The effect of the rice white tip nematode, *Aphelenchoides besseyi* Christie, on the yield components of rice cultivars in a glasshouse condition

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**Abstract.** White rice tip nematodes, *Aphelenchoides besseyi*, causes gradual yield loss worldwide including in Indonesia. There are no reports regarding yield losses due to this nematode in North Sumatra. This research was conducted to verify the influence of white tip nematodes on the yield of rice cultivar in greenhouse conditions. The experiment was carried out in a Randomized Complete Block Design (RCBD) with 2 factors and four replications. The first factor is rice cultivar (Ciherang, Sintanutr, Pepe, and IPB 3S), and the second factor is the condition of the seeds (naturally infected, uninfected seeds). The results showed that plants with naturally infected seeds decreased the number of tillers and weighed 100 seeds. The number of non-infected puppies is greater than naturally infected seed, but not significantly different at the 5% level.

**1. Introduction**

Rice is an important commodity in Indonesia. Almost all Indonesian communities consider rice as their main source of carbohydrate. Therefore, the increasing amount of rice production becomes the primary priority. However, in its implementation, many obstacles which obstruct any effort of the increasing, one of them is the existence of pest and other diseases on rice planting [1]. One of the diseases is the rice white tip disease caused by *Aphelenchoides besseyi* Christie nematode. This nematode causes damage on the leaf, which initial symptoms on leaf tips were white or yellow, then later the leaf tips become brown or black. Further symptoms on developing leaves were twisting and wrinkling. The flag leaves continue to twist to above panicle until the leaf growth is inhibited. The generative phase causes the reduction of the length of the panicle and the decreasing of the grains. The severe vitiation is able to impede the emersion of the panicle due to the short leaves [2-3].

Indonesia, this nematode was detected in 1981 but the name of the founder is unknown [4]. Indonesia was again included as a *A. besseyi* regional country [5-6]. Fitrianingrum & Supramana [7] reported that this disease was found in Bogor Regency, West Java. Similarly, Lisnawita et al. found that this nematode was detected in several rice plants in North Sumatra [8].

Yield losses due to *A. besseyi* has been widely reported. In general, yield losses reach 10 to 50% [9]. The level of damage varies, depending on how to plant cultivation and rice cultivar [10]. However, there is no report about the rice yield losses due to the damage of this nematode in Indonesia, particularly in Northern.

The estimated data on the yield loss is useful for the farmers in carrying out an act of controlling, allocation of controlling resources, and the reference of expected income from the harvest by calculating the risk of whether the disease on plant exists or not [11]. Based on the background above, this present study aimed to test the four varieties widely grown in Northern Sumatra under glasshouse conditions to finally determine yield losses accounted by rice white tip nematode.
2. Material and methods

2.1. Rice seed samples
Four rice cultivars respectively, Ciherang, Sintanur, Pepe, and IPB 3S were used in this study.

2.2 Method
The experiment was designed as Factorial Randomized Complete Block Design (RCBD), with 2 factors and four replications. The first factor was rice cultivars (Ciherang, Sintanur, Pepe, and IPB 3S), and the second factor was the condition of the seeds (naturally infected, uninfected seeds).

* A. besseyi-* infected seeds and nematode-free seed from each variety were used in the experiment. Nematode-free seeds were obtained by selecting visually healthy seeds from each variety. Furthermore, nematode-free seeds were immersed in cold water for 3 until 5 hours, followed by hot water up to 60°C for 15 min to ensure the seeds were free of *A. besseyi* nematodes, and used as control [12].

Observations were made on the number of productive tillers, number of rice grains, and the multiplication rate of nematodes at the end of the experiment. Multiplication rate of nematodes was calculated by the formula: Multiplication rate of nematode = final population (Pf) / initial population (Pi).

2.3. Statistical analysis
Data were analysed using standard analysis of variance by a one-way ANOVA of SPSS software. The mean comparison was carried out by Duncan’s Multiple Range Test [13] at 5-percent probability level.

3. Results and discussions
The results showed that the number of productive tillers in *A. besseyi*-infected seeds was lower than nematode-free seed (Table 1), because if *A. besseyi*-infected rice seeds were planted, the nematodes become active and move to the meristematic areas of the rice during tillers. This causes the growth of productive tillers to be disrupted.

| Rice cultivars | Seed Condition | Mean |
|----------------|----------------|------|
|                | Nematode-free seeds | Nematode-infected seeds |      |
| V1 (Ciherang)  | 10.88           | 10.00           | 10.44c |
| V2 (Sintanur)  | 12.63           | 10.38           | 11.50b |
| V3 (Pepe)      | 12.38           | 12.13           | 12.25a |
| V4 (IPB 3S)    | 7.68            | 6.50            | 7.06d  |
| Mean           | 10.88a          | 9.75b           |       |

Notes: The numbers followed by the same letter notations in the same table do not differ significantly on the basis of Duncan’s multiple range test at 5-percent probability level.

Similar results also obtained in the number of rice grains. In this research four rice cultivars were tested, nematode-infected seeds had a lower number of rice grains than nematode-free seed (Table 2). The presence of *A besseyi* in plants causes a reduced the number of rice grains. During the generative period, nematodes move vertically towards the flag leaves. Flag leaves shrink, rotate, white, and dry [14].

Multiplication rate *Aphelencoides besseyi*-infected seeds and nematode-free seeds is shown in Table 3. Table 3 shows that all rice cultivars tested were *A. besseyi* hosts. The nematode multiplication...
rate on all cultivars was above 1. If multiplication rate value is more than 1, it indicates that the infected plant is a good host candidate for the nematode, whereas a multiplication rate value is less than 1, it indicates that the plant is not a good host candidate [15].

**Table 2.** The number of rice grains in *Aphelenchoides besseyi*-infected seeds and nematode-free seeds

| Rice cultivars | Seed Condition          | Nematode-Free seeds | Nematode-infected seeds | Mean     |
|----------------|-------------------------|---------------------|-------------------------|----------|
| V1 (Ciherang)  | Nematode-free           | 530.25              | 500.63                  | 515.44c  |
| V2 (Sintanur)  | Nematode-free           | 573.38              | 444.25                  | 508.81d  |
| V3 (Pepe)      | Nematode-free           | 745.50              | 680.63                  | 713.06a  |
| V4 (IPB 3S)    | Nematode-free           | 649.75              | 516.63                  | 583.19b  |
| Mean           |                         | 624.72a             | 535.53b                 |          |

Notes: The numbers followed by the same letter notations in the same table do not difference significantly on the basis of Duncan’s multiple range test at 5-percent probability level

**Table 3.** Means of multiplication rate *Aphelenchoides besseyi*-infected seeds and nematode-free seeds

| Rice cultivars | *Aphelenchoides besseyi* per100 grains (Pi) | *Aphelenchoides besseyi* per100 grains (Pf) | Multiplication rate (Pf/Pi) |
|----------------|--------------------------------------------|---------------------------------------------|-----------------------------|
| V1 (Ciherang)  | 11.00                                      | 14.00                                       | 1.27                        |
| V2 (Sintanur)  | 36.00                                      | 48.00                                       | 1.33                        |
| V3 (Pepe)      | 9.00                                       | 11.25                                       | 1.25                        |
| V4 (IPB 3S)    | 21.00                                      | 31.63                                       | 1.51                        |

4. Conclusions
The presence of *A. besseyi* in rice seeds caused a decrease in the rice yield components, including the number of productive tillers, and the number of rice grains. All four rice cultivars tested were a good host candidate for *A. besseyi*.

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