特 別 講 演 要 旨

Physiological and Genetical Characters for Early Maturity in Barley and Common Wheat

Shozo YASUDA
(Research Institute for Bioresources, Okayama University, Kurashiki, Japan)

Abstract

(1) Physiological and genetical characters for early maturity

Time of heading and anthesis of cereal crops grown in the field involves physiological complexes that can be resolved into several genotypic factors each responding to various environmental factors prevailing during different growth periods. Takahashi and Yasuda (1957, 1970) and Yasuda and Shimoyama(1965) reported that at least three physiological factors were responsible for determining earliness in barley and common wheat(called as wheat bellow) varieties : namely (a) spring and winter habit of growth or vernalization requirement, (b) photoperiodic response and (c) earliness in a narrow-sense or minimal vegetative growth.

When barley and wheat varieties are sown outdoors in the fall in central and south western Japan, the ecological significance of these factors is explained as follows : winter growth habit is mainly necessary for safe overwintering by controlling initiation of ear primordia at the seedling stage. After vernalization is complete, photoperiodic response acts as the chief factor determining heading time. Earliness in a narrow-sense, which can be determined by long-day at high temperature after vernalization, also affects heading time though not so strongly. These three physiological characters are all genetic factors controlled by major or minor gene or genes. As to vernalization requirement, one recessive and two dominant genes, sh, Sh-2 and Sh-3 located on chromosome 4, 7 and 5, respectively, are for spring habit and all the genes allelic to them for winter habit.

On account of epistasis of spring genes to winter genes, namely, Sh-2 and Sh-3 to Sh and sh to sh-2 and sh-3, only a single genotype ShShsh-2sh-2sh-3sh-3 is capable of exhibiting winter habit. In wheat, five dominant spring genes, Vrn-1(chromosome 5A), Vrn-2, Vrn-3(chromosome 5D) Vrn-4 and Vrn-5(chromosome 7B) have been reported at the present.

One of the genes responsible for photoperiodic response in barley is ca-k(chromosome 5) neutral to day-length, which has firstly found in Kinai 5(Yasuda et al. 1965, Yasuda 1977). In wheat, Ppd-1 on chromosome 2D has been known to have similar activity to the ea-k in barley (Welsh et al. 1973).

As to the gene or genes for earliness in a narrow-sense, one dominant gene was found in F_2 from a cross between early and late lines under 24h/day at high temperature, which were selected from a cross of Hayakiso 2 and Kirin Choku 1, and were selfed for five or more generations. In wheat, there is no information about earliness in a narrow-sense, at present.

(2) Differences of mechanism for early maturity between barley and wheat

It is far from easy in Japan to breed wheat varieties as early as to be comparable to the earliest barley varieties. In these circumstances, it is very important from ecological viewpoint to compare the role of the internal factors in barley plants with that in wheat plants.

When barley and wheat varieties were sown outdoors in fall of ordinary sowing time at Kurashiki, south western parts of Honshu, Japan, time of double ridge stage of ear primordia(T1) in wheat plants were clearly retarded in average from those of barley plants. In onset of stem elongation(T2), after the T1, however, there were no differences between barley and wheat varieties. And, time of heading (T3), anthesis(T4) and maturity(M) were again retarded in wheat varieties than in barley varieties. Relationships between the T1 and vernalization requirement were firstly investigated under the controlled condition using wheat and barley varieties having different grades of vernalization requirement. Retardation of time of shoot apex development was not related to the grades of vernalization requirement in both

barley and wheat. Under the controlled condition, effects of short photoperiod on shoot apex development were also not different between barley and wheat. However, it was recognized that beginning times of shoot apex development in wheat plants were retarded by low temperature as compared with barley plants.

In addition to these, the differences in early maturity in a open field between wheat and barley varieties were analysed from various viewpoints. As the results, it was recognized that the differences in the translocation of photosynthetic substances from stems and leaves to kernels. This may be the main constraint on the breeding of wheat cultivars as early in maturity as the barley ones.