Perspective of breaking stagnation of soybean yield under monsoon climate

Tatsuhiko Shiraiwa

Graduate School of Agriculture, Kyoto University, Japan

Abstract

Soybean yield has been low and unstable in Japan and other areas in East Asia, despite long history of cultivation. This is contrasting with consistent increase of yield in North and South America. This presentation tries to describe perspective of breaking stagnation of soybean yield in East Asia, considering the factors of the different yields between regions. Large amount of rainfall with occasional dry-spell in the summer is a nature of monsoon climate and as frequently stated excess water is the factor of low and unstable soybean yield. For example, there exists a great deal of field-to-field variation in yield of 'Tanbaguro' soybean, which is reputed for high market value and thus cultivated intensively and this results in low average yield. According to our field survey, a major portion of yield variation occurs in early growth period. Soybean production on drained paddy fields is also vulnerable to drought stress after flowering. An analysis at the above study site demonstrated a substantial field-to-field variation of canopy transpiration activity in the mid-summer, but the variation of pod-set was not as large as that of early growth. As frequently mentioned by the contest winners of good practice farming, avoidance of excess water problem in the early growth period is of greatest importance. A series of technological development took place in Japan in crop management for stable crop establishment and growth, that includes seed-bed preparation with ridge and/or chisel ploughing, adjustment of seed moisture content, seed treatment with mancozeb+metalaxyl and the water table control system, FOEAS. A unique success is seen in the tidal swamp area in South Sumatra with the Saturated Soil Culture (SSC), which is for managing acidity problem of pyrite soils. In 2016, an average yield of 2.4 tha^{-1} was recorded for a 450 ha area with SSC (Ghulamahdi 2017, personal communication). This is a sort of raised bed culture and thus the moisture condition is kept markedly stable during growth period. For genetic control, too, many attempts are on-going for better emergence and plant growth after emergence under excess water. There seems to exist two aspects of excess water resistance, one related to phytophthora resistance and the other with better growth under excess water. The improvement for the latter is particularly challenging and genomic approach is expected to be effectively utilized. The crop model simulation would estimate/evaluate the impact of environmental and genetic factors. But comprehensive crop models for soybean are mainly for cultivations on upland fields and crop response to excess water is not fully accounted for. A soybean model for production on drained paddy fields under monsoon climate is demanded to coordinate technological development under changing climate. We recently recognized that the yield potential of recent US cultivars is greater than that of Japanese cultivars and this also may be responsible for different yield trends. Cultivar comparisons proved that higher yields are associated with greater biomass production specifically during early seed filling, in which high and well sustained activity of leaf gas exchange is related. In fact, the leaf stomatal conductance is considered to have been improved during last a couple of decades in the USA through selections for high yield in several crop species. It is suspected that priority to product quality of soybean as food crop, especially large seed size in Japan, did not allow efficient improvement of productivity. We also recently found a substantial variation of yielding performance under an environment of Indonesia among divergent cultivars from tropical and temperate regions through in a part biomass productivity. Gas exchange activity again seems to be involved. Unlike in North America where transpiration adjustment is considered necessary to avoid terminal drought,

under the monsoon climate with wet summer plants with higher activity of gas exchange than current level might be advantageous. In order to explore higher or better-adjusted canopy function, the methodological development is demanded for canopy-level evaluation of transpiration activity. The stagnation of soybean yield would be broken through controlling variable water environment and breeding efforts to improve the quality-oriented cultivars for stable and high yield.

Corresponding author:
Tatsuhiko Shiraiwa
Graduate School of Agriculture, Kyoto University, Kita-Shirakawa, Sakyo Kyoto 606-8502, Japan
+81 75 753 6042
Email: shiraiwa@kais.kyoto-u.ac.jp