity associated with heading in Hokkaido rice varieties

（北海道イネ品種に見られる出穂に関連した温度感受性遺伝子の同定）

Rice (*Oryza sativa* L.) is a crop of worldwide importance because of a staple food for over half of the world's population. Rice was formerly a tropical plant, but it is now grown in a variety of climates, including high-latitude areas like Japan's Hokkaido. By concentrating on early heading and low photoperiod sensitivity to suit the short growing season, more than a century of genetic progress has led to successful rice production in Hokkaido, one of the northernmost rice-producing regions. Small genetic alterations in locally adapted cultivars are often obscured by environmental factors and are still not well understood. This research investigates the genetic basis of early heading in rice. To identify and describe small-effect genetic contributions, heading date variation was examined in this research by excluding the environmental factors. The results imply that a small-effect genetic locus may independently promote early heading in addition to known flowering genes. This little influence might be crucial in improving local adaptation when paired with major genes.

### **1. Cryptic heading variation among rice varieties in Hokkaido is responsible for regional genetic diversity**

Genes such as *Ghd7*, *OsPRR37*, *Hd1*, and *DTH8* determine the heading time of Hokkaido's locally adapted rice varieties (LAVs). Most Hokkaido varieties contain unfunctional alleles for *Ghd7* and *OsPRR37*, indicating these are the main factors responsible for early heading. In contrast, the functional and unfunctional alleles in *Hd1* and *DTH8* are shared by Hokkaido varieties, suggesting that these genes are responsible for varying degrees of the heading earliness. Despite the low level of phenotypic variation in Hokkaido LAVs, heading time may be controlled by variable genes with small-effects. Unidentified genetic variations may customize rice varieties to meet particular local demands.

## **2. Identification of the gene for thermosensitivity associated with heading in Hokkaido rice varieties**

When comparing the time of panicle initiation and heading between Kitaake and A58, Kitaake was found to be earlier than A58, with its earliness being more prominent at high (25°C) temperature than low (23°C) temperatures. Both Kitaake and the early lines (progeny lines resulting from crossed between A58 and Kitaake) exhibited greater thermosensitivity in panicle initiation than A58 and the late lines. I pinpointed a QTL, *qFDTH4*, that influences heading difference between Kitaake and A58 by high-resolution fine mapping. This gene is located within a refined region on chromosome 4, which exhibits a 3bp deletion polymorphism at position 32,611,365 between parental lines. This polymorphism is present in the 1st intron of the gene LOC/Os04g54840, and the same polymorphism can also be found in only Hokkaido rice varieties. This gene is highly expressed in young inflorescences. Its predicted functions related to DNA dependent RNA polymerase may potentially impact other flowering-time genes at the transcriptional or post-transcriptional level, possibly involving splicing variations.

## **3. Thermo-sensitivity of heading date found in Hokkaido rice varieties influenced by the novel gene affects heading synchrony and premature heading**

To understand how temperature affects heading in rice, particularly focusing on the gene LOC\_Os04g54840, in this study, I examined panicle initiation and heading times in A58, Kitaake, and their early and late-heading offspring under high (25°C) and low (23°C) temperatures. Kitaake and the early lines showed greater thermosensitivity in panicle initiation compared to A58 and the late lines, which aligned with their respective genotype versions of LOC\_Os04g54840. Leaf age progression was not significantly different between early and late lines under the two temperatures. In my study, I investigated premature early heading and heading synchrony. I used my mapping populations to understand the gene effect regarding these two heading traits. After comparing two different genotypes, it was very prominent that the first heading difference was significantly higher than the second panicle heading. The Kitaake type genotypes exhibited significantly longer heading synchrony than the A58 type genotypes. If the A58 likely contains wild type allele, the gene LOC\_Os04g54840 in Kitaake may function to repress ectopic initiation of the panicle by the high temperature. The knockout individuals of the candidate genes couldn't survive that may cause the lethal action of the null of the gene. It is hypothesized that cells with successful edits were non-viable and could not regenerate into whole plants, thus preventing the recovery of any mutants.