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# Reduction of the Incidence of Rice Neck Blast by Integrated Soil Improvement Practice

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# 農土培養이 목稻熱病 發生에 미치는 影響

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## ABSTRACT

The integrated soil improvement practice reduced neck blast incidence by ranging from 6.3 to 59.5 percent compared to control plot. However, effect of integrated soil improvement practice in reducing neck blast incidence was greater in Tongil type cultivars.

On the contrary, mean value of plant height of eleven rice cultivars was taller by 6.4cm in the integrated soil improvement plot with 2.3 more tillers than that of control plot. As a result, yield increase of milled rice by metric tons per hectare was 24.1 percent in the integrated soil improvement plot.

## INTRODUCTION

About 32% of total acreage for rice cultivation in Korea is classified as sandy soil and approximately 74% of the sandy soil is required for integrated soil improvement practices[10].

Wollastonite, as a main source of silica ($SiO_2$), is highly recommended to rice farmers for several reasons. First, it is needed to grow healthy rice plants by enriching paddy soil with $SiO_2$, and thus it results in good yield. Second benefit is to reduce blast incidence. The reduction of neck blast by $SiO_2$ has been well documented by many researchers[2,3,5,6,7]. The role of $SiO_2$ in the nitrogen metabolism pool is known to control the uptake of nitrogen and maintain balance with nitrogen and results in reduction of ammonium nitrogen[4] which finally becomes glutamine or asparagine combined with amino acids[8,9].

One of the government's policies for increase of rice productivity is to improve the physical and chemical characteristics of the low productive paddy land and it is recommended for rice farmers to improve their sandy soil for higher yield by integrated soil improvement practices. If the national soil improvement project is conducted on the low productive paddy land, it will greatly accelerate self-sufficiency of rice production in association with reduction of neck blast incidence.

The main purpose of this experiment is to evaluate the effect of integrated soil improvement on reducing neck blast incidence. The authors extend their thanks to Mr. Jeong Nam Im, Department of Soil Physics, IAS, for his kind prescription of expe-

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rimental plot for integrated soil improvement practice. They are also indebted to Mr. Hong Sik Min for his continuous assistance during the experiment.

## MATERIALS AND METHODS

### Test Cultivars

Five cultivars from Tongil type including Taebaegbyeo, Baegunchalbyeo, Milyang 23, Milyang 30 and Geumgangbyeo, and six cultivars from Japonica, namely; Gwanagbyeo, Dobongbyeo, Seolagbyeo, Nongbaeg, Jinjubyeo and Akibare were tested.

### Transplanting Date and Fertilizer Level

Fourty-day old seedlings were transplanted on May 24, 1981. Fertilizer level was 150 : 90 : 100kg of N:P:K for Tongil type and 110 : 60 : 70kg for Japonica per hectare.

### Paddy Soil Improvement Practice

| Acreage (ha) | Amount of additional materials(%) | | | | |
|---|---|---|---|---|---|
| | Clayey earth | $P_2O_5$ | $SiO_2$ | $Ca(OH)_2$ | Compost |
| 1 | 450 | 0.3 | 2.1 | 1.1 | 14.7 |

Clayey earth taken from hillsides was added on the paddy surface and then compost was evenly spread out. Application of $P_2O_5$, $SiO_2$ and $Ca(OH)_2$ was followed and the paddy soil was plowed by 18cm depth in middle April. The content of $SiO_2$ was maintained with 140 ppm and soil pH was 6.0.

### Field Observations

Plant height and number of tillers were measured on Augost 10, 1981, and neck blast incidence was observed 40 days after heading in each of experimental plots. Yield estimation was made just before harvest.

## RESULTS AND DISCUSSION

The incidence of rice neck blast, caused by *Pyricularia oryzae* Cavara, in four rice cultivars was less in the integrated soil improvement practice plot than that of control plot (Table 1). The percentage of neck blast incidence was variable depending upon rice cultivars and ranged from 2.5 to 34.5% in the integrated soil improvement plot while that of control plot varied from 4.6 to 79.0% under no fungicide application condition.

This, in turn, means that integrated soil improvement practice reduced neck blast incidence by ranging from 6.3% for Jinjubyeo to 59.5% for Milyang 23 compared to control plot. Among four rice cultivars observed, Milyang 23 and Geumgangbyeo, Tongil type cultivars, showed more severe incidence of neck blast than those Japonica type cultivars Akibare and Jinjubyeo. Severe incidence in Tongil type cultivars might be due to the prevalence of races which could attack these cultivars. Incidence of neck blast in seven cultivars such as Taebaegbyeo and Milyang 30 was nil or negligible.

In the characteristics of leaf blade, there are 2~3 longitudinal rows of bulliform or motor cells between vascular bundles which are known to function in the rolling and unrolling of the leaf blade. When silica is absorbed by the rice plant, it is accumulated in the epidermal cells and these motor cells are considered as major infection sites for penetration of *P. oryzae*. In the recent study, Yoshino[11] reported that 58.8% of total percent penetration was accomplished through the motor cells. The general understanding on the function of silica is known to be localization

**Table 1.** Comparison of neck blast incidence in four rice cultivars between integrated soil improvement plot and control plot under no fungicide application condition.

| Percentage of | Milyang 23 | | Geumgangbyeo | | Akibare | | Jinjubyeo | |
|---|---|---|---|---|---|---|---|---|
| | ISI[a] | CON[b] | ISI | CON | ISI | CON | ISI | CON |
| Neck blast | 15.1[c] | 37.3 | 34.5 | 79.0 | 2.5 | 4.6 | 5.9 | 6.3 |
| Reducing effect | 59.5 | — | 56.3 | — | 45.6 | — | 6.3 | — |

a) Integrated soil improvement plot (ISI).
b) Control plot (CON).
c) Mean value obtained from 20 hills.

**Table 2.** Comparison of plant height, number of tillers and yield of eleven cultivars between integrated soil improvement plot and control plot.

| Cultivar | Plant height(cm) | | Numer of tillers | | Milled rice (M/T/ha)[a] | |
|---|---|---|---|---|---|---|
| | ISI[b] | CON[c] | ISI | CON | ISI | CON |
| Taebaegbyeo | 91.9 | 86.0 | 13.3 | 12.0 | 6.2 | 5.2 |
| Baegunchalbyeo | 102.2 | 96.4 | 11.8 | 10.2 | 5.7 | 4.3 |
| Milyang 23 | 99.2 | 97.2 | 13.6 | 11.8 | 6.6 | 5.5 |
| Milyang 30 | 89.0 | 85.4 | 16.5 | 14.0 | 6.6 | 6.2 |
| Geumgangbyeo | 93.0 | 91.4 | 13.0 | 12.1 | 6.2 | 5.7 |
| Gwanagbyeo | 113.0 | 103.5 | 18.3 | 16.0 | 6.0 | 5.5 |
| Dobongbyeo | 111.8 | 99.7 | 16.0 | 12.7 | 6.0 | 5.0 |
| Seolagbyeo | 90.2 | 84.8 | 17.4 | 14.5 | 5.7 | 5.7 |
| Nongbaeg | 118.3 | 114.9 | 12.9 | 10.5 | 6.5 | 5.2 |
| Jinjubyeo | 110.1 | 104.6 | 15.5 | 14.4 | 6.7 | 5.5 |
| Akibare | 105.5 | 89.9 | 20.6 | 16.0 | 5.7 | 5.2 |
| Mean | 102.2 | 95.8 | 15.4 | 13.1 | 6.7 | 5.4 |

a) Yield was estimated at Growth stage 9.
b) Integrated soil improvement plot (ISI).
c) Control plot (CON).

along the transpiration stream and the silica gel layer in the epidermis plays an important role in transpiration and prevention of fungus penetration or insect invasion[7].

When plant height, number of tillers and yield were compared between two plots, plant hieght was taller in the integrated soil improvement plot with the range of 2.0cm in Milyang 23 to 15.6cm in Akibare and mean value of plant height of eleven cultivars was taller by 6.4cm. More tillers in the integrated soil improvement plot observed with the range of 0.9 in Geumgangbyeo to 4.6 tillers in Akibare. Taller plant height and more tillers resulted in increased yield by integrated soil improvement practice. (Table 2). For instance, Tongil type cultivar Baegunchalbyeo produced 5.7M/T of milled rice per hectare in the integrated soil improvement plot and exhibited 33% increase than that of control plot. Out of 11 cultivars tested, they showed 8 to 33% increase of milled rice per hectare expect Seolagbyeo and mean increase was 24%. Um[10] also reported that improvement practice of sandy soil resulted in 7 to 58% increase of yield. These facts indicate that the national project of integrated soil improvement is a short cut to achieve self-sufficiency in staple food, because integrated soil improvement practices resulted in better growth of rice plant and higher yield as well as reduction of blast incidence. The blast disease of rice caused by *P. oryzae* is one of the important limiting factors for rice production. Yield loss of rice due to the blast disease in Korea was about 4.2 % in 1978 when the blast was epidemic. Annual yield losses during the period of 1971~1980 varied from 0.2 to 5.5% with an average of 2.2%[1].

The exact mechanisms on the less incidence of neck blast by the integrated soil improvement practice are not yet clarified, however, two major factors might be involved in the suppression of neck blast incidence. First, the blast fungus, *P. oryzae*, has to secure its bridgehead immediately after penetration for colonization inside the rice plant tissue. Since glutamic acid or its amide glutamine is known as the most favorable nutrient source for the hyphal growth of *P. oryzae* and ammonium nitrogen is the source of glutamine[9], enough content of $SiO_2$ in the soil and rice plant tissue controls the uptake of nitrogen and results in reduction of ammonium nitrogen[4]. Thus it finally controls the excess accumulation of glutamic acid and the blast fungus has less chance to multiply and colonize in the tissues. Second, as indicated by many researchers[2,3,5], $SiO_2$ is accumulated in the epidermal cells and acts as a mechanical

barrier against the blast fungus penetration. These series of events result in less neck blast incidence and reduce losses from the disease.


## 摘 要

우리나라 논 土壤面積의 約 32%에 該當하는 409,901.9ha가 砂質土壤으로 그中 約 74%인 303,683.3ha는 客土를 要하는 面積이다. 現在 政府에서는 쌀의 增産을 爲하여 農土培養事業을 積極 推進하고 있는데 農土培養은 土壤의 物理化學性을 改良하여 增收의 効果가 있을 뿐만 아니라 稻熱病의 發生抑制에도 큰 効果가 있다. 本 試驗에서는 農土培養을 했을때 목稻熱病의 發生은 品種에 따라 客土하지 않은 논에 比하여 6.3~59.5%까지 적게 걸렸으며 목稻熱病의 發生輕減効果는 一般系品種보다 統一系品種에서 더욱 컸다. 한편 農土培養區에서 11個 供試品種의 草長은 平均 6.4cm 길었고 이삭數는 2.3個가 많았으며 玄米重에 있어서도 平均 24.1%의 增收効果가 있었다.


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