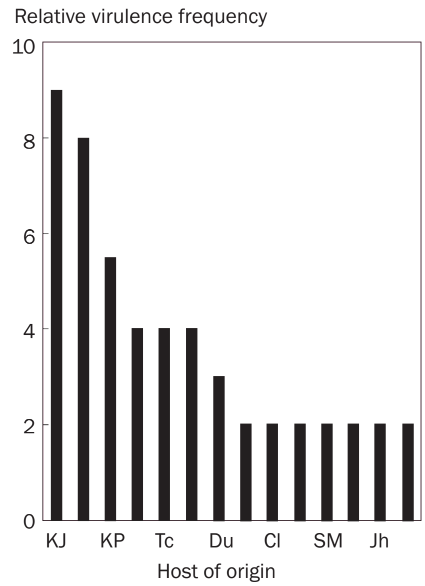
**Table 2. Frequency of virulent phenotypes in 25 *Pyricularia grisea* isolates collected in 2000 at Lumle, Rampur, Khumaltar, and Hardinath, Nepal, and tested in 2001.**

| Genotype | Known resistance genes | Frequency of virulent phenotypes |
|---|---|---|
| C101TTP-4L23 | *Pi-4* + *Pi-?* | 0.60 |
| BL121 | *Pi-1* + *Pi-2* | 0.20 |
| BL142 | *Pi-1* + *Pi-4* | 0.52 |
| BL23-181-2 | *Pi-2* + *Pi-3* | 0.32 |
| BL123-56-2 | *Pi-1* + *Pi-2* + *Pi-3* | 0.20 |
| A57-115-8 | *Pi-1* + *Pi-2* + *Pi-4* | 0.20 |
| CO 39 | *Pi-a?*[a] | 1.00 |
| Lijiangxintuanheigu | | 0.56 |
| Masuli | Unknown | 1.00 |
| Laxmi | Unknown | 0.00 |

[a]Unknown.

lower FVP on Lijiangxintuanheigu (LTH) could mean the presence of avirulence genes for LTH in the Nepalese pathogen population. The RVF of isolates from Kalo Jangali (*Oryza rufipogon*) and N22 was markedly higher than that of the other isolates (see figure). Isolates recovered from Kinandang Patong, K59 (*Pi-t*), Taichung 176, Tsuyuake (*Pi-K*$^{m}$), and Dular (*Pi-K*) had an intermediate RVF. The isolates from the rest of the genotypes had a low RVF.

The results indicate that the Nepalese blast pathogen populations varied in virulence. The compatibility of all isolates with Masuli and CO 39 indicates that these genotypes, either in mixture or alone, could be used for spreader rows to build up inoculum in the blast nursery. The most virulent isolates from *O. rufipogon* and N22 could be useful for screening rice germplasm in the greenhouse. The incompatibility of the isolates with Laxmi suggests that this variety could be a potential donor parent in breeding for blast resistance.




**Relative virulence frequency of *Pyricularia grisea* isolates recovered from 14 rice genotypes (KJ = Kalo Jangali, N22, KP = Kinandang Patong, K59, Tc = Taichung 176, Tsu = Tsuyuake, Du = Dular, NR56 = NR1556, CI = CI5309, NR256 = NR10293, SM = Sona Masuli, Ma = Masuli, Jh = Jhingling78, Ka = Kanto51) during 2000 and tested during 2001.**

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# Brown planthopper injury vs mechanical injury to the rice plant


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Insect pests cause injury to the rice plant in various ways. The brown planthopper sucks assimilates from the phloem (Sogawa 1982) and reduces plant height and organ dry weights (Rubia-Sanchez et al 2003). Mechanical injury is the removal of leaves or tillers using scissors. The manner by which injury is inflicted may vary, but the response of the rice plant to injury may be similar. Hence, it is important to compare the effects of BPH injury with that of mechanical injury to better understand plant response to BPH feeding. We chose two cultivars, Nipponbare, which belongs to japonica rice, and Taichung

Native I (TN1), which belongs to indica rice, to determine if there is a difference between the two cultivars in plant response to injury.

Twenty-six-day-old Nipponbare and TN1 were subjected to the following treatments in the glasshouse (25/20 °C day/night T, 14L:10D photoperiod, and 70% RH): T1—control (healthy intact plant), T2—cutting one primary tiller, T3—cutting the two lowest leaves of the main tiller, T4—cutting all the leaves of the main tiller, T5—cutting two upper leaves of the main tiller, T6—exposing the plant to 16 fourth-instar BPH for 10 d, and T7—cutting the main tiller. Except for T1, all treatments were applied 10 d after the introduction of BPH (T6). The experiment was arranged in a randomized complete block design with four replications. Two weeks after treatment, plant height, number of tillers, leaf area, and plant dry weights were recorded. Data were analyzed using ANOVA and the control means were compared with the other treatment means using Dunnett's test.

Unlike with removal of some leaves, BPH-infested plants did not recover from BPH injury 2 wk after treatment (Table 1). BPH feeding decreased plant height, leaf area, and leaf, stem, and root dry weights of the two cultivars. Similarly, the removal of the main tiller also decreased plant growth of the two cultivars (Table 1). There seems to be a similarity in plant response to injury between BPH-infested plants and plants without the main tiller, even though the method by which plants were injured differed. Removal of the main tiller took out a huge amount of assimilates at one time, whereas, in the case of BPH injury, the assimilates were slowly taken out of the plant.

For BPH-plant interaction, production of new tillers was not an immediate response by rice plants to BPH injury (Table 2). For stem borer-plant interaction, plants compensate for stem borer injury by producing new tillers (Rubia-Sanchez et al 1996). Two weeks after treatment, IR64 had a 23% increase in the number of tillers in response to stem borer injury, whereas TN1, another indica cultivar, had an 18% decrease in the number of tillers in response to BPH injury. Although Rubia-Sanchez et al (1999) showed that healthy tillers could translocate assimilates to BPH-injured tillers, the present study suggests that the amount of assimilates may not be sufficient to produce more tillers 2 wk after BPH injury. Failure to produce new tillers in response to BPH injury may be due to the effect of BPH feeding on root growth. BPH injury decreased root dry weight (Table 1). The roots transport nutrients and assimilates to form new tillers.

Regardless of the treatment applied, BPH injury or mechanical injury, Nipponbare was more susceptible to injury than TN1 (Tables 1 and 2). For example, BPH reduced plant height and leaf area of Nipponbare by 28% and 63%, respectively, whereas those of TN1 decreased by 6% and 37%, respectively. Removal of one primary tiller reduced leaf area of Nipponbare by 46%

**Table 1. Effects of various treatments, including BPH injury, on plant height, leaf area, and leaf, stem, and root dry weights.[a]**

| Treatment | Plant height (cm) | | Leaf area ($cm^2$) | | Leaves (mg) | | Stems (mg) | | Roots (mg) | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Nipponbare | TN1 | Nipponbare | TN1 | Nipponbare | TN1 | Nipponbare | TN1 | Nipponbare | TN1 |
| Healthy | 61.9 | 55.0 | 162.7 | 141.1 | 61.2 | 53.0 | 75.0 | 68.0 | 58.0 | 99.7 |
| Removal of one primary tiller | 60.6 | 54.2 | 87.1* | 130.7 | 33.8* | 49.2 | 47.2* | 54.0 | 37.2 | 93.7 |
| Removal of two lowest leaves of the main tiller | 59.6 | 54.1 | 109.8 | 139.4 | 39.8* | 50.8 | 60.2 | 70.0 | 38.2 | 77.3 |
| Removal of all leaves of the main tiller | 53.0* | 44.1* | 116.8 | 115.5 | 29.2* | 40.2* | 46.2* | 52.8 | 39.0 | 60.3 |
| Removal of two upper leaves of the main tiller | 48.3* | 48.6* | 117.2 | 160.9 | 43.8* | 56.8 | 62.8 | 71.8 | 60.8 | 59.0 |
| BPH feeding | 44.4* | 51.8 | 59.9* | 89.5* | 24.8* | 33.2* | 33.8* | 46.0* | 21.8* | 36.3* |
| Removal of the main tiller | 37.4* | 43.4* | 55.9* | 97.6* | 18.2* | 32.2* | 23.8* | 33.8* | 23.2* | 48.3* |
| F ratio | 20.63 | 11.23 | 7.51 | 9.41 | 12.99 | 11.82 | 12.12 | 8.15 | 6.87 | 3.77 |
| Prob>F | <0.0001 | <0.0001 | 0.0002 | <0.0001 | <0.0001 | <0.0001 | <0.0001 | 0.0001 | 0.0004 | 0.0105 |

[a]In a column, means followed by an asterisk are significantly different from those of the healthy control.

**Table 2. Effects of treatments, including BPH injury, on the number of tillers 2 wk after treatment.[a]**

| Treatment | BPH injury | | Stem borer injury[b] |
|---|---|---|---|
| | Nipponbare | TN1 | IR64 |
| Healthy | 3.75 | 3.25 | 3.30 |
| Removal of one primary tiller | 2.25* | 3.00 | 0 |
| Removal of two lowest leaves of the main tiller | 3.00 | 3.75 | – |
| Removal of all leaves of the main tiller | 3.00 | 3.75 | 3.20 |
| Removal of two upper leaves of the main tiller | 3.25 | 4.00 | 3.00 |
| BPH feeding | 2.25* | 2.75* | – |
| Removal of the main tiller | 3.00 | 3.00 | 2.30 |
| Stem borer feeding[b] | – | – | 4.30 |
| F ratio | 4.8 | 3.8 | – |
| Prob>F | 0.0031 | 0.01 | – |

[a]In a column, means followed by an asterisk are significantly different from those of the healthy control.
[b]Data from Rubia et al (1996).

and TN1 by 7%; plant dry weights of Nipponbare and TN1decreased by 39% and 10%, respectively. TN1 grew faster and had a greater photosynthetic rate and N content than Nipponbare (Rubia-Sanchez et al, unpubl.), which probably makes TN1 less susceptible to injury. Interestingly, root dry weights of both cultivars injured by BPH decreased by about 60%. This shows the important effect of BPH feeding on root growth. Our earlier study showed that BPH also decreased the root N content of many cultivars (Rubia-Sanchez et al 2003). BPH feeds near the base of the rice plant so that its feeding may interfere with the transport of nutrients from the roots to the shoots and vice versa.

To conclude, except for main tiller removal, the effects of BPH injury on plant growth of Nipponbare and TN1 2 wk after treatment were more significant than with leaf removal or primary tiller removal. BPH-injured plants did not immediately recover from injury by the formation of new tillers, unlike stem borer-injured plants. Lastly, cultivar Nipponbare was more susceptible than TN1 to any type of injury.

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