INTRODUCTION

South Sulawesi is the fourth highest rice production center in Indonesia of 5.74 million tons (BPS, 2018). One of the difficulties in rice production is the tungro virus. Tungro disease has been reported in Sidrap, South Sulawesi, in 2018 covering an area of 6 ha, and now there are many symptoms similar to tungro disease. The most common symptoms of tungro are dwarf, yellowish leaves, stunted growth, and the inability to produce panicle. Tungro disease can reduce rice production and even cause puso (harvest failure) if the infection occurs since the beginning of the vegetative phase or at the nursery stage (Hasanuddin, 2002).

Tungro is caused by two different types of viruses: stem-shaped virus, *Rice tungro bacilliform virus* (RTBV) with DNA type genome; and spherical virus, *Rice tungro spherical virus* (RTSV) with RNA type. RTBV has a diameter of 35 × 150–350 nm with a length of 100.300 nm while the RTSV has a diameter of 30 nm (Hibino *et al.*, 1978; Omura *et al.*, 1983). Both types of viruses do not have the same serological kinship but can infect plants together without causing cross-protection between the viruses (Mukhopadhyay, 1995). The tungro virus is only transmitted by green leafhoppers in a semi-persistently (Hibino & Cabunagan, 1986).

Molecular detection with **Polymerase Chain Reaction** (PCR) techniques to detect viruses with DNA genome and **Reverse Transcription** (RT)-PCR for viruses with RNA genome is very sensitive and accurate compared to other methods such as serology and nucleic acid hybridization. (Takahashi *et al.*, 1993). The PCR technique is very advantageous in detecting the presence of rice viruses because it is easier and faster than other techniques such as in South Sulawesi, one of the largest rice production centers in Indonesia, which currently has many tungro disease symptoms. The symptoms of the outbreak are varied and the intensity is getting higher hence...
apart from being based on the symptoms it is necessary to further identify the distribution and cause so that it can be used as a basis for developing effective and environmental-friendly control strategies.

Many methods are used to control tungro disease such as the use of insecticides to control planthopper. However, this method is considered less effective and harms the environment. One of the environmental-friendly control alternatives is using varieties resistant to the tungrovirus and green leafhopper as vector insects (Sama, 1985 cit. Praptana & Muliadi, 2005). According to Suprihatno (1985) cit. Praptana et al. (2005), known and utilized sources of tungro disease resistance genes are Latisail, CR-94-13, Gam-Pai 15, and resistant varieties which are crossed breeding from those parents. Varieties with vertical resistance have always been a mainstay in reducing the plant hopper. The use of resistant varieties is constrained by the adaptability of green leafhoppers by forming new biotypes so that the varieties that are released shortly afterward was broken their resistance. Tungro disease infection in resistant varieties causes no symptoms in the form of a slightly yellowish leaf that disappears as the plant ages (Choi et al., 2009). Tungro symptoms would begin to appear when the plants aged 10–15 days after the inoculation of the virus, whereas in fields, symptoms would appear when the plants are 21–30 days after planting (Raga et al., 2004). This study aimed to detect the presence of the tungrovirus molecularly in South Sulawesi and determine the response of the resistance of some rice varieties to the tungrovirus.

MATERIALS AND METHODS

The survey was conducted in several districts of rice production centers in South Sulawesi: Maros, Sidrap, Pinrang, and Wajo. Laboratory research was conducted at the Laboratory of Plant Virology, Department of Plant Protection, Faculty of Agriculture, Universitas Gadjah Mada, Yogyakarta. Materials and types of equipment used are tungro symptomatic rice leaf samples collected from various locations, RNA extraction kit Mini plant kit (Geneaid), DNA extraction kit Mini plant kit (Geneaid), Kit for making cDNA (Toyobo), PCR Mix Ready to Use (MyTaq HS Mix), agarose, PCR machine (Bio-Rad T100TM Thermal Cycler), a set of equipment for electrophoresis, and ultraviolet (UV) transilluminator. Research in the greenhouse was conducted at the Faculty of Agriculture, Universitas Gadjah Mada, Yogyakarta, and in the greenhouse of the Tungro Disease Research Station (Lollittungro), Sidrap, South Sulawesi. Tungro symptomatic rice plants were collected from several locations in South Sulawesi. The rice varieties used in the disease resistance test were Ciherang, TN1, Mekongga, Tukad Unda, Inpari 36, and Inpari 37.

RTSV Detection Using RT-PCR Technique

The detection phase of RTSV began with the extraction of total RNA from rice leaf samples, the stage of total RNA extraction followed the protocol of the commercial kit (mini RNA kit plant, Geneaid). The total RNA extracted was used as a template in the reverse transcription reaction to produce cDNA (complementary DNA). The making of cDNA was performed by the RT-PCR (Reverse Transcriptase-Polymerase Chain Reaction) method with a total volume of 10 µl containing 2 µl total RNA of, 3.5 µl RNase Free H2O, 0.5 µl RNase Inhibitor, 0.5 µl ReverTraAcc, 2 µl 5x RT Buffer, 1 µl dNTP Mixture, and 0.5 µl oligo primer (dt) 20. The reverse transcription reaction was carried out at 42°C for 20 minutes, followed at 99°C for 5 minutes, and at last 4°C. The result of cDNA was used as a DNA template in the amplification reaction.

Amplification was conducted using a specific pair of RTSV-F primers (AAACGGTCATTGTGGGGAGGT) and RTSV-R (CAGGCCCAGCAACGACATAA) with a target of 1115 bp (Shen et al., 1993). The reaction for PCR was made with a total volume of 10 µl containing 0.5 µl RTSV-F primers, 0.5 µl RTSV-R primers, 3 µl DH2O, 1 µl cDNA Samples, and 5 µl MyTaqTM HS RedMix PCR Mix. The amplification process was preceded by initial denaturation temperature of 95°C for 2 minutes, denaturation temperature of 95°C for 30 seconds, the annealing temperature of 57°C for 30 seconds, extension temperature of 72°C for 30 seconds, the final temperature of extension of 72°C for 7 minutes, and the hold temperature of 4°C ∞, over35 cycles. The amplification results were electrophoresed at 100 V for 30 minutes and colored with ethidium bromide (0.5 g/ml) for 15 minutes. The results of DNA visualization on the UV transilluminator were then documented with a digital camera.
RTBV Detection Using PCR Technique

RTBV detection began with the extraction of total DNA from each rice leaf sample. Total DNA extraction followed the protocol of a commercial kit (DNA Mini kit plant, Geneaid). The total DNA was used as a DNA template in the PCR reaction using a pair of RTBV-B2F specific primers (GCAGAACGAACTCTAAGGC) and RTBV-B2R (GTCTAA GGCTCATGCTGGAT) with product target of 430 bp (Cabauatan et al., 1999). The PCR reaction was made with a total volume of 10 µl containing 1 µl DNA template, 0.5 µl RTBV-B2F primer, 0.5 µl RTBV-B2R primer, 3 µl DH2O, and 5 µl MyTaqTM HS RedMix PCR Mix. The amplification process was performed over 35 cycles preceded by initial denaturation temperature of 95°C for 2 minutes, denaturation temperature of 95°C for 30 seconds, the annealing temperature of 53°C for 30 seconds, temperature extension 72°C for 30 seconds, final extension temperature of 72°C for 7 minutes, and the hold temperature at 4°C ∞. The amplification results were electrophoresed at 100 V for 30 minutes and colored with ethidium bromide (0.5 g/ml) for 15 minutes. Visualization of the amplified DNA results was similar as described previously.

Tungrovirus Transmission Test in Six Rice Varieties

Samples of rice contained both types of tungrovirus (RTSV and RTBV) based on the results of detection by PCR then used as a source of inoculum. The acquisition of the virus was carried out by inoculating 200 green leafhoppers into confinement containing rice plants that were positively infected by the two tungroviruses over 24 hours for the acquisition feeding period. The inoculation feeding by green leafhoppers was conducted for 24 hours on healthy rice seeds of each variety aged 1 week using the test tube method (tube test). Each test tube (in a total of 10 tubes) containing 1 plant and 1 green leafhopper with 3 replications. Inoculated seedlings were then transplanted in pots containing planting media. Observation of symptoms was done after the plants aged 2 weeks and scoring based on the Standard Evaluation System for Rice (IRRI, 1996). The formula for Disease Incidence (I) and Disease Intensity (DI) (Zadoks & Schein, 1979) are as follows:

\[ I = \frac{n}{N} \times 100\% \]

Remarks: I = disease incidence, \( n \) = number of plants affected by tungro, \( N \) = number of plants observed

\[ DI = \frac{n(1)+n(3)+n(5)+n(7)+n(9)}{tn} \]

Remarks: DI = disease index, \( n \) = number of plants affected by tungro with a certain score, \( tn \) = total unhealthy plants according to the attack category, \( Z \) = highest disease symptom score, \( N \) = number of plants observed.

Percentage of table grouping disease severity based on plant disease symptoms

| DI (%) | Reaction         |
|--------|------------------|
| 0–30   | Resistant/tolerance |
| 31–50  | Slightly resistant/moderate |
| >51    | Susceptible       |

Furthermore, the calculation results of the disease severity were used to classify the response of plant resistance to disease using IRRI classification (1996) (Table 1 and 2).

Table 1. Score assessment of tungro disease symptoms of rice plants in the greenhouse based Standard Evaluation System for Rice (IRRI, 1996)

| Score | Criteria                                      |
|-------|-----------------------------------------------|
| 1     | Asymptomatic                                  |
| 3     | 1–10 % decrease of plant height, without leaf discoloration |
| 5     | 10–30 % decrease of plant height, without leaf discoloration |
| 7     | 31–50 % decrease of plant height, with leaf discoloration (yellow to orange) |
| 9     | 50 % decrease of plant height, with leaf discoloration from yellow to orange |

Table 2. Score assessment of tungro disease symptoms of rice in the field (IRRI, 1996)

| Score Category | Symptoms Type                                             |
|----------------|-----------------------------------------------------------|
| 0 Healthy      | Asymptomatic                                             |
| 1 Mild         | Slightly stunted and yellow leaves                        |
| 2 Moderate     | Stunted, withered or yellow leaves, tillers appear normal |
| 3 Heavy        | Stunted, yellow leaves, increased tillers numbers         |
| 4 Crop failure | Very stunted, dry and yellow leaves, increased the tillers numbers |
RESULTS AND DISCUSSION

Observation tungro disease symptoms on rice were carried out on the rice fields owned by farmers in several districts in South Sulawesi consisting of 19 observation locations and 4 districts (Wajo, Maros, Pinrang, and Sidrap). Several symptoms of tungro disease were found, i.e. yellowish leaf, twisting, stunted, and increased tillers, with the disease incidence ranged of 10–55% (Table 3). It was suspected that the virus was transmitted by green leafhoppers in the previous planting season and then survived on weeds and the rest of the rice plants that have been harvested (ratun) around the rice fields. The disease intensity in the fields in Kabrinang was 5–10%, Maros Regency was 5–10%, Sidrap was 5–15%, and Wajowas 5–12%. Insect population vector such as green leafhoppers also contributed to the growth of rice plants in the field, while observations on fields in several districts in South Sulawesi showed that the tungro virus attack had a different disease intensity and insect population vector. The higher the number of insect population vector, the higher the disease incidence caused, as in Sidrap has the highest disease incidence of 55% with a population of 10 insect vectors (Table 3).

The most likely symptom detected in the field was leaf discoloration and differences in the plant height (uneven growth) from visual observation. Tungro and stunted symptomatic plants were found clustered in one plot and there were uneven spots and plant growths seen on the rice fields. Vectors play an important role in the transmission and spread of the viruses. The highest population of green leafhopper obtained from Sidrap and Maros, ranged from 10–14 individuals, with disease incidence reached 50–55% (Table 3) showed that the higher the vector population density, the higher the disease incidence (Hibino & Cabunagan, 1986).

Tungro virus Detection by PCR

PCR analysis results indicated that the presence of rice tungro virus had been detected, namely RTBV and RTSV on plant samples obtained in several districts in South Sulawesi. Observation of disease incidence in the field was found with severe symptoms of tungro

Table 3: Disease incidence and insect population vector in several districts of rice production centers in South Sulawesi

| Location          | Variety  | Age (DAP) | Planthopper Population | I (%) | Symptoms variation |
|-------------------|----------|-----------|------------------------|-------|--------------------|
|                   |          |           | bp | gl | wp | zl |               |                     |
| **Wajo Region**   |          |           |    |    |    |    |               |                     |
| Tonralipue - Tanah.Sitolo | Ciherang | 30    | 0  | 5  | 0  | 1  | 10  | ss,ys             |
| Assorajang - T.Sitolo | Inpari 64 | 60    | 2  | 3  | 52 | 2  | 25  | ys,ss,tl          |
| Buloe - Maniangpajo | Mekongga | 21    | 1  | 1  | 0  | 2  | 32  | ss,ys             |
| **Maros Region**  |          |           |    |    |    |    |               |                     |
| Semangki - Simbang | Mekongga | 25    | 1  | 0  | 0  | 0  | 15  | ss               |
| Jenetesia - Simbang | Mekongga | 21    | 0  | 2  | 1  | 0  | 16  | ss               |
| Kalabirang - Bantimurung | Inpari 7 | 30    | 0  | 6  | 0  | 0  | 18  | ys               |
| Alatengae - Bantimurung | Inpari 4 | 20    | 0  | 2  | 0  | 0  | 16  | ys               |
| Minasabaji - Bantimurung | Ciherang | 14    | 5  | 4  | 0  | 19 | 10  | ys               |
| Leangleang - Bantimurung | Ciherang | 15    | 12 | 4  | 0  | 2  | 18  | ys               |
| Borribelaya - Turikale | Inpari 3 | 60    | 7  | 14 | 0  | 0  | 50  | ys,ss             |
| **Pinrang Region** |          |           |    |    |    |    |               |                     |
| Paleteang - Paleteang | Inpari 32 | 60    | 1  | 1  | 1  | 0  | 15  | ys,ss             |
| Toe - Tiroang     | Ciherang | 40    | 1  | 3  | 1  | 2  | 25  | ys               |
| Sallo - Matirrosompe | Inpari 8 | 40    | 1  | 0  | 3  | 0  | 10  | y                |
| **Sidrap Region** |          |           |    |    |    |    |               |                     |
| Panreng - Baranti | St bagendit | 80   | 3  | 7  | 0  | 16 | 15  | ss,bs             |
| Tangkoli - Baranti | Inpari 7 | 70    | 2  | 0  | 5  | 0  | 10  | ys               |
| Tonrongerijang - Baranti | Inpari 4 | 70    | 4  | 9  | 21 | 1  | 15  | ys,ss             |
| Kedidi - Pancarijang | Ciherang | 14    | 0  | 9  | 0  | 7  | 16  | ys,ss             |
| Tanete - Maritengae | Ciherang | 10    | 7  | 0  | 0  | 30 | 15  | ys,ss             |
| Carawali - Watangpulu | Inpari 4 | 60    | 2  | 10 | 5  | 0  | 55  | ys,ss             |

Remarks: DAP: Days After Planting, I: Disease Incidence, bp: brown planthopper, gl: rice green leafhopper, wp: white-backed planthopper, zl: zigzag leafhopper, ss: stunted symptoms, ys: yellow symptoms, tl: twisted leaf, bs: brown spots on the leaves (Primer data sources in the field)
disease in Pinrang District (Figure 1), this was proven by laboratory test results using PCR techniques showed that the Pinrang sample had been infected by RTSV with DNA band size of 1115 bp and RTBV of 430 bp (Figure 2). Other samples such as Sidrap and Maros isolates positively infected by RTBV, based on observations in the field with mild symptoms and also found a green leafhopper vector. Detection results indicated that the tungrovirus infection had transmitted by green leafhopper.

**Sequencing Analysis**

Homology analysis of RTBV showed that the first subgroup (Sidrap, Maros, and Pinrang) had a kinship of 97%. Meanwhile, the second subgroup (Philippines IC/G1) had a kinship of 94% and the third subgroup (Chainat-Thailand, Seberang Perai- Malaysia, and Serdang-Malaysia) of 92% (Table 4). The results of the dendrogram analysis showed that the sample from Sidrap had a very close relationship and belonged to one group with the sample from Maros and Pinrang, but had a close or different group from the Philippines, Malaysia and Thailand samples (Figure 3).

RTSV homology analysis showed that the RTSV nucleotide sequences of Pinrang had similarities between nucleotide bases and Subang (92.49%), Bali (92.69%), India (82.96%), Malaysia (84.38%), and Philippines (85.80%) (Table 5). This finding indicated that the RTSV sample in Indonesia had a close relationship of 92% compared to samples from other Asian regions, such as India, Malaysia, and the Philippines ranging from 82–85% (Table 5). This was similar to King et al. (2012) that a virus has a close kinship if it has a homology of nucleotide sequences >89%. Dendrogram of the genetic relationship between RTSV samples based on the nucleotide base sequence of polyprotein gene sequences showed that the Pinrang sample was in one group with AF113827–Subang and AF113823–Bali samples. (Figure 4). The variations in the nucleotide bases that make up the DNA and amino acid sequences produce the genetic diversity of RTSV samples. This is because the diversity of the nucleotide structure and virulence rate of the tungrovirus in Southeast Asia differ from the tungrovirus gene in South Asia (Azzam & Chancellor, 2002).

**The Response of Six Rice Varieties to Tungro**

Based on the resistance test of six rice varieties showed that there were symptoms and different plant heights were observed, namely yellowish of leaves from the tips to the base (Figure 5). Disease Incidence (I) ranged from 40–100% with the highest I came from TN1 variety (100%) and the lowest was Inpari 36 (40%). While the highest Disease Intensity (DI) was TN1 variety (60.66%, susceptible) and the lowest was Inpari 36 (22.21%, resistant). The average incidence of tungro disease from transmission in each variety ranged from 40–100%, with an average incubation period of 8–17 days, while the intensity of tungro disease ranged from 22–60% (Table 7).

All varieties inoculated with tungro virus showed symptoms of the tungro disease. TN1 and Ciherang varieties showed the most severe symptoms until the plant became stunted and had a yellowish color.
Table 4. Homology level of RTBV P4 gene nucleotide sequences on Maros, Pinrang, Sidrap, and other RTBV samples obtained from Genbank NCBI

| No. | Sample Origin                  | Accession Code | Homology (%) |
|-----|--------------------------------|----------------|--------------|
|     |                                |                | 1  | 2  | 3  | 4  | 5  | 6  | 7  |
| 1   | RTBV Maros-South Sulawesi      | ID             |    |    |    |    |    |    |    |
| 2   | RTBV Pinrang- South Sulawesi   | 97.15          | ID |    |    |    |    |    |    |
| 3   | RTBV Sidrap- South Sulawesi    | 97.72          | 95.44 | ID |
| 4   | RTBV Philippines 1 RTBV- Ic    | AF113832.1     | 94.58 | 92.87 | 94.58 | ID |
| 5   | RTBV Philippines 2 RTBV- G1    | AF113830.1     | 94.58 | 92.30 | 94.01 | 98.29 | ID |
| 6   | RTBV Chainat - Thailand       | AF220561.1     | 92.30 | 90.59 | 92.87 | 94.30 | 93.73 | ID |
| 7   | RTBV Seberang Perai - Malaysia| MK552377.1     | 92.30 | 90.59 | 93.16 | 93.73 | 93.73 | 92.59 | ID |
| 8   | RTBV Serdang - Malaysia       | AF076470.1     | 92.02 | 89.74 | 92.02 | 92.87 | 92.87 | 92.30 | 93.44 |

Table 5. Homology level of RTSV polyprotein gene nucleotide sequences on Pinrang samples and other RTSV samples obtained from Genbank NCBI

| No. | Sample Origin                  | Accession Code | Homology (%) |
|-----|--------------------------------|----------------|--------------|
|     |                                |                | 1  | 2  | 3  | 4  | 5  |
| 1   | RTSV Pinrang- South Sulawesi   | ID             |    |    |    |    |    |
| 2   | RTSV Subang- West Java         | AF113827.1     | 92.49 | 94.49 | ID |
| 3   | RTSV Bali                      | AF113823.1     | 92.69 | 77.77 | 98.78 | 29.67 | ID |
| 4   | RTSV India                     | AM234048.1     | 82.96 | 89.04 | 92.49 | 98.78 | ID |
| 5   | RTSV Malaysia                  | U70689.1       | 85.80 | 91.48 | 90.75 | 91.07 | 92.67 | ID |
| 6   | RTSV Philippines               | M95497.1       | 95.80 | 91.48 | 90.75 | 91.07 | 92.67 | ID |

Figure 3. Phylogenic three of RTBV molecular from Maros, Sidrap, dan Pinrang with other various RTBV samples that had been published by Genbank data base NCBI

Figure 4. Phylogenic three of RTSV molecular from Maros, Sidrap, dan Pinrang with other various RTSV samples that had been published by Genbank data base NCBI
Figure 5. Variation of tungro disease symptoms on each variety aged 4 WAI (weeks after inoculation by RTSV and RTBV simultaneously); (A) TN1, (B) Ciherang, (C) Mekongga, (D) Tukad Unda, (E) Inpari 36, (F) Inpari 37

Figure 6. Plant aged 4 WAI (weeks after inoculation by RTSV and RTBV simultaneously); (1) control plant (without treatment), (2) plant with tungrovirus inoculation; (A, a) TN1, (B, b) Ciherang, (C, c) Mekongga, (D, d) Tukad Unda, (E, e) Inpari 36, (F, f) Inpari 37

Figure 7. The plant height after inoculated by tungrovirus on several varieties in the greenhouse
Meanwhile, Mekongga, Tukad Unda, Inpari 36, and Inpari 37 varieties showed mild symptoms that were characterized by leaf discoloration, yellowish. The TN1 and Ciherang varieties showed more susceptible reactions compared to Mekongga, Tukad Unda, Inpari 36, and Inpari 37 varieties which is more resistant. The change in the resistance reaction with the inoculation test from susceptible to slightly resistant or resistant might be because the resistance of the varieties was specific to the strain of the virus at a particular region but not to the strain of the virus in other areas. According to Praptana et al. (2005), some varieties that are initially known to be resistant in one location would show a susceptible reaction in other locations, and previously susceptible varieties became resistance in other locations. The resistance of rice varieties to green leafhopper vectors is also determined by other factors, i.e. biochemical factors such as nutrient content and biophysical factors (plant tissue thickness or the interaction of these two factors on reproductive cells) hence it affects the number and hatching rate of green leafhopper eggs (Pakki, 2011).

Several varieties of rice tested showed that not all plants could be infected by the tungrovirus. The severity score of disease symptoms per plant was mostly 1, 3, and 5, and only a few plants were valued 7 and 9 (Table 6). Furthermore, there were differences in disease intensity between resistant, slightly resistant, and susceptible varieties (Table 7). Tungro disease symptoms were characterized by leaf discoloration from green to yellow-orange and stunted growth about 1–10% compared that to the control plants of each variety. Each variety could potentially be infected by the tungrovirus. The intensity of the disease with the same or different values depends on the variety planted. This finding showed that there were different varieties in responding to the tungrovirus infection by green leafhoppers.

**CONCLUSION**

Viruses detected using the PCR technique was *Rice tungro bacilliform virus* (RTBV) DNA band size of 430 bp from Maros, Sidrap, and Pinrang samples; and *Rice tungro spherical virus* (RTSV) DNA band size of 1115 bp from Pinrang sample. Transmission of the tungrovirus in the greenhouse showed that the response of resistance to six different rice varieties in terms of disease intensity, disease incidence, and incubation period. The highest percentage of tungro disease intensity was from TN1 variety, while the slightly resistant rice varieties were Mekongga and Tukad Unda, and resistant varieties were Inpari 36 and Inpari 37.

### Table 6. Scoring of tungro disease symptoms from inoculation in the greenhouse

| No. | Variety | 1 | 3 | 5 | 7 | 9 | Σ Sample |
|-----|---------|---|---|---|---|---|----------|
| 1   | TN1     | 0 | 5 | 14| 10| 1 | 30       |
| 2   | Ciherang| 1 | 8 | 16| 3 | 2 | 30       |
| 3   | Mekongga| 1 | 14| 10| 4 | 1 | 30       |
| 4   | Tukad Unda | 7 | 14| 7 | 2 | 0 | 30       |
| 5   | Inpari 36 | 18| 9 | 3 | 0 | 0 | 30       |
| 6   | Inpari 37 | 14| 11| 3 | 2 | 0 | 30       |

### Table 7. The disease incidence and disease intensity of tungro

| No. | Variety | IP (Days) | I (%) | DI (%) | Reaction |
|-----|---------|-----------|-------|--------|----------|
| 1   | TN1     | 8.20d     | 100a  | 60.66a | susceptible |
| 2   | Ciherang| 8.40d     | 96.66a| 53.32ab| susceptible |
| 3   | Mekongga| 10.90c    | 96.66a| 48.14b | slightly resistant |
| 4   | Tukad Unda | 14.40b | 76.66a| 36.29c | slightly resistant |
| 5   | Inpari 36 | 17.30a | 40c   | 22.21d | resistant   |
| 6   | Inpari 37 | 15.10b | 53.33c| 28.14d | resistant   |

Remarks: Means followed by the same letter in the same column were not significantly different according to DMRT (P = 0.05). IP: Incubation Period, I: Disease Incidence, DI: Disease Intensity
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