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The Effect of Dosage and Type of Fertilizer on the Percentage of Attacks of Brown Planthopper (*Nilaparvata lugens* Stall.) On some Varieties of Paddy (*Oryza sativa* L.)

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Abstract

The effect of dosage and type of fertilizer on the percentage of attacks of brown planthopper (*Nilaparvata lugens* Stal.) on some varieties of Paddy (*Oryza sativa* L.). This study aims to determine the dose of cow manure on the percentage of brown planthoppers' attacks on some varieties of paddy. This research was conducted in Serdang village in March-June 2021. This research used a Randomized Block Design (RBD) of two factors and three replications. The first factor is fertilizer dose consisting of 4 treatments inorganic, 50 kg/plot, 100 kg/plot, and 150 kg/plot). The other factor is a variety of 2 treatments (Inpari 10 and Inpari 32). The results showed that the dosage of 100 kg/plot cow manure was the best treatment for production per plot and resistant to the percentage of brown planthopper's attack. Inpari 32 is the best treatment to increase production per plot and is resistant to brown plant hopper attack intensity. The interaction of fertilizer dosage and variety (Inpari 32 + 100 kg/plot) is the best treatment to increase production per plot and resistant to the percentage of brown plant hopper attack.

Keywords: *Nilaparvata lugens*; rice; fertilizers; varieties

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Introduction

Most Indonesians still need rice as their primary need. Until now, Indonesia has not been able to meet domestic rice needs, so it still depends on imports. This condition is exacerbated by the conversion of fertile land in Java so that rice production growth is sloping. This study examines the performance of paddy field use, its contribution, and prospects for increasing national rice production. The study results indicate that paddy fields are the primary source of rice production. Another potential is improving the quality of intensification through superior varieties and integrated plant and resource management (1).

The brown stem planthopper (BPH) has become an essential and endemic pest of rice plants in Indonesia. Brown planthopper attack can reduce rice productivity because it is also a vector for grass dwarf and empty dwarf diseases (2).

The main factors that contributed to the increasing population and attack of the brown stem planthopper in recent years were the high biotic potential of the brown stem leafhopper, abiotic factors, and the rice cultivation system that supported the development of the brown stem leafhopper population. These three factors work together (3).

Planting planthopper-resistant Superior Varieties of Rice (VUTW) is one of the WBC pest management efforts that has proven to be very beneficial because of its relatively easy and inexpensive application and is also environmentally friendly (4). Select varieties make a significant contribution to the increase in rice production. The gift of using high-yielding types to the rise in national rice production reached 56%. In contrast, the interaction between irrigation water, improved varieties, and fertilization on the rate of increase in rice production contributed up to 75%. The use of high-yielding varieties also contributes to the reduction in pesticide use.

The decline in rice productivity in Indonesia is likely due to the decrease in soil fertility due to improper application of fertilizers. Therefore, technology is needed to fix degraded soil, increase the ability of the earth to absorb nutrients so that fertilization becomes more efficient, store more water, and improve the soil's physical, chemical, and biological fertility (5).

Using inorganic fertilizers continuously and in excessive amounts negatively impacts the soil (damaging soil quality), which causes decreased organic matter levels, environmental pollution, reduced soil microorganism activity, and soil compaction. Alternatives that can be used to reduce the impact of using inorganic fertilizers and intensive tillage are biological and organic fertilizers and conservation tillage. The addition of organic matter is one alternative to reduce the negative effects of using inorganic fertilizers because, in addition to being able to provide balanced nutrition for plants, organic matter can function to improve soil structure, act as an energy source for soil microorganisms, and increase the soil's ability to hold water. And increase cation exchange capacity and can increase plant resistance to pest attacks (5).

Material and Method

Research Design

This research was conducted in Serdang Village. This study used a two-factor randomized block design (RBD) with three replications. The first Factor was the dosage of fertilizer, which consisted of 4 treatments (inorganic fertilizer (Urea, SP36, KCL), 50 kg/plot of manure, 100 kg/plot of manure, and 150 kg/plot of manure). The second Factor was the variety consisted of 2 varieties of treatments (Inpari 10 and Inpari 32). Manure was applied a week before planting time using the treatment dosage. In contrast, organic fertilizer was laid on the 7th day after planting (DAP) and the 42nd day of DAP.

Analysis of Plant Nutrient Content

The plant nutrient content observed in this study was N and K nutrients, where the nutrient content analysis was carried out in the laboratory of PT. Socfindo, Medan. The number of samples analyzed was 24 (representing each experimental plot; Samples were taken at 6 WAT). The N and K nutrient contents were analyzed to determine the effect of manure application on plants.

Percentage of the brown planthopper attack

The attacked parts of plants were observed and compared with a non-attacked parts of plants, then calculated using equation (5).

$$\mathbf{I = (a/b) \times 100\%}$$

Where:

I: Percentage of attacks (%)

a: The number of the attacked parts of plant by pests from the sample observed

b: The number of the observed parts of plant

1.4. Production per plot

Production per plot is calculated by combining the total grain yields in one experimental plot and then weighing them. Before being considered, the grain is dried in the sun for 3 days, and then the empty grain is separated. The filled grain is then weighed to calculate the production per plot.

Result and Discussion

The N Nutrient Content in Plants

The variance test result showed that the treatments, including the fertilizer dosage, the variety, and the interaction of both, significantly affected plants' total N nutrient content. The average different test of total N nutrient content of several paddy varieties with fertilizer dosage application can be seen in Table 1.

Table 1. Total N Nutrient Content of Several Paddy Varieties With Fertilizer Dosage Applications

Dosage of Fertilizer	Varieties		Mean
	V_1 (Inpari 10)	V_2 (Inpari 32)	
	..........................%		
P_0 (Inorganic fertilizer)	2,93a	2,30de	2,61a
P_1 (50 kg/plot)	2,27e	2,34cd	2,31d
P_2 (100 kg/plot)	2,21f	2,53b	2,37c
P_3 (150 kg/plot)	2,40c	2,54b	2,47b
Mean	2,45a	2,42b	

Note: The numbers followed by unequal letters in the same column are significantly different according to DMRT at the 5% test level.

Table 1 shows that P0 (Inorganic Fertilizer), which is 2.61%, is significantly different from other treatments. Where the application of urea fertilizer increases the total N-nutrient levels in plants, this follows the statement of (6), which states that adding urea fertilizer will reduce or eliminate N immobilization so that the N needs of plants are fulfilled.

In the observation of N-total nutrient levels, V1 (Inpari 10) significantly differed from other treatments. This indicates that the Inpari 10 rice variety was more responsive in increasing the total N-nutrient content by 2.45%. These differences occur in addition to genetic differences from the plants themselves. Still, they are also influenced by environmental factors. According to (7), the internal factors stimulating plant growth are in genetic control, but climate, soil, and biological elements such as pests, diseases, weeds, and competition for nutrients. The highest total N nutrient content with a variety of V1 (Inpari 10) on the plant was found in the dosage of P0 fertilizer (Inorganic Fertilizer). The highest total N nutrient content with a variety of V2 (Inpari 32) on the plant was found in the dosage of P2 fertilizer (100 kg/plot). The total N nutrient content occurred due to the inorganic fertilizer application. Applying inorganic fertilizer into the soil could increase fast nutrient availability for plants (8).

The K Nutrient Content in Plants

Based on the results of the variance test, it was shown that the dose of fertilizer, variety, and their interaction significantly affected total K-nutrient levels in plants. The test of differences in the average K-total nutrient content of several rice varieties with the application of fertilizer doses can be seen in Table 2.

Table 2 shows that P2 (100 kg/plot) is 2.52% significantly different from other treatments. Applying 100 kg/plot of manure can increase the total K-nutrient levels in rice plants. This follows (9) that adding organic matter can facilitate the recycling of nutrients in the soil-plant system. Adding organic matter to the soil can add nutrients to plants.

Table 2. Total K Nutrient Content of Some Paddy Varieties with Fertilizer Dosage Applications

Dosage of Fertilizer	Varieties		Mean
	V_1 (Inpari 10)	V_2 (Inpari 32)	
	..........................%		
P_0 (Inorganic Fertilizer)	1,84g	2,10f	1,97d
P_1 (50 kg/plot)	2,18e	2,26d	2,22c
P_2 (100 kg/plot)	2,33c	2,70a	2,52a
P_3 (150 kg/plot)	2,35b	2,38b	2,36b
Mean	2,18b	2,36a	

Note: The numbers followed by unequal letters in the same column are significantly different according to DMRT at the 5% test level.

The P2V2 interaction (100 kg/plot + Inpari 32) was 2.70%, significantly different from the other treatments. This indicates that the dose of P2V2 fertilizer can increase total K-nutrient levels in plants. There was a difference in plant response to the dose of fertilizer which was also seen in the K-total levels. The difference is due to different plant responses due to the genetic nature of a variety. According to the results of research by (10), it shows that the effect on plant growth is not only due to the application of fertilizer, but the variety is very influential because each variety has different genetic, morphological, and physiological characteristics.

Attack Percentage

Based on the results of the variance test, it was shown that at 2 WAT, the dose of fertilizer had a significant effect on the percentage of attacks. Fertilizer dose treatment, variety, and their interaction significantly impacted the rate of attacks at 3-7 WAT. At 8 WAT, the dose of fertilizer and type greatly affected the percentage of attacks. The test of the mean difference in the rate of attacks of several rice varieties with the application of fertilizer doses can be seen in Table 3.

From Table 3, it can be seen at 2 WAT. The highest attack percentage was P0 (Inorganic fertilizer) which was 1.40%, significantly different from other treatments. The highest percentage of attack with a dose of P0 fertilizer (Inorganic Fertilizer) was found in the V1 variety (Inpari 10). The percentage of attack with fertilizer doses P1 (50 kg/plot), P2 (100 kg/plot), and P3 (150 kg/plot) on varieties V1 (Inpari 10) and V2 (Inpari 32) was 0%. The highest percentage of attack with variety V1

(Inpari 10) was found at the dose of P0 fertilizer (Inorganic Fertilizer). The highest percentage of attack with variety V2 (Inpari 32) was found at the dose of P0 fertilizer (Inorganic Fertilizer). Attacks at 2 WAT can be indicated as attacks that occur due to pest migration at the beginning of the planting week. (11) stated that pest migration in the tropics is generally caused by the depletion of food resources, for example, when rice is approaching harvest so that pests move to other areas.

Table 3. Attack percentage of 2-8 WAT of Several Paddy Varieties with Fertilizer Dosage Applications

Age	Dosage of Fertilizer	Varieties		Mean
		V_1 (Inpari 10)	V_2 (Inpari 32)	
		....................%	....	
2 WAT	P_0 (Inorganic Fertilizer)	1,40	1,39	1,40a
	P_1 (50 kg/plot)	0,00	0,00	0,00b
	P_2 (100 kg/plot)	0,00	0,00	0,00b
	P_3 (150 kg/plot)	0,00	0,00	0,00b
	Mean	0,35	0,35	
3 WAT	P_0 (Inorganic Fertilizer)	2,41a	0,87b	1,64a
	P_1 (50 kg/plot)	0,00c	0,00c	0,00b
	P_2 (100 kg/plot)	0,00c	0,00c	0,00b
	P_3 (150 kg/plot)	0,00c	0,00c	0,00b
	Mean	0,60a	0,22b	
4 WAT	P_0 (Inorganic Fertilizer)	3,49a	1,93b	2,71a
	P_1 (50 kg/plot)	1,65c	0,59d	1,12b
	P_2 (100 kg/plot)	0,39e	0,00f	0,20c
	P_3 (150 kg/plot)	0,00f	0,00f	0,00d
	Mean	1,38a	0,63b	
5 WAT	P_0 (Inorganic Fertilizer)	7,14a	5,15b	6,15a
	P_1 (50 kg/plot)	2,76c	1,81d	2,28b
	P_2 (100 kg/plot)	1,26e	0,53f	0,89c
	P_3 (150 kg/plot)	0,52f	0,52f	0,52d
	Mean	2,92a	2,00b	
6 WAT	P_0 (Inorganic Fertilizer)	10,66a	7,97b	9,32a
	P_1 (50 kg/plot)	6,41c	5,85d	6,13b
	P_2 (100 kg/plot)	4,46e	1,72g	3,09c
	P_3 (150 kg/plot)	1,84f	1,95f	1,96d
	Mean	5,84a	4,37b	
7 WAT	P_0 (Inorganic Fertilizer)	4,03a	2,28b	3,15a
	P_1 (50 kg/plot)	2,43b	1,23c	1,83b
	P_2 (100 kg/plot)	1,17c	0,86de	1,01c
	P_3 (150 kg/plot)	0,96d	0,69e	0,82d
	Mean	2,15a	1,27b	
8 WAT	P_0 (Inorganic Fertilizer)	1,61	1,50	1,55a
	P_1 (50 kg/plot)	0,84	0,47	0,65b
	P_2 (100 kg/plot)	0,00	0,00	0,00c
	P_3 (150 kg/plot)	0,00	0,00	0,00c
	Mean	0,61a	0,49b	

Note: The numbers followed by unequal letters in the same column are significantly different according to DMRT at the 5% test level.

From Table 3, it can be seen that the use of inorganic fertilizers increased the attack of planthoppers in the 6th week. At 6 WAT, the highest attack percentage was P0 (Inorganic fertilizer), which was 9.32%, significantly different from other treatments. The inorganic fertilizer treatment increased the attack percentage at 6 WAT. This is because the application of inorganic fertilizers increases the total N-nutrient content (Table 1). Elemental nitrogen is needed for plant growth and development, but high levels of N can cause plants to be sensitive to insect attacks. (12) stated that high levels of N can cause plants to be exposed to water stress and susceptible to insect attack. According to (13), nitrogen is very closely correlated with the development of meristem tissue, so it determines plant growth. In addition, the element N acts as a constituent of all proteins, chlorophyll, nucleic acids, and the formation of coenzymes.

The peak attacks at 6 WAT occur due to the initial invasion at 2-3 WAT. The attack in the early weeks of planting allows the planthoppers to breed, and the peak occurs at 6 WAT. This is supported by research by (14) which states that if migration occurs at 2-3 MST, immigrants will breed in two generations. The peak population of the first and second generation of nymphs appeared at 5-6 WAT, respectively.

The interaction between the fertilizer dose on rice varieties significantly affected the percentage of attack at 6 WAT, where P0V1 (Inorganic Fertilizer + Inpari 10) was significantly different from other treatments. Where this occurs because the highest total N nutrient content (Table 3) is found in the treatment combination. This is supported by (15), who said that increasing nitrogen in rice plants makes rice more susceptible to insect pests. (16) stated that the number of planthoppers and dry mass of a pair of adult planthopper imago were significantly higher in plants with high nitrogen content. Body weight and the number of planthoppers increased with the addition of nitrogen fertilizer doses on susceptible and resistant rice varieties.

The P2V2 interaction at 6 WAT had the lowest attack percentage (1.72%). This is supported by the highest total K-level of plants (Table 2) in the treatment combination (2.70%). The application of K to rice shows an increase in plant tolerance to pests which can alter several other chemicals, such as lower levels of soluble protein and free sugars in plant tissues, thus creating an unfavorable environment for insects. The levels of dissolved sugars, organic acids, and amino acids tend to increase in K-deficient plants (17). (18) stated that most plants lacking potassium show symptoms of a weak stem, so plants easily collapse. The availability of K and K-total in plants affects crop quality and plays an essential role in developing pest populations (18).

At 7-8 WAT, there was a decrease in the percentage of attacks in each treatment. This is closely related to the age of the plant that has entered the generative phase. During the generative phase, the plant stems become more challenging and less suitable for the planthopper's environment. Thorny stems are also closely related to plants' K content, which can increase stem strength. (19) stated that resistant and moderately resistant varieties have tough stems and slightly rough leaf surfaces. This is generally not favored by the BPH. Thorny stems and coarse leaves are thought to make it difficult for BPHs to stick a tool in their mouths to suck plant juices and can also cause nymphs to die because they can't eat. (20) stated that stem strength can be used as one of the criteria for resistance to falls, so applying potassium fertilizer can increase the resistance to falls.

Production per plot

Based on the results of the variance test, it was shown that the treatment dose of fertilizer, variety, and their interaction had a significant effect on the production per plot. The test of the difference in average output per plot of several paddy varieties with the application of fertilizer doses can be seen in Table 4.

Table 4. Production Per Plot of Several Paddy Varieties With Application Of Fertilizer Doses

Dosage of Fertilizer	Varieties		Mean
	V_1 (Inpari 10)	V_2 (Inpari 32)	
	........................g.......................		
P_0 (Inorganic fertilizer)	2178,67e	2355,00c	2266,83d
P_1 (50 kg/plot)	2291,33e	2423,67b	2357,50c
P_2 (100 kg/plot)	2299,67d	2610,67a	2455,17b
P_3 (150 kg/plot)	2362,33b	2681,00a	2521,67a
Mean	2283,00b	2517,58a	

Note: The numbers followed by unequal letters in the same column are significantly different according to DMRT at the 5% test level.

Table 4 shows that P3 (150 kg/plot) 2521.67 g is the highest and significantly different from other treatments where the application of manure 150 kg/plot increases the production per plot of rice. This is presumably due to manure's ability to maintain the soil's ability to support nutrients. According to (21), organic fertilizer can increase nutrient availability because it can help N nutrients so that they are not easily lost through washing or leaching into soil particles. (21), also stated that each variety differs in completing the generative phase, namely in filling the grain, so it affects the weight of the grain.

V2 (Inpari 32) was significantly different from other treatments in the observation of production per plot. This indicates that the Inpari 32 rice variety increased production per plot by 2517.58 g. (22), Each variety has different growth and yield potentials according to its genetic potential.

In Table 4, it can also be seen that P2V2 (100 kg/plot + Inpari 32) was better at increasing production per plot than P3V2 (150 kg/plot + Inpari 32). This is presumably due to the Inpari 32 variety being a new high-yielding variety released in 2009, compared to Inpari 10, which was released in 2000. The Inpari 32 variety is also more adaptive to the environment in which it grows. Where more adaptive varieties will encourage better plant growth. This follows the statement of (23), which states that each rice variety has its adaptability to environmental biophysical conditions.

Conclusion

The results showed that the dosage of 100 kg/plot cow manure was the best treatment for production per plot and was resistant to the percentage of brown plant hopper attacks. Inpari 32 is the best treatment to increase production per plot and is resistant to brown plant hopper attack intensity. The interaction of fertilizer dosage and variety (Inpari 32 + 100 kg/plot) is the best treatment to increase production per plot and is resistant to the percentage of brown plant hopper attacks.

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