31 May 2013

Plant growth #2. Plant growth and crop harvest by Kazuhiko KOBAYASHI

The aim: to understand plant's use of assimilates for growth and human intervention in plant growth

1. Plant growth: how do they (plants) assimilate and use carbohydrates?

1.1. Scaling-up leaf photosynthesis to plant canopy biomass production

a. Light and nitrogen: Monsi-Saeki model for light transfer within canopy and canopy photosynthesis (Figs. 20 & 21)

b. Hirose-Werger Model for optimizing light use of photosynthesis by distributing leaf N along the light profile (Fig. 22-23).

c. Altering irradiance profile for higher canopy photosynthesis (Fig. 24).

1.2. Distributing assimilates (carbohydrate and nutrients) for growth and the final product

- Concept of *source* and *sink.*
- Vegetative phase: spans from exponential growth with positive source-sink feedback to resource-limited growth (Fig. 25).
- Reproductive phase: phenological switch turned on to form a new sink and distribute-redistribute the assimilates to the sink (Fig. 25).
- Sink size is somehow regulated by the amount of resource available (Fig. 26).
- Maximum grain yield is attained by optimal use of the amount of nutrient taken up by the plants (Fig. 27).

2. Breeding and intensification: how modern varieties increased the crop production?

a. Increased N application increased the grain yield of a modern variety but reduced that of a traditional variety (Fig. 28).

b. No difference between modern varieties and traditional ones or wild relatives in the effect of leaf N content on photosynthetic rate (Fig. 29).

c. Shorter stature: reduced plant height (Fig. 30) and reduced lodging damage (Ref. 2). Erect leaves and increased Harvest Index (Fig. 31).

d. General trend of increasing harvest index in newer varieties across crop species (Fig. 32).

e. Shorter growth duration with greater harvest index (Fig. 33) for growing dry season crop with diminished photoperiod sensitivity:
   - Roles of photoperiodism a biological calendar (Figs. 34 and 35).
   - Higher solar irradiance (Fig. 36) leads to the greater yield in dry season than rainy season (Fig. 37).

f. Increased crop production due to increased cropping intensity (Fig. 38) and crop yield (Fig. 39)

g. Why has the higher yield of modern varieties made sense?
   - Market-oriented crop production (read the story of IR8 or Honda-rice in Ref. 2).
   - Better control of water, nutrients, and competing species.

References

1) Evans, L.T. (1993) Crop Evolution, Adaptation, and Yield. Cambridge University Press.
2) IRRI (2006). *Rice Today* Vol. 5, No. 4.
3) Jones, H.G. (1992) Plants and Microclimate Second edition. Cambridge University Press.
4) 東京大学光合成教育研究会編（2007）光合成の科学．東京大学出版会.

Question:

Read Ref. 2 and summarize what was most impressive for you.