特 別 講 演 要 旨

Root System Formation and Its Relation to Grain Yield in Rice Plants

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Abstract

A rice shoot can be assumed to be a vertical continum of "shoot units" (abbreviated as SUs), each of which comprises a leaf, a subjacent stem segment and a tiller bud at its base. From each SU, except several higher SUs with elongated stem segments, appear two groups of primary roots, the upper and the lower ones, respectively, demarcated by their position on each stem segment.

When, during a shoot growth, the n-th leaf, counted from base of the shoot, begins to emerge from subjacent leaf sheath, both groups of primary root in the (n-3)-th SU begins to outgrow synchronously. Such regular pattern of development between primary roots and leaves is maintained throughout vegetative growth period of the plants, irrespective of the shoot being a main one or tillers. As a plant grows, the number of tillers as well as primary roots increases rapidly. The number of primary roots per hill amounts to 700-1000 at heading stage, under the conditions of Japanese paddy fields.

Each primary root elongates vigorously after emergence and its growth continues in the following 20 to 30 days, meanwhile many thin and a few thick secondary roots develop acropetally along the primary axis. On the thick secondary roots, the tertiary roots develop in the same manner as the secondary one on the primary axis. The primary roots formed at early growth period of a plant are thin and short, while the ones developing later tend to be thicker and longer.

However, the upper primary roots of each SU remain usually thin and short with more branching, as compared to the lower ones of the same SU. Thus, fully developed root system of rice is composed of many primary roots with diversified forms and branching habits.

It is generally recognized that the thick primary roots have a trend to grow vertically, while the thinner ones, rather horizontally. As a result, the root system of a rice plant as a whole spreads deeply and widely into many directions of soil as the plant grows. Among many primary roots thus formed, the lower primary

roots which grow near to the heading time at higher SUs are thickest and longest, growing deep into the soils, while the upper primary roots of the same SUs attenuate rapidly after emergence, grow horizontally and develop much secondary and/or tertiary branch roots, making "root mat" near the soil surface. Many primary roots, which emerge during heading stages or later, stop growing soon after their emergence and become stunted.

The final form of root system are highly diversified according to the environmental conditions they grow. Hard plow pan usually limits the root penetration deep into soils. Abundant application of chemical nitrogen fertilizer increases number as well as branching of primary roots, however, inhibits their growth rates, making the whole root system to be condensed one in restricted soil volume. Chemical nitrogen fertilizer also accelerates the "root mat" formation near to the soil surface, especially when the fertilizer is top dressed many times. On the other hand, abundant application of organic manure makes the whole root system to develop deep as well as dense into the soils. The reason of this phenomenon is still obscure. Mutual shading due to over—luxuriant growth of terrestrial parts of plants or artificial shading often make root system to spread within shallow soil horizon.

As to relationships between root, system and grain yield of rice plants, the followings have been clarified. Surveys of the actual paddy field show that fresh weight of "root mat" per unit soil volume is highly correlated with grain yield, as far as the fields concerned remain in low yielding levels. However, in the fields of high yielding levels, such correlation becomes obsure, suggesting not only the superficial root system but also the deeply developed root system might play an important role in increasing the grain yields. In this connection, shading treatment during later panicle formation period is very suggestible. By this treatment, root system become shallower with much superficial roots, and although no difference is observed in flower number between treated and control plots, grain yield decreases significantly in treated plot.

Summing up the result hitherto obtained in my laboratory, it is estimated that one primary root corresponds roughly to two ripened grains or 40 mg of ripened grain weight. These figures of course vary according to the forms of root systems, modified by various conditions as mentioned above. It is our present assumption that deeply grown thick roots with dense branching may be very effective for high yielding ability. Recent experiment, comparing Japanese cvs. and Korean cvs. bred through Japonica—Indica hybridization, shows that the latters produse usually many thick primary roots with much branching, which might in parts explain the high yielding characteristics of these cvs.