Vol. 12, No. 2 (2023) : 338 - 349
DOI : http://dx.doi.org/10.23960/jtep-l.v12i2.338-349

JURNAL TEKNIK PERTANIAN LAMPUNG

ISSN 2302-559X (print) / 2549-0818 (online)
Journal homepage : https://jurnal.fp.unila.ac.id/index.php/JTP

Salibu Rice Cultivation in Tungro Endemis Region

Khaerana Khaerana[1], I Nyoman Widiarta[1], Achmad Gunawan[1], Arif Muazzam[1]

[1]Badan Riset dan Inovasi Nasional, INDONESIA

Article History :

Received : 29 August 2022
Received in revised form : 31 January 2023
Accepted : 5 February 2023

Keywords :
Green leafhopper,
Natural enemies
Rice tungro virus disease,
Salibu.

✉Corresponding Author:
khaerana.hafid@yahoo.com

ABSTRACT

Salibu is modified ratoon rice which has advantages in economic and time-saving. Tungro disease is one of probable handicap for salibu to be controlled in their endemic area. Rice virus tungro disease is caused by Rice Tungro Bacilliform Virus (RTBV) and Rice Tungro Spherical Virus (RTSV) which are transmitted by leafhopper. The research goals are to know the growth of leafhopper population and the spread of the tungro disease in salibu and conventional rice farming system as well as their effect on yield. The research was conducted in split plot experiment and designed in a randomized block design. The main plot were 1) salibu system and 2) conventional system (non -salibu). The subplots were varieties 1) TN1 (sensitive variety), 2) Ciherang (commonly used by the farmer), and 3) Inpari 36 (tungro new resistant variety). The results revealed that the tungro attack rate, dry milled grain yield, and 1000 dry grain weight were significantly higher in conventional cultivation than salibu ($P < 0.05$). The number of leafhopper populations tended to be higher in salibu system than in conventional system. The number of natural enemies did not show a particular pattern related to green leafhopper's presence. The Shannon Wiener diversity index for natural enemies ranged from low to medium. Regarding to the results, salibu system is not recommended yet in the tungro endemic areas.

1. INTRODUCTION

Rice is the staple food of Indonesian people. The need for rice increases every year in line with the growth of Indonesia's population. According to BPS data for 2015, Indonesia's population was 254.9 million people and currently (2021) is estimated to be 272.7 million people (BPS, 2022). In 2010, rice consumption in Indonesia has reached 38.55 million tons, while rice production at the same time reached 38 million tons (Ika, 2013). Currently rice production is 55.27 million tons of dry unhusked paddy (equivalent to 33.16 million tons of rice at a milled yield of 60%). Efforts to increase rice production must continue to be carried out in line with the growth in population (Sudarmawan *et al*., 2017).

Increasing the cropping index is one of the efforts made to increase agricultural production. The acceleration of planting and increasing the planting index proclaimed by the Minister of Agriculture increases labor costs, so that it becomes a separate problem in the implementation of the program. The ratoonized paddy, locally called "salibu" rice, is one way of rice cultivation technology that is expected to answer this problem. Plants that have been harvested can be directly cultivated using the "salibu" or ratoon technique (Erdiman, 2012).

Farming efficiency is an important aspect of rice cultivation (Umar & Pangaribuan, 2017). Cultivation of "salibu" rice is one of the technological innovations in an effort to increase production. This technology was first developed in West Sumatra Province. "Salibu" technology is a modified ratoon rice cultivation technology. Some of the advantages of ratoon cultivation include lower production costs, because there is no costs for tillage and planting, less fertilizer requirement, and shorter plant harvesting age. So it is more efficient (Susilowati, 2013; yawaluddin *et al*., 2018). Hybrid rice those cultivated with "salibu" will save costs required to buy seeds. "Salibu" rice can be harvested 15-20% faster than the time of regular planting (Juanda, 2016).

One of the obstacles that is expected to be faced in increasing production with "salibu" rice is tungro disease. Tungro disease will cause a decrease in rice yields, and can even result in 100% fail or "puso", especially in asynchronous rice cropping patterns which cause rice plants to be available throughout the year in the field (Muliadi et al. 2011). This study aims to determine the development of green leafhopper populations, the attack of tungro disease, and its effect on production of "salibu" rice, as well as to provide recommendations for technological components that can be used to suppress tungro disease in tungro endemic areas.

2. MATERIALS AND METHODS

2.1. Research in the Experimental Field

The research was conducted at the Tungro Disease Research Station Experimental Garden which is located at -3.85017 South latitude, and 119.8334 East longitude. The study used a split-plot design in a randomized block design (RBD). As the main plot is the method of cultivation, namely: 1) "salibu" (T1); and 2) conventional rice cultivation (T2) which is usually done by farmers. Subplots were varieties consisting of:

1) TN1, a sensitive variety (V1),
2) Inpari 36, a tungro resistant variety (V2), and
3) Ciherang, a variety commonly used by farmers (V3).

The plot size for each experimental unit was 8 m x 8 m, and each treatment was repeated 4 times, so there were 24 experimental units.

In the "salibu" plot during the first growing season (mains), the transplanted seedlings were 21 days old, using jajar legowo 2:1 technology. Fertilization was carried out 2 times, namely fertilization I with a dose of 100 kg/ha of urea and 200 kg/ha of phonska, followed by fertilization II with 250 kg/ha of urea. Maintenance includes weeding and managing the availability of water until harvest.

In the second growing season (salibu-1), after the parent plants are harvested, irrigation is carried out for 2-3 days at ± 5 cm high, until the new shoots come out after cutting the plants. The plants were cut again at ± 7-10 days after harvest, and left 5 cm high. At the age of 2 weeks after cutting or after most of the shoots appear, fertilization I is carried out with urea as much as 100 kg/ha + 200 kg/ha phonska (soil condition in field capacity). At the age of 40 days after cutting, fertilization II (250 kg/ha urea) was applied. Furthermore, the plants are maintained until harvest.

The non "salibu" plots were planted in planting season II together with salibu-1. Seeds that were 21 days old were transplanted into the plots, one plant per hole, with a jajar legowo 2:1 spacing. Irrigation is carried out intensively from the nursery until the milk matures. Fertilization was performed 2 times: fertilization I with a dose of 100 kg/ha of urea and 200 kg/ha of phonska, and fertilization II with 250 kg/ha of urea. Maintenance includes weeding and managing water availability until harvest, with the duration of planting from seedling to harvest for approximately 115-125 days.

Parameters observed in this study included population density of green leafhoppers, density of natural enemies of green leafhoppers, and percentage of tungro occurrences. Observations were made when the plants were 1, 2, 3, and 4 weeks after transplanting (MST) for conventional plantations, whereas for "salibu" plantations, the week after "salibu" (MSS). Observation of green leafhoppers and natural enemies was carried out using an insect net (sweep net) of 10 double swings in a diagonal direction. The caught insects are put in insect cages, observed and counted. Insect identification refers to (Shepard *et al*., 1987). Symptoms of the disease were observed by visual observation, with the characteristics of plants attacked by tungro, namely leaf discoloration from yellow to yellow-orange, stunted plants, and a small number of tillers. To analyze the insect diversity index, the Shanon-Wiener index is used, as has been done by (Sari *et al*., 2020), with the following formula:

$$H' = -\sum\left[\frac{n_i}{N} ln\left(\frac{n_i}{N}\right)\right] \quad (1)$$

where H' is diversity index, n_i is the number of individuals in one type of insect, and N is the total number of individual insects.

2.2. Greenhouse Research

Time of Planting I The implementation of the research was started by planting the three tested varieties in pots, one plant per pot, repeated 4 times. Plants that are 2 weeks old after planting are covered and invested in each of 5 green leafhoppers that have been infected with the tungro virus, left for 2 days to transmit the virus. Symptoms of tungro disease in plants were observed for the severity of tungro disease at 3 weeks after inoculation. As a comparison, the three varieties were grown in pots, but no inoculation was carried out. The severity of tungro disease is evaluated based on the IP score as in Table 1.

Table 1. IP scores and the severity interpretation

IP Score	Interpretation
3	Shorter plant height, reaching 1-10%, leaf color changes from yellow to yellow-orange are not significant.
5	Shorter plant height, reaching 11-30%, leaf color changes from yellow to orange-yellow are not significant.
7	Shorter plant height reaches 31-50%, leaf color changes from yellow to yellow to orange.
9	Shorter plant height reaches >50%, leaf color changes from yellow to yellow to orange.

Planting Season Salibu-2 when the plants are 7 days old after harvest, they are inundated with water for 2-3 days. At the age of 14 days after harvest or until new shoots come out, the plants are cut again, and are left 5 cm high. Plants were observed for the severity of tungro disease that occurred in new tillers (singgang). The observation parameter is the severity of tungro disease visually based on the Standard Evaluation System for Rice method (IRRI, 2013). Tungro disease index (IP) is calculated by the formula:

$$IP = \frac{n(3) + n(5) + n(7) + n(9)}{tn} \quad (2)$$

where *n* is number of tungro infected plants with related score, and *tn* is total plant clumps. The criteria for resistance to tungro are classified based on the range of the tungro disease index with categories as shown in Table 2.

Table 2. Tungro disease index and rice resistance categories

IP score	Resistance Category
0–3	Resistant
4–6	Slightly resistant
7–9	Prone

3. RESULTS AND DISCUSSION

3.1. Green Leafhoppers and Natural Enemies

The results of observing the number of green leafhoppers between the varieties tested and the cultivation techniques used showed no interaction between the two treatments. There was no significant difference in the number of green leafhoppers between the TN1, Ciherang and Inpari 36 varieties. Likewise, in conventional and salibu cultivation techniques, the observed populations of planthoppers were not significantly different between cultivation techniques, but the number of green leafhoppers in the salibu cultivation plots (average 1.12 heads/plot) was slightly higher than that of conventional cultivation plots (average 1.06 heads/trial plot). This is because the salibu cultivation technique will eliminate fallow periods in rice planting, so that the available hosts can perpetuate the cycle of pests and diseases in rice (Kurnia & Liferdi 2017).

The development of green leafhopper population density fluctuated from the first week of observation to the fourth week of observation. In the first to second week the green leafhopper population increased, but in the third week it began to decrease (Figure 1). Green leafhopper population density fluctuations in the three types of varieties and both types of planting technology in this experiment showed the same pattern as reported by (Widiarta *et al.* 1999). Particularly in conventional cropping plots, in the fourth week the population density increased for TN1 and Ciherang varieties. In general, the population density of green leafhoppers is relatively low, with an average population of 0-3 per 10 double swings.

There were differences in the pattern of population density between the salibu cropping system and the conventional one in the first and fourth weeks of observation. In the first week, the highest population density of green leafhoppers was recorded in the TN1 variety in salibu, while in conventional plantings the number of green leafhoppers was considered very low. In contrast, in the fourth week, the highest population density of green leafhoppers was observed in TN1 with conventional cultivation techniques, but in the salibu cultivation technique the population of green leafhoppers was relatively low. This is due to differences in the age of the plants. In conventional cropping, the plants are formed from germinated seeds, so that the age of the plants is relatively younger than the salibu plants. In salibu, new plants emerge from ratooned rice stalks, not starting from the beginning of germination but formed from old plant segments, so that the supply of nutrients does not depend on the old stalks that have been cut. This causes the vegetative phase of the plant to be very short and then enter the initial generative phase. The salibu rice technology can save about 40 days of planting time compared to transplanting (Abdulrachman *et al*. 2015), this causes the preference for green leafhoppers to be low and they choose to migrate to look for younger plants that are still possible to be used as hosts. Whereas in conventional cropping at the age 4 weeks the plants were still in the vegetative phase, so green leafhoppers still preferred to be their hosts. Senoaji & Praptana (2015), stated that green leafhoppers tend to migrate if the food source and environmental conditions are not suitable for their survival, even migration will go on quickly after probing or searching for suitable food.

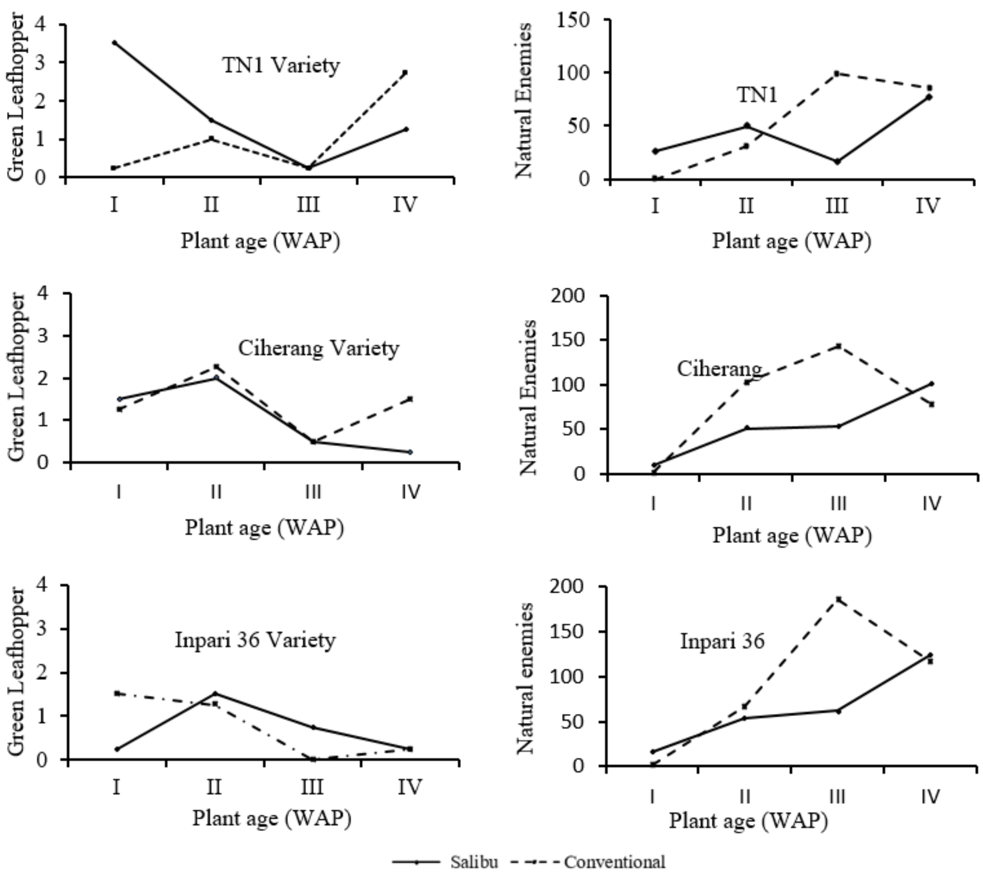

Figure 1. The population development of green leafhopper (left) and its natural enemies (right) in ten double swings in salibu and conventional cultivation system of TN1, Ciherang, and Inpari 36 varieties.

The presence of green leafhoppers and natural enemies is different for each habitat, both in the cultivation techniques used and in the varieties tested. The population density of natural enemies in conventional planting was higher than that in the salibu planting. The increase of natural enemies in conventional planting occurred until the third week and then decreased, while the increase of natural enemies in the salibu cultivation occurred until the fourth week. The increase in the population of natural enemies affected the population of green leafhoppers in the Inpari 36 variety of conventional cultivation techniques, the Ciherang variety with the salibu cultivation system, and the TN1 variety with the conventional cultivation system. In principle, if the density of natural enemies increases, the number of green leafhoppers will be suppressed (Sista *et al.* 2015). However, this phenomenon did not occur in the Ciherang variety with the conventional cultivation system and in the TN 1 variety with the salibu method (Figure 1). In general, it can be said that there is no clear pattern between fluctuations in the green leafhopper population and the presence of natural enemies in the plantations. This is in line with the results of a study (Senoaji & Praptana 2015), which states that the density of predator populations does not follow the pattern of fluctuations in the density of green leafhopper populations. The diversity of insect pests and natural enemies is influenced by various habitats (Khan, 2013).

Beetles dominate the population of natural enemies, namely carabid beetles (*Carabidae*) and koksi beetles (*Coccinellidae*) in both cultivation systems. Spider species were also detected from the first week of observation, especially round spiders (*Araenidae*), hunting spiders (*Lycosidae*), and long-limbed spiders (*Tetragnathidae*). Meanwhile, bitch-eyed spiders (*Oxyopidae*) show a low population, and are only found in the salibu system. The existence of long-antennae grasshoppers (*Tettigonidae*), needle dragonflies (*Coenagrionidae*), tomcats (*Paedorus*), crickets (*Gryllidae*), and large dragonflies (*Libulludae*) is quite evenly distributed in both cultivation systems and the varieties tested and with relatively low population numbers with an average the average occurrence ranged from 0.25-2.75 individuals (Tables 3 and 4).

Table 3. Average population of natural enemies for green leafhoppers at salibu rice cultivation under varieties of TN1, Ciherang, and Inpari 36 during 4 weeks (I – IV) observation

Natural enemies	TN1				Ciherang				Inpari 36			
	I	II	III	IV	I	II	III	IV	I	II	III	IV
Araenidae	2.5	0.25	2.25	0.25	2	1	0.25	0.25	3.25	0.25	0.75	0
Lycosidae	0	0.75	0.25	0.25	0	0.75	0.25	0	0	1	0.5	0
Tetragnathidae	0.25	1.5	0	0	0	4	0	0	1	1.25	0	0
Oxyopidae	0	0.25	0	0	0	0.25	0	0	0	0	0	0
Tettigonidae	9.75	2.5	1.25	2	1.75	0.25	1.5	1.25	2.5	1.5	2	2.75
Coenagrionidae	0.25	0	0	0.75	0	0	0.25	0	0	0	0.25	0.25
Carabidae	0	0.5	6.25	1.75	0	0	4	3.25	0.25	0.25	1	3.5
Coccinellidae	13	43.75	5.5	72.5	5.5	44.5	46.5	94.75	9.25	49.25	57.5	117.5
Paedorus	0.25	0	0.5	0	0.75	0.25	0.5	0	0.25	0.5	0	0
Gryllidae	0	0	0	0	0	0	0	1.5	0	0	0	0
Libelludae	0	0.25	0	0	0	0	0	0.25	0	0	0	0

Table 4. Average population of natural enemies for green leafhoppers at conventional rice cultivation under varieties of TN1, Ciherang, and Inpari 36 during 4 weeks (I – IV) observation

Natural enemies	TN1				Ciherang				Inpari 36			
	I	II	III	IV	I	II	III	IV	I	II	III	IV
Araenidae	0	0.75	1.75	1	0.25	0.75	1	1.75	0	0	0.5	1.5
Lycosidae	0	0	0	0.25	0.25	0	0	0.25	0	0	0	0.25
Tetragnathidae	0	0.25	1	0	0	0	1	2	0	0	0.25	0.25
Oxyopidae	0	0	0	0	0	0	0	0	0	0	0	0
Tettigonidae	0	0	0.25	1.5	0	0	0.25	0.5	0	0	0.25	1.5
Coenagrionidae	0	0	0.25	2.75	0	0	0.25	4.5	0	0	0.75	4
Carabidae	0	0.25	0.75	5.75	0	0	1	9.75	0	0	2	8.75
Coccinellidae	0	29.75	94.5	72.25	1.75	101.25	136.5	57.5	2.25	66.5	181.75	99
Paedorus	0	0.25	0.67	1.5	0	0.5	3	0.75	0	0	0.25	0.75
Gryllidae	0	0	0	0	0	0	0	0	0	0.25	0	0
Libelludae	0	0	0	0.5	0	0	0	0.5	0.25	0	0	0.75

According to (Santosa & Sulistyo 2007) the types of natural enemies that are effective in terms of preying on leafhoppers, and have an effect on reducing leafhopper populations are *Lycosa pseudoannulata* (*Araneida; Lycosidae*), *Paederus sp. (Coleoptera; Coccinellidae), Ophionea sp. (Coleoptera; Carabidae), Coccinella sp. (Coleoptera; Coccinellidae) dan Cyrtorhinus lividipennis (Hemiptera; Miridae*). Furthermore Ooi, (2015), stated that Odorata: Coenagrionidae, is a natural enemy that can control green planthopper populations.

The diversity index of natural enemies of green leafhoppers planted in salibu and conventional cultivation techniques ranged from low to medium scale (Table 5). In the first week of observation, the diversity of natural enemies in the salibu technique was moderate, higher than conventional cultivation techniques. When the plants were converted to salibu, the surrounding crops were already harvested, the food source for neutral insects and pests was lower, so natural originators would choose plants that had been ratooned (Widiarta *et al.* 2006). Plants that have been trimmed will produce new shoots, along with irrigation on the plantation.

Table 5. Diversity index (H') of natural enemies within salibu (T1) and conventional (T2) rice cultivation with TN1 (V1), Inpari 36 (V2), dan Ciherang (V3) varieties for 4 weeks (I – IV) observation.

Treatment	Diversity of natural enemies			
	1 MSS/MST	2 MSS/MST	3 MSS/MST	4 MSS/MST
T1V1	1.074	0.378	0.724	0.406
T1V2	1.227	0.316	0.362	0.219
T1V3	1.15	0.508	0.533	0.326
T2V1	0	0.25	0.264	0.667
T2V2	0.326	0.025	0.135	0.652
T2V3	0.684	0.074	0.252	0.956

Observations of natural enemies in the second and third weeks showed a greater diversity index in the salibu technique, but the difference with conventional cultivation techniques was not so high, because both were on low scale. Changes in composition were shown in the fourth week of observation where the diversity index in conventional is greater than in salibu. The reason for this change is because the salibu plantations have entered the early generative phase, so that the green leafhoppers will choose a more appropriate host. This is in accordance with the opinion of Senoaji & Praptana (2015), which states that green leafhopper populations will decrease in the generative phase of rice plants, because they are not suitable for the development of green leafhoppers and tend to migrate to other younger crops. The anthropod population is highly dependent on the type and amount of food available in nature. An increase in the number of anthropods will have a positive correlation with the number of hosts available, and vice versa (Sari *et al*. 2017).

Apart from changes in the number and composition of the hosts, the decrease in the diversity index of natural enemies is also commonly caused by exposure to chemicals, in the form of spraying pesticides. The research of Khairia (2009), showed that the diversity index of arthropods in the use of controlled pesticides was greater than the use of uncontrolled pesticides.

3.2. Tungro Disease and Yield

There was an interaction between the variety and the cultivation technique on the weight of 1000 grains, the yield of dry unhusked grain (moisture content 14%), and the level of tungro attack in the plants. The weight of 1000 grains shows that the Ciherang variety with the salibu culture technique and Inpari 36 in the conventional cultivation technique is significantly different from the TN1 (both conventional and salibu) as presented in Table 6.

Table 6. Interactions between varieties (TN1, Ciherang, Inpari 36) and cultivation techniques (conventional, salibu) on the weight of 1000 grains (g), grain yield, and tungro attack intensity

Variety	Cultivation technique	Weight of 1000 grains (g)	Yield GKG (kg/ ha)	Tungro
TN1	Conventional	24,5[b]	5700,8[b]	0,2[d]
Ciherang	Conventional	26,1[ab]	8821,3[ab]	0,4[cd]
Inpari 36	Conventional	27,9[a]	15035,1[a]	0,1[d]
TN1	Salibu	25,0[b]	4220,5[b]	5,1[a]
Ciherang	Salibu	28,0[a]	4823,3[b]	3,7[ab]
Inpari 36	Salibu	25,5[ab]	6525,6[b]	2,6[bc]

Numbers followed by different letters in the same column show a significant difference according to Tukey's test at α = 5%.
GKG = unhusked dry rice paddy

From the yield of dry unhusked grain, the best results were obtained on the Inpari 36 variety within conventional cultivation techniques, but not significantly different from the Ciherang variety on conventional cultivation. Even though the yield of Inpari 36 was quite high in conventional cultivation, after converting to salibu, there was a decrease in yield of 56.6%, the highest yield loss compared to other varieties, namely

Ciherang (45.3%) and TN1 (26.0%).

The highest tungro attack intensity was shown by salibu TN1 variety, but not significantly different from Ciherang with salibu. Meanwhile, Inpari 36 showed the lowest tungro attack intensity, significantly different from the TN1 and Ciherang varieties. These results prove that the Inpari 36 variety exhibits resistance to tungro, both in salibu and conventional cultivation.

The intensity of the tungro attack on the salibu cultivation technique was higher than that of the conventional cultivation technique, indicating that plants that had been infected with the tungro virus in the previous cropping cycle would still be attacked by tungro after being ratooned, and the level of attack would be even more severe, except for using varieties that were resistant to the tungro virus (Table 7). This condition causes plants that have been attacked by diseases to show low productivity. The success of the ratoon (salibu) plant is strongly influenced by the parent plant (Liu *et al.* 2012).

Table 7. Tungro disease index (IP) in conventional and salibu plants on TN1, Ciherang, and Inpari 36 varieties

Variety	IP tungro conventional	IP tungro salibu
TN1	4	6
Ciherang	3	4
Inpari 36	2	2

Paddy variety greatly influences the success in controlling tungro disease, including its relationship with the preference level of green leafhoppers as a tungro virus vector. Praptana & Muliadi (2013) stated that the spread of tungro would occur more quickly if the proportion of susceptible varieties was higher than resistant varieties. The use of resistant varieties, both resistant to the green leafhopper vector, tungro virus, or both, is an easy and fast technology that can be adopted by farmers (Hasanuddin, 2008). Inpari 36 is a variety that is resistant to tungro virus variant 073 in the category of highly virulent virus (Widiarta & Pakki, 2015; BPPP, 2019). In general, for both salibu and conventional cultivation techniques, Inpari 36 showed a lower tungro disease index than TN1 and Ciherang. According to (Widiarta & Pakki 2015), virus virulence is grouped into 3 groups, namely (1) very virulent group with a virulence variant >0.70; (2) malignant with a virulence variant between 0.11-0.71; and (3) weak with a virulence variant <0.11. Based on the presence of tungro and the scale of symptoms expressed, inoculum sources from Subang, Bulukumba, Bantaeng (South Sulawesi), and Polewali Mandar (West Sulawesi) have the highest virulence level of 0.73, which means they can break the resistance of Bondoyudo, Kalimas, Tukad Balian, and Tukad Unda varieties (Suprihanto, 2010; Susilowati, 2013).

In addition to the use of resistant varieties, there are several components in controlling tungro disease, namely: 1) selection of planting time; 2) concurrent cropping pattern; 3) eradication of parent plants infected with tungro); 4) method of planting and setting spacing; 5) appropriate N fertilization (not excessive); 6) regulation of water availability (Praptana &Yasin 2008). The application of jajar legowo planting can be applied to reduce the occurrence of green leafhoppers (Widiarta, 2005). The use of several tungro control components in this study, including the use of the Inpari 36 variety which is a tungro resistant, planting spacing using a 2:1 jajar legowo, as well as choosing the planting time to avoid peak populations of green leafhoppers which commonly occur in February and August. However, this does not prevent the plantations from being free from tungro disease. The asynchronous cropping pattern is the main reason why it is difficult to avoid tungro infection which causes a decrease in yield, in addition to other pest attacks. According to Burhanuddin *et al.* (2006), the choice of planting time is adjusted to fluctuations in the green leafhopper population. Choosing the right planting time should avoid the early vegetative phase of the plant coinciding with the peak of the green leafhopper population, so that the plants are protected from tungro attack (Widiarta & Suharto 2009). Green leafhopper population density is influenced by the cropping pattern practiced by farmers. Widiarta & Yulianto (1997) states that cropping patterns that are not in uniform will increase the number of green leafhoppers that scatter compared to uniform cropping. The dispersal of high imago on asynchronous cropping patterns widens the spread of tungro (Muhsin & Widiarta, 2009).

The intensity of pest attacks on salibu plants is quite high, especially rats and birds, which is also the cause of the decrease in yield. This is because after the plants are ratooned, the surrounding planting plots have been harvested, so the rat attack cannot be avoided even though preventive measures have been taken in the form of installing a TBS (Trap Barrier System) and safety nets in the planting area.

4. CONCLUSIONS AND SUGGESTIONS

Rice plants cultivated with salibu technique in tungro endemic areas were attacked by tungro disease with a higher presence of the disease and lower yields on both tungro virus resistant and susceptible varieties. The high rate of tungro attack and yield loss in the salibu technique as compared to conventional cultivation, indicates the need to introduce other control technology components besides the use of virus-resistant varieties and jajar legowo cropping patterns such as 1) uniform cropping pattern; 2) eradication of inoculum sources (including parent plants infected with tungro); 3) method of planting and spacing selection; 4) proper N fertilization (not excessive); and 5) regulation of water availability, if salibu technique is to be developed in tungro endemic areas.

REFERENCES

Abdulrachman, S., Suhartatik, E., Erdiman, S., Zaini, Z., Jamil, A., Mejaya, M. J., Sasmita, P., Abdulah, B., Suwarno, Y. B., & Dhalimi, A. (2015). *Panduan Teknologi Budidaya Padi Salibu*. http://bbpadi.litbang.pertanian.go.id/index.php/publikasi/panduan-teknis/panduan-teknologi-budidaya-padi-salibu. Diakses pada, 21 Mei 2022.

BPS (Badan Pusat Statistik). (2014). Proyeksi Penduduk. Diakses tanggal 12 Mei 2022 dari http://www. https://bps.go.id/subject/12/ kependudukan.html#subjekViewTab3,

Burhanuddin, I., Widiarta, I., & Hasanuddin, A. (2006). Penyempurnaan pengendalian terpadu penyakit tungro dengan strategi menghidari infeksi dan pergiliran varietas tahan. *Jurnal Hama dan Penyakit Tumbuhan Tropika*, ***6***(2), 92–99.

Erdiman. (2012). Teknologi Salibu Meningkatkan Produktivitas Lahan (3-6 Ton/Ha/ Tahun). *Balai Pengkajian Teknologi Pertanian Sumtera Barat*.

Hasanuddin, A. (2008). Perbaikan ketahanan varietas padi terhadap penyakit tungro. *Iptek Tanaman Pangan*, ***3***(2), 215-228.

Ika, S. (2013). Kedaulatan Pangan dan Kecukupan Pangan: Negara Wajib mewujudkannya. *Rubrik Edukasi Fiskal*.

IRRI. (2013). *Standard Evaluation System for Rice*. International Rice Research Instiitute. http://www.clrri.org/ver2/uploads/SES_5th_edition.pdf

Juanda, B.R. (2016). Potensi peningkatan produksi padi dengan meningkatkan IP (Indek Panen) melalui penerapan teknologi padi salibu. *Jurnal Penelitian Agrosamudra*, ***3*** (1), 75–81.

Khairia, W. (2009). Dampak Penggunaan Pestisida Terhadap Keanekaragaman Arthropoda Tanah Dan Kadar Residu Pestisida Pada Buah Jeruk (Kasus Petani Hortikultura Di Kabupaten Karo). [*Tesis*]. Department of Natural Resources Management and Environment, Universitas Sumatera Utara.

Khan, M.M.H. (2013). Abundance and diversity of insect pests and natural enemies in coastal rice habitat. *Bangladesh Journal of Entomology*, **23**(1), 89–104.

Kurnia, K., & Liferdi, L. (2017). Keragaan budidaya padi salibu di Kabupaten Sumedang. *Buletin Hasil Kajian*, ***7***(07), 28-32.

Liu, K., Qin, J., Zhang, B., & Zhao, Y. (2012). Physiological traits, yields and nitrogen translocation of ratoon rice in response to different cultivations and planting periods. *African Journal of Agricultural Research*, ***7***(16), 2539-2545. https://doi.org/10.5897/AJAR10.416

Muhsin, M., & Widiarta, I. N. (2009). Patosistem, strategi, dan komponen teknologi pengendalian tungro pada tanaman padi. *Iptek Tanaman Pangan*, ***4***(2), 202–221.

Muliadi, A., Nasrullah, N., Sumardiyono, Y., & Trisyono, Y. (2011). Pewarisan ketahanan penyakit tungro pada galur padi OBSTG02-28. *Jurnal Penelitian Pertanian Tanaman Pangan*, ***30***(2), 121–126.

Ooi, P.A.C. (2015). Common insect pests of rice and their natural biological control: An illustrated guide to the insect pests that feed on rice plants and the organisms that feed on and control those pests. *Utar Agriculture Science Journal*, ***1***(1), 49–59.

Praptana, R.H., & Yasin, M. (2008). Epidemiologi dan strategi pengendalian penyakit tungro. *Iptek Tanaman Pangan* ***3***(2), 184–204.

Praptana, R.H., & Muliadi, A. (2013). Durabilitas ketahanan varietas padi terhadap penyakit tungro. *Iptek Tanaman Pangan*, ***8***(1), 15-21.

Santosa, S. J., & Sulistyo, J. (2007). Peranan Musuh alami Hama Utama Padi Pada Ekosistem Sawah. *Jurnal Inovasi Pertanian*, ***33***(1), 1–10.

Sari, P., Syahribulan., Sjam, S., & Santoso, S. (2017). Analisis keragaman jenis serangga herbivora di areal persawahan Kelurahan Tamalanrea Kota Makassar. *BiomaX Jurnal Biologi Makassar*, ***2***(1), 36–45.

Sari, A.R.K., Rahmawati, D., & Samrin, S. (2020). Keragaman hama dan musuh alami pada pertanaman padi (*Oryza sativa*) di Wawotobi, Sulawesi Tenggara. *Jurnal Penelitian Pertanian Tanaman Pangan*, ***4***(3), 145-151. https://doi.org/10.21082/jpptp.v4n3.2020.p145-151

Senoaji, W., & Praptana, R.H. (2015). Perkembangan populasi wereng hijau dan predatornya pada beberapa varietas padi. *Jurnal Perlindungan Tanaman Indonesia*, ***19***(1), 65–72.

Shepard, B.M., Barrion, A.T., & Litsinger, J.A. (1987). Helpful insects, spiders, and pathogens: friends of the rice farmer. *Helpful Insects, Spiders, and Pathogens: Friends of the Rice Farmer.*

Sista, C.C., Sarjan, M., & Haryanto, H. (2015). Populasi dan intensitas serangan hama penghisap daun pada pertanaman kentang di dataran tinggi Sembalun Lombok Timur. *Jurnal Penelitian Program Studi Agroekoteknologi Fakultas Pertanian Universitas Mataram*, 1–11.

Sudarmawan, M., Rosadi, B., & Triyono, S. (2017). Aplikasi irigasi pada padi gogo (*Oryza sativa L.)* varietas Inpago 9. *Jurnal Teknik Pertanian Lampung*, ***3***(6), 141–150.

Suprihanto, I. (2010). Evaluasi virulensi virus tungro dari beberapa daerah endemi dan uji ketahanan plasma nutfah padi. *Jurnal Perlindungan Tanaman Indonesia*, *16*(1), 33–41.

Susilowati. (2013). Peningkatan produktivitas dan efisiensi usahatani padi sistem ratun di lahan pasang surut. *Buletin Inovasi Teknologi Pertanian*, *1*(1), 12–17.

Umar.S., & Pangaribuan, S. (2017). Evaluasi penggunaan mesin tanam bibit padi (*rice transplanter*) sistem jajar legowo di lahan pasang surut. *Jurnal Teknik Pertanian Lampung*, *2*(6), 105–114.

Widiarta, I.N. (2005). Wereng hijau (*Nephotettix virescens* Distant): Dinamika populasi dan strategi pengendaliannya sebagai vektor penyakit tungro. *Jurnal Litbang Pertanian*, *24*(3), 85–92.

Widiarta, I.N., Kusdiaman, D., & Hasanuddin, A. (1999). Dinamika populasi Nephotettix virescens pada dua pola tanam padi sawah. *Jurnal Perlindungan Tanaman Indonesia*, *5*(1), 42–49.

Widiarta, I.N., & Pakki, S. (2015). Variasi virulensi virus tungro bersumber dari inokulum di daerah endemis tungro di Indonesia. *J. HPT Tropika*, *15*(1), 1–9.

Widiarta, I.N., & Suharto, H. (2009). Pengendalian hama dan penyakit tanaman padi secara terpadu. *Badan Penelitian dan Pengembangan Pertanian-Balitbangtan*, 441 –442.

Widiarta, I.N., & Yulianto, Y. (1997). Status penyebaran penyakit tungro pada padi di Jawa Barat. *Jurnal Perlindungan Tanaman Indonesia*, *3*(1), 23–31.

Widiarta, N., Kusdiaman, D., & Suprihanto. (2006). Keragaman arthropoda pada padi sawah dengan pengelolaan tanaman terpadu. *Jurnal HPT Tropika*, *6*(2), 61–69.