

## Ecological Studies on Rice Sheath Blight Caused by *Rhizoctonia solani*

### IV. Inoculation Time of Sclerotium and Disease Development

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### 벼 잎집무늬마름病的 生態學的 研究

#### IV. 菌核의 接種時期와 發病

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#### ABSTRACT

Natural sclerotia of *Rhizoctonia solani* causing rice sheath blight were inoculated at 10 day intervals from June 15 to July 15 in paddy field, Icheon, Korea. Percentage of infected stems, top lesion height and percentage of lesion height vs. plant height were higher in the early inoculated plots than in the late inoculated ones. However, no significant differences among inoculation dates of sclerotia were found on the basis of degree of damage at maturing stage and rice yield. These results suggest that the time of initial symptom appearance under the same inoculum potential may not affect the damage of rice plants by the fungus.

*Key words:* *Rhizoctonia solani*, sclerotia, disease development.

#### 要 約

*Rhizoctonia solani* 自然菌核을 6月 15日부터 7月 15日까지 10日 間隔으로 利川所在 病理試驗圃場에서 接種하였다. 罹病莖率, 病斑높이, 病斑高率은 後期接種區보다 早期接種區에서 높았다. 그러나 成熟期の 被害度 및 收量에 있어서는 接種時期間에 有意的인 差異가 認定되지 않았다. 이러한 結果는 같은 量의 傳染源이 存在할 때에는 잎집무늬마름病 初期病斑의 出現時期의 早晚이 成熟期の 被害度에는 큰 影響을 미치지 않고 있음을 示唆하고 있다.

#### INTRODUCTION

Disease severity and damage of rice sheath blight caused by *Rhizoctonia solani* Kühn have been reported to be greater under early cultivation system (1, 5, 6, 8). In our previous study, it was suggested that early transplanting, narrow planting space and high nitrogen

level favor development of rice sheath blight and increase damage (10). The overwintered sclerotia play an important role as the primary inoculum for sheath blight disease (2, 7), and the number of overwintered sclerotia present in 10a reached more or less  $10^6$  in 1977, Korea, depending upon nitrogen levels and cultivars (9).

In the present study, disease development phases of

rice sheath blight were periodically measured after artificial inoculation of sclerotia at different dates in paddy field.

## MATERIALS AND METHODS

The Japonica x Indica hybrid cultivar Wopungbyeo was transplanted on May 24 by 27 x 15cm planting space. Total 50% of nitrogen fertilizer, i.e., N: 225kg, P: 90kg, K: 100kg/ha, was overdressed to easily induce disease development.

On the following day of transplanting, a 15m<sup>2</sup> plot per treatment was installed with lawn cloth by 60cm height to prevent inflow of floating sclerotia. To eliminate the sclerotia inside the plots, each plot was flooded up to lawn cloth height at 3 and 7 days after transplanting and then the floating sclerotia were removed. The sclerotia ( $5 \times 10^5$ /10a) were inoculated on June 15, June 25, July 5 and July 15. The control plots not inoculated were allowed for natural infection.

Percentage of infected stems, top lesion height and percentage of lesion height vs. plant height were measured by examining 10 hills per plot at 10 day intervals after 10 days of inoculation. At maturing stage of rice plants, degree of damage by sheath blight (11) and rice yield were estimated from 3 replications by randomized block design.

## RESULTS

**Percentage of infected stems.** Symptoms caused by *R. solani* were observed on the leaf sheaths after 10

days of inoculation (Table 1). Percentage of infected stems (PIS) in June 15 and June 25 inoculated plots was low during the first rating made at 10 days after inoculation, but it remarkably increased from the successive rating showing 90% since July 25. In July 5 and July 15 inoculated plots, PIS at the first rating were relatively high, i.e., 55.9% and 36.6%, respectively. However, there was no significant difference in PIS by different inoculation dates since August 15. In contrast, PIS under natural infection became relatively low.

**Top lesion height.** The top lesion height (TLH) was higher in the early inoculated plots than in the late inoculated plots throughout the development of rice plants (Fig. 1). Increase of TLH was linear and it was over 40cm since August 5 except July 15 inoculation plot. The difference in TLH between June 15 and July 5 inoculation plots was smaller, but that between June 15 and July 15 plots was greater.

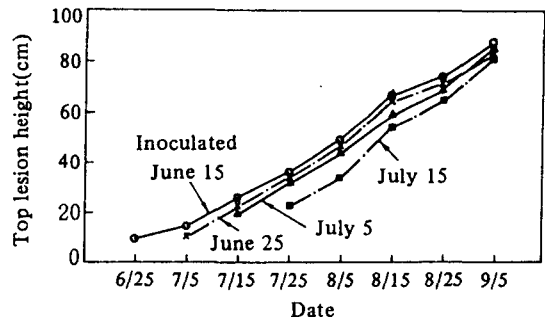


Fig. 1. Top lesion height of sheath blight disease on rice plants at different stages of growth after artificial inoculation of natural sclerotia of *Rhizoctonia solani* at different dates.

Table 1. Percentage of infected stems of rice plants after inoculation with natural sclerotia<sup>a</sup> of *Rhizoctonia solani* at different dates

Observation date	Natural infection	% Infected stems			
		June 15	June 25	July 5	July 15
June 25	—	11.2	—	—	—
July 5	1.8	41.5	16.9	—	—
15	16.5	73.5	69.4	55.9	—
25	40.2	95.2	95.0	94.6	36.6
Aug. 5	68.6	97.8	100.0	100.0	70.5
15	78.0	99.8	100.0	97.7	90.8
25	84.1	100.0	96.2	95.1	96.0
Sept. 5	92.3	100.0	100.0	98.4	96.2

<sup>a</sup> About 500,000 sclerotia/10a were inoculated by hand at a 15m<sup>2</sup> plot at June 15, June 25, July 5 and July 15, respectively.

Percent lesion height vs. plant height. Percentage of lesion height vs. plant height (PLPH) was higher in the early inoculated plots than in the late inoculated plots (Fig. 2). The difference in PLPH was greater in the earlier stages of plant growth than in the later stages. The increase pattern of PLPH showed the same tendency as in the TLH.

Degree of damage by sheath blight and yield. Degree of damage by sheath blight at maturing stage was higher in June 15 inoculated plot than in June 25 inoculated plot (Table 2). However, there was no

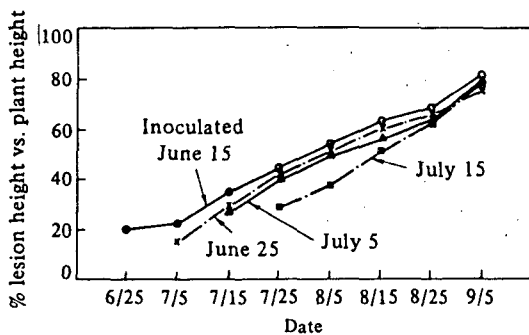


Fig. 2. Percentage of lesion height vs. plant height after artificial inoculation of natural sclerotia of *Rhizoctonia solani* at different dates.

Table 2. Degree of damage and yield of rice after inoculation with natural sclerotia of *Rhizoctonia solani* at different dates

Inoculation date	Degree of damage <sup>a</sup>	Yield(kg/3.3m <sup>2</sup> )
June 15	88.4 a <sup>b</sup>	2.45 b
June 25	74.1 ab	2.62 ab
July 5	80.8 a	2.69 ab
July 15	79.6 ab	2.58 ab
Natural infection	57.5 b	2.92 a

<sup>a</sup> Degree of damage was calculated by Yoshimura's method(11) at maturing stage which is represented by the equation of Degree of damage(%)

$$= \frac{3n_1 + 2n_2 + 1n_3 + 0n_4}{3N} \times 100, \text{ where}$$

- n<sub>1</sub> : number of tillers where lesions reached the flag leaf/sheath,
- n<sub>2</sub> : number of tillers where lesions reached the second leaf/sheath,
- n<sub>3</sub> : number of tillers where lesions reached the third leaf/sheath,
- n<sub>4</sub> : number of healthy tillers, and
- N : total number of tillers observed.

<sup>b</sup> Means followed by the different letters are significantly different at the 0.01 level according to Duncan's multiple range test.

significant difference in the degree of damage between four inoculation dates. At the same time, the degrees of damage in June 25 and July 15 inoculated plots were similar to natural infection plots. Likewise, no significant difference was found in rice yield among four inoculation dates, or between the natural infection plot and the plots inoculated since June 25.

## DISCUSSION

It has been known that sclerotia of *Rhizoctonia solani* play an important role as the primary inoculum of rice sheath blight (7) and amount of floating sclerotia in paddy field affects disease severity (7, 8). The first symptom of sheath blight disease usually appears around June 20 when the mean temperature exceeds 22C under the field condition and thereafter, percentage of infected stems and vertical development of lesions gradually increase. Horizontal development of the disease (increase of infected stems) may be affected first, by the sclerotia floated in paddy field and second, by the mycelia produced on the lesion. Thus, in this experiment, disease development phases of rice sheath blight, i.e., percentage of infected stems, top lesion height, percentage of lesion height vs. plant height and degree of damage by *R. solani*, were estimated at 10 day intervals after artificial inoculation of sclerotia at different dates.

Symptoms of rice sheath blight were observed for the first rating at all inoculation plots tested. The data obtained indicated that percentage of infected stems, top lesion height and percentage of lesion height vs. plant height exhibited greater differences in the earlier growth stage of rice plants when measured on July 25, but they became smaller in the later growth stage. Percentages of infected stems ranged from 95.2% (June 15 inoculated plot) to 36.6% (July 15 inoculated plot), but they were over 90% on August 15 except natural infection plot. As a consequence, it seems evident that the degree of damage by sheath blight and rice yield at maturing stage of plants did not show significant difference, regardless of their differences between inoculation dates.

Hori *et al.* (7) and Inoue *et al.* (8) indicated that the degree of damage by rice sheath blight and loss of yield at maturing stage of rice plant were great in the

plots where overwintered sclerotia were abundant. In our study, however, each plot was inoculated with the same amount of sclerotia at different growth stages of rice plants, which, nevertheless, had less effect on degree of damage by sheath blight and rice yield. This result suggest that temperature and relative humidity within the canopy may affect disease development after the symptom initiation. Hashiba (3) and Hashiba *et al.* (4) reported the importance of meteorological parameters *ad hoc* temperature and humidity within the canopy for horizontal or vertical development of sheath blight disease.

Disease development patterns under natural infection and artificial inoculation were different. Percentage of infected stems under natural infection increased gradually and it was 78.0% on August 15, while that of inoculated plots was over 90% (Table 1). This may be mainly due to the difference in the amount of primary inoculum. Although the same amount of sclerotia was inoculated, there was a great difference in percentage of stems at the first rating, which was considered due to the different inoculation dates. As the number of tillers per hill was low in case of early inoculation (June), the inoculated sclerotia had less chances to attach to the rice plants. But in the inoculation after July, the number of tillers became increased, thus providing the microenvironment within the canopy more favorable for the sclerotia to initiate symptom development.

Our results demonstrated that disease development of rice sheath blight under the same inoculum potential is a little faster by early inoculations, but it gives no significant difference for the degree of damage by sheath blight or yield at maturing stage of rice plants compared with late inoculations.

#### ACKNOWLEDGEMENTS

The authors are greatly indebted to Dr. Byung Kook Hwang, professor of College of Agriculture, Korea University, for his advice during the preparation of this manuscript.

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