

# Enhancing Soybean Productivity in the Paddy Fields in Japan

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## Abstract

In Japan, more than 80% of soybean acreage is performing on the paddy fields which are temporally converted to upland condition, where soil moisture is prone to excess at early growing period and to dry at midsummer. NARO has developed new seeding methods for avoiding excess moisture injury in paddy fields. Soybean productivity has not been increased recently in Japan, probably due to decreasing soil fertility of the paddy soils. Therefore it is needed to enhance nodule nitrogen fixation in paddy fields. A new subirrigation and drainage system (FOEAS) for controlling water table in a paddy field has been developed. We evaluate the effectiveness of FOEAS for soybean production in a low soil nitrogen, heavy clay paddy field. Water table depth control by FOEAS at -32cm depth increased photosynthesis and nodule nitrogen fixation resulted in 20 to 40% yield increase, compared to conventional drainage management.

## Media summary

A new water-table controlling system, FOEAS is effective for improving soybean productivity in low soil nitrogen paddy fields.

## Key Words

excess moisture injury, nodule nitrogen fixation, paddy field, seeding machine, soybean, water table

As the paddy rice productivity has been increasing in Asian countries, it causes overproduction of rice in some countries. Japanese government encouraged the farmers to produce soybean instead of rice in paddy fields since late of 1970s, and more than 80% of soybean acreage is now performing on the paddy fields that are temporally converted to upland condition. Those paddy-upland rotation fields are prone to excess moisture injury in early growing period due to rainy season. NARO organized research units for improving soybean productivity and had developed some new seeding machines that are able to relieve excess moisture injury by making ditch during seeding (Hosokawa 2006).

Soybean productivity had been increased until late of 1990s, however it remains at the same level or is slightly decreasing, as the paddy soil fertility has been decreasing by soybean cultivation. Increasing soil fertility by applying large amount of manures will be effective for increasing soybean productivity, however it will not be a realistic way as high soil fertility spoil the taste of paddy rice. Therefore it is needed to develop a new cultivation method for enhancing nodule nitrogen fixation in paddy fields (Shimada 2006). A

potential of soybean nodule nitrogen fixation should be very high, however it is very sensitive to soil moisture. A new subirrigation and drainage system (FOEAS) for controlling water table in a paddy field has been developed (Fujimori 2006). The effect of FOEAS for soybean production was evaluated in a heavy clay with low soil nitrogen paddy field.

### **Methods of FOEAS experiment**

Two soybean varieties, Tachinagaha (normal nodulation) and En1282 (non-nodulation) were sown on a heavy clay with low soil nitrogen paddy field with 60cm row-width and 10cm intra-row spacing at June 22, 2006 and June 20, 2007. Fertilizer was applied as before sowing as basal dressing with rate of N 30, P<sub>2</sub>O<sub>5</sub> 100, K<sub>2</sub>O 100 kg ha<sup>-1</sup>, respectively. The soil water control treatments consisted as follows, **ODD**; open ditch drainage without irrigation, **WTD20**; water table depth was kept at -20cm from the soil surface, **WTD32**; water table depth was kept at -32cm from the soil surface.

### **Results of FOEAS experiment**

Water table control by FOEAS eased the soil moisture change in upper soil layer during growing season. Leaf chlorophyll content (SPAD) and apparent photosynthetic rate (AP) of ODD was obviously lower than that of WTD20 and WTD32 during seed filling period in both years. The reduction of AP in ODD was mainly due to lower stomatal conductance. Relative abundance of ureide in xylem sap (RAU) as an index of nodule nitrogen fixation in soybeans, showed more than 70% in all treatments and tended to be highest in WTD32 during seed filling period. In spite of the yield of non-nodulating variety En1282 was about 0.3 to 0.5t ha<sup>-1</sup> as the soil nitrogen fertility was very low, the yield of nodulating variety Tachinagaha in WTD32 reached about 3.7t (2007) to 4t (2006) ha<sup>-1</sup>, that were 20% or 40% higher compared to ODD. It is concluded that FOEAS is effective for improving soybean productivity in low soil nitrogen paddy fields.

### **References**

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