J. Trop. Plant Pests Dis.
Vol. 22, No. 2, September 2022
Pages: 168–175

ISSN: 1411-7525
E-ISSN: 2461-0399
DOI : 10.23960/j.hptt.222168-175

RESEARCH PAPER

Performance of tungro disease resistant rice lines in Lanrang, South Sulawesi, Indonesia

Mansur & Arif Muazam

Manuscript received: 7 November 2021. Revision accepted: 18 February 2022. Available online: 14 September 2022.

ABSTRACT

Efforts to increase rice production and productivity nationally are still being disturbed by plant pest organisms. One of the diseases that have received serious attention is the tungro disease, which has the ability to attack rice plants in endemic areas. The purpose of this study was to investigate the resistance of several rice lines towards the Lanrang South Sulawesi tungro virus inoculum including morphological characteristics. This study was conducted at the Tungro Disease Research station from June to September 2020. A total of 14 lines were tested for resistance compared to the Tukad Petanu, Tukad Balian, Inpari 8 and Tukad Unda lines against the tungro disease. The rice lines were planted in the form of an augmented design consisting of five blocks. Each block contained three test lines and four comparison varieties, the lines were planted in plots (1 × 5) m, with 25 × 25 cm spacings. The results showed that the population of green leafhoppers at the age of 20 DAP and 30 DAP was found to range from 1 to 95 individuals per line/variety, while the incidence of tungro disease was 1.3 to 11.3% in the three test lines, namely STLRG17 15 LR 1, STLRG17 15 LR 2, and STLRG17 108 LR 1. The highest 1000 seed weight was found in the STLRG17 176 LR 2 line (25.1 g) and the lowest was STLRG17 51 LR 1 (17.6 g). The STLRG17 175 LR 1, STLRG17 176 LR, STLRG17 -175-LR-1, STLRG17-28-LR-1, and STLRG17-26-LR-2 5 lines had a fairly good and consistent appearance at 1000 seed weight, higher yield, productive tillers, plant height, and resistance to tungro disease compared to the comparison varieties.

Key words: disease, lines, resistance, tungro

INTRODUCTION

The rice lines obtained from crossbreeding that passed the screening selection stage and categorized as resistant needed further testing in hopes that they will be selected to become the next generation of rice lines that have good phenotypic characteristics and are resistant to the rice tungro virus. One of the early stages of plant breeding in search for varieties that are resistant to plant pest organisms is to increase the variability of genetic traits. The resistance of the variety is specific to the tungro virus variant and vector colonies which means that a variety shows a resistant reaction to tungro virus variants and vector colonies in certain areas but is not necessarily resistant to tungro virus variants and vector colonies in other areas. This indicates that there is variation in tungro virus virulence and vector colony diversity from different regions. So far, the incidence of tungro is often found in the same variety in several areas, even though these varieties do not have genes for resistance to tungro viruses or vectors.

Tungro control using resistant varieties must be adapted to variations in virulence of tungro virus and vector colonies, so availability and zoning in the distribution of resistant varieties are required (Praptana et al., 2013). The steps taken are by combining resistant genes with high-yielding potential genes through hybridization. Assembling resistant vector varieties can be done through introgression and pyramidization of resistant genes to increase the durability of their resistance (Wang et al., 2004). Conventional breeding through crosses between donor parents of resistant traits, both vector-resistant and tungro virus-resistant, with varieties that have good agronomic characteristics are expected to obtain resistant varieties to expand resistance diversity and extend durability of resistance. (Praptana et al., 2013). The populations of the crossbred lines were tested for their resistance to the tungro disease for several generations. The lines that showed resistance were evaluated for their yield potential, and other advantages such as resistance to other pests.

The problem with using green leafhopper-resistant varieties is that their resistance is less durable, because the virulence of the tungro virus

---

Corresponding author:
Mansur (mansurfairus@gmail.com)

Tungro Disease Research Center, Jl. Bulo No.101, Lanrang, Sidrap, South Sulawesi, Indonesia 91651

against rice varieties varies widely (Widiarta et al., 1999). Therefore, genetic diversity of resistance of rice varieties to tungro vectors and viruses is needed as an effort to extend the resistance period of varieties to tungro disease (Muliadi et al., 2014). According to Suprihanto et al. (2016), the resistance from the source lines to the tungro disease can be seen based on the severity of tungro disease. The grouping of resistant, from moderate to susceptible plants, from the group of pathogens caused by viruses, is generally based on the percentage of a population of infected strains, this avoids differences in the researchers' judgment in assessing the nature of resistance of virus-infected plants.

The development of tungro disease is slower in certain lines compared to other lines, due to the ability of plants to prevent the infection process or limit the colonization of viral pathogens. If the host is able to limit the infection process and the tungro virus develops, its resistance will be shown by the absence of symptoms. Conversely, if the host is unable to limit the infection process, the plant will become stunted and the leaves will change color (Hasanuddin, 2009). The discovery of tungro-resistant test lines from endemic areas with high stress gives hope of finding potential varieties that have a high duration of resistance and are adaptive in several locations. Superior varieties that have stable resistance to tungro can prevent widespread tungro attacks. The use of tungro resistant varieties is the most effective way to control tungro disease. Increasing the use of resistant varieties in an area has a significant effect on reducing the intensity of tungro in the field (Mansur et al., 2011).

Daradjat et al. (2004) stated that the development of tungro-resistant varieties continues to be carried out in Indonesia, both through strategies for resistance to green leafhoppers and tungro viruses. Sources of rice resistance to green leafhoppers have been identified as many as 13 resistant genes, four of which are named Glh 1, Glh 2, Glh 4 and Glh 5 have been used for the preparation of resistance traits of new high yielding varieties. The epidemic of tungro disease is influenced by genetic uniformity of varieties over a very wide expanse with the same environmental conditions. The presence of varieties with the same resistance gene will accelerate the selection pressure of green leafhoppers and the occurrence of tungro virus mutations. The epidemic of tungro disease is also influenced by plant stadia, inoculum source stadia and infective green leafhopper population. The younger the plants and the availability of young plants in the field will accelerate the occurrence of epidemics, for example in areas with asynchronous cropping patterns there will always be young plants so that the transmission of tungro virus will occur continuously (Praptana et al., 2013).

Sources of rice resistance to the tungro virus have been identified in 11 assessments, namely Acc 16680, Acc 16682, Acc 16684, Acc 21473, Acc 124281, Acc 22176, Acc 12437, Acc 26527, Acc 5346, Acc 16602, and ARC 7140 (Daradjat et al., 2004). The discovery of several cases of slower disease development in certain varieties compared to other varieties is based on the ability of the plants in preventing the infection process or limiting the colonization of viral pathogens (Praptana et al., 2005). If the host is able to limit the infection process and the virus is unable to develop, then its resistance is expressed by the absence of symptoms, as well as the low number of infected individuals in a population of strains that have homogeneous characters. On the other hand, if the host is unable to limit the infection process, the plant will become stunted and the leaves will change color (Praptana et al., 2005). Symptoms of the virus that are expressed by the occurrence of changes in leaf color are a result of phloem necrosis and the occurrence of starch translocation disorders, due to inhibition of enzyme work (Stajner et al., 2019). Assembling resistant varieties from sources of tungro-resistant parents with preferred varieties in an area needs to be done to obtain site-specific resistant varieties that can reduce tungro attacks and support variety rotation (Praptana et al., 2005). The main purpose of this research was to cross-check whether the lines from the screening research have resistance in the field and to obtain some observed lines that are truly resistant to the tungro virus and have high yield potential.

MATERIALS AND METHODS

Research Site. The study was conducted in the experimental farm of the Tungro Disease Research Station, Sidrap Regency, South Sulawesi, Indonesia at -3°50'56",119° 49'30",95.0m,118°, in the second planting season (June−September 2020).

Genetic Material and Experimental Design. A total 14 rice lines: (STLRG17-15-LR-1, STLRG17-15-LR-2, STLRG17-25-LR-1, STLRG17-26-LR-2, STLRG17-28-LR-1, STLRG17-60-LR-2, STLRG17-51-LR-1, STLRG17-51-LR-2, STLRG17-103-LR-1, STLRG17-103-LR-2, STLRG17-107-LR-1, STLRG17-108-LR-1, STLRG17-175-LR-1, and STLRG17-176-LR-2) were evaluated for their resistance to the tungro disease and other morphological characteristics with comparison varieties which are Tukad Petanu, Tukad Balian, Inpari 8, and Tukad Unda. The rice lines were planted in an augmented design consisting of five blocks, each block (35 m²) contains three test lines and four comparison varieties (Tukad Petanu, Tukad Balian, Inpari 8, and Tukad Unda). Each line was planted in plots (1 × 5 m), with a spacing of 25 × 25 cm.

Population of Green Leafhopper. Observations on the population of green leafhoppers were carried out using insect nets (Kumar et al., 2019) as much as 10 double swings per observation plot, then the catch was put into the observation box and then the population of green leafhoppers was calculated in the nymph and imago phases, observations were made 20 days after planting and 30 days after planting.

Productive Tillers. Productive tillers were observed when the plants were 90 days after planting by counting the number of plants that produced panicles.

Flowering Age. The flowering age of the test lines was calculated from the time of seedling until the plants had produced flowers or 50% rice panicles on the test plants.

Weight of 1000 Grains. Thousand grain weight (TGW) is an important parameter for the evaluation of grain yield (Wenhua et al., 2018). The traditional measurement method relies on manual steps: weighting and counting used Analitic Grain seed counter. The weight of 1000 grains of rice is divided into 3 categories, namely: weight of 1000 seeds small if less than 20 g; medium size between 20–25 g; for large sizes more than 25 g.

Grain moisture and yield kg/ha measurement was used Gwon Grain Moisture when the new grain was harvested. The yields in each test plot were then weighed per plot and expressed in kg/ha.

Data Analysis. The data obtained were analyzed based on Augmented design, if the difference is significant, the Duncan test will continue (Steel & Torie, 1995) and (Baihaki, 2000).

RESULTS AND DISCUSSION

The observations on the green leafhopper vector population at 20 DAP (Day After Planting) and 30 DAP showed that the adult green leafhopper population caught ranged from 1–95 individuals per line/variety plot, while the nymph population ranged from 1–19 individuals per line/variety plot. The population in the field was dominated by the adults, with the highest population found at 20 DAP, the condition was suspected to be caused by migrating insects from other crops because the surrounding plantations had entered the generative phase and were expected to enter the peak of the population, then the population seemed to tend to decline again at 30 DAP. The existence of the population is closely related to its activity in the field where the adult insect activity pattern from the asynchronous cropping pattern is more actively dispersed than the simultaneous cropping pattern (Said & Adnan, 2008).

The condition of the population in the field was also influenced by cropping patterns such as the triple-rice which showed an increase in the population of green leafhoppers after the next generation of immigrants came. The population decreases again when entering the generative cropping phase, the population will be low for all forms of cropping patterns (Widiarta et al., 1999).

The existence of green planthopper populations in each test line and comparison varieties showed that green leafhoppers were able to adapt and develop well in each line and comparison variety. The population density of green leafhoppers illustrated that green leafhoppers did not have a particular preference for one or several lines nor certain varieties, this condition could be seen from the distribution of green leafhoppers in each test line and comparison varieties. Green leafhoppers were able to move from plant to plant, especially in younger plants, in the process of finding food and a suitable place for laying their eggs (Figure 1).

Symptoms of the tungro damages in the field occurred at 20 DAP and 30 DAP observations with damages ranging from 1.3 to 11.3% in three test lines mention in Figure 2, namely STLRG17-15-LR-1, STLRG17-15-LR-2, and STLRG17-108-LR-1. The highest incidence of the tungro virus was found in the test line STLRG17-15-LR-1, while the comparison varieties did not show signs of tungro symptoms (Figure 2).

This condition was possible because the Tukad Unda and Tukad Petanu varieties as the comparison resistant varieties were resistant lines to the tungro disease and were still recommended to be planted in South Sulawesi (Widiarta et al., 2003). The occurrences of tungro disease in the test lines were influenced by the level of virus virulence, active transmitting insects, and the support for the population density of green leafhoppers. Observations at 20 and 30 DAP showed that the population of green leafhoppers was very high and spread throughout the test lines and comparison varieties so that it greatly affected the resistance response and it was possible for the incidence of the tungro disease to occur in lines that were not resistant to the tungro virus. Therefore, the use of tungro-resistant varieties has a significant effect on reducing the intensity of tungro damages in the field (Hasanuddin, 2009).

The flowering age of 50% of the test lines was faster than the comparison varieties. There were five test lines, including STLRG17-15-LR-1, STLRG17-26-LR-2, STLRG17-15-LR-2, STLRG17-103-LR-1, and STLRG17-107-LR-1 had a shorter flowering age than the flowering age of all comparison varieties, 85–87 DAP (Figure 3).

Plant heights ranged from 96.3–135.1 cm, but there were four lines that were shorter than the compared varieties (96.3 cm–109.1 cm), which were STLRG17-15-LR-1, STLRG17- 15-LR-2, STLRG17-103-LR-1, and STLRG17-103-LR-2 (Figure 4).

Meanwhile, Figure 5 showed that for productive tillers, there were two test lines that exceeded the productive tillers of the comparison variety, Tukad

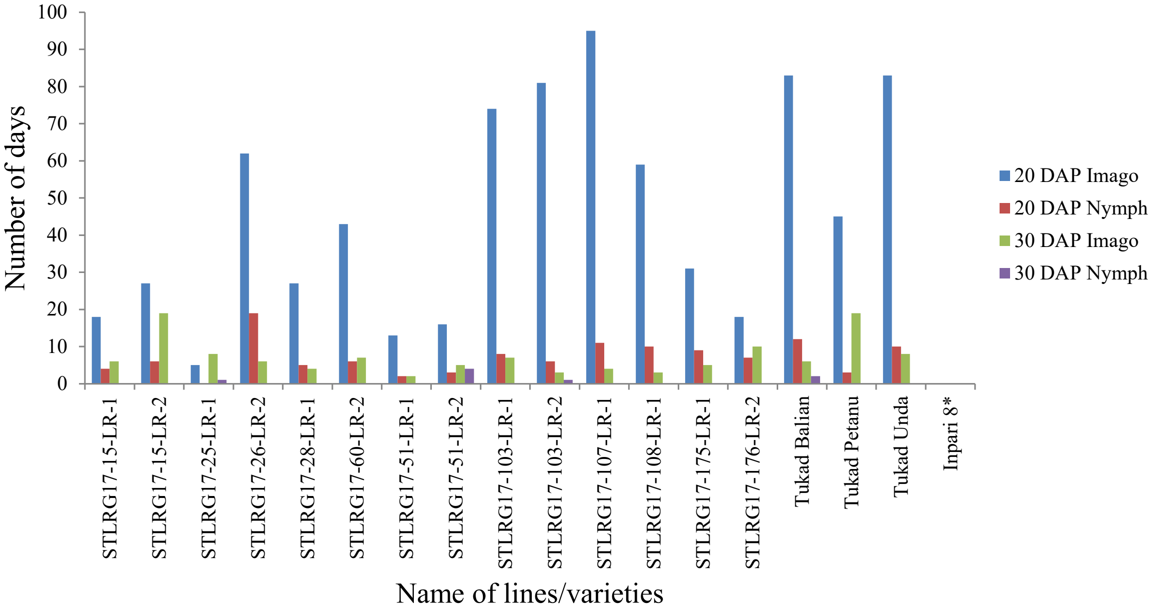

Figure 1. Population density of green leafhoppers at 20 DAP and 30 DAP in tungro virus-resistant rice test lines at the experimental farm of Tungro Disease research Station Lanrang, South Sulawesi.

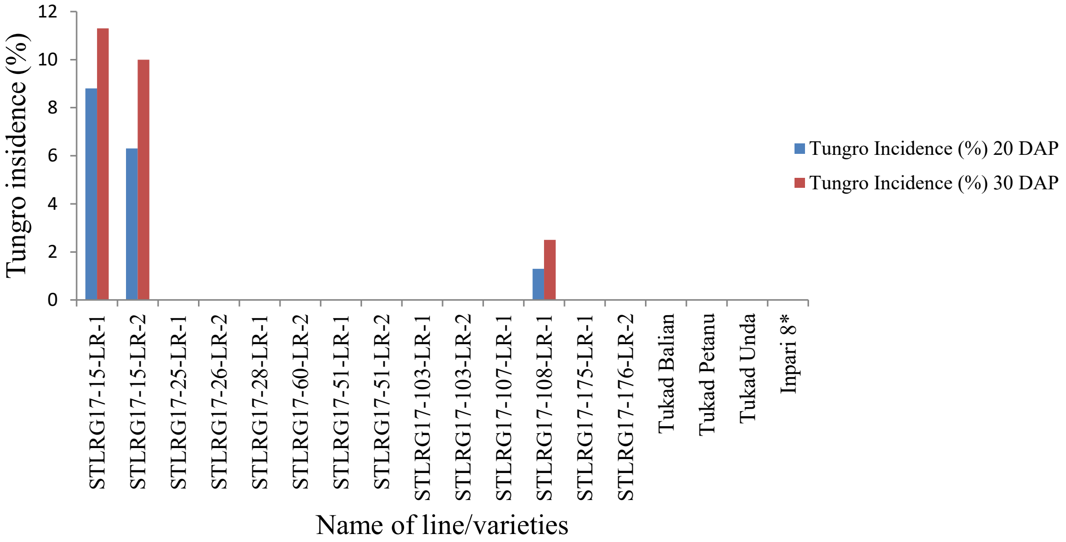

Figure 2. Incidence of tungro at 20 DAP and 30 DAP in test lines of tungro virus-resistant rice at the experimental farm of Tungro Disease research Station Lanrang, South Sulawesi.

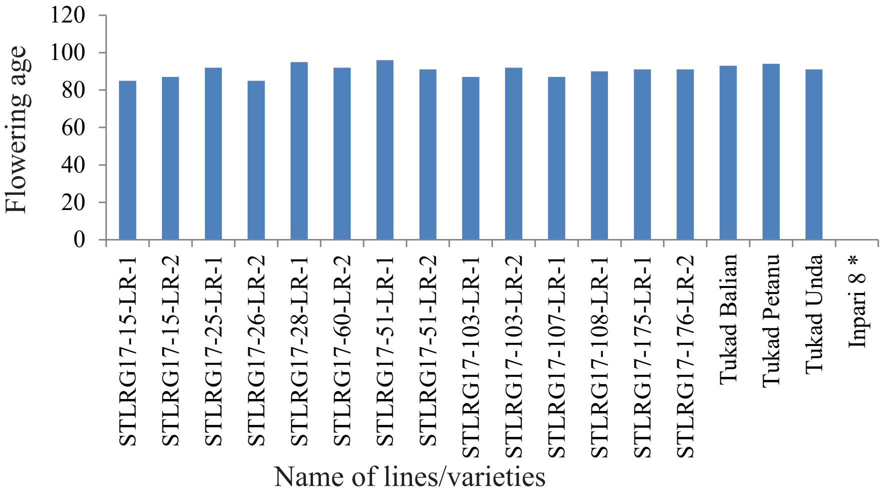

Figure 3. About 50% flowering age (DAT) in test lines of tungro virus-resistant rice at the experimental farm of Tungro Disease research Station Lanrang, South Sulawesi.

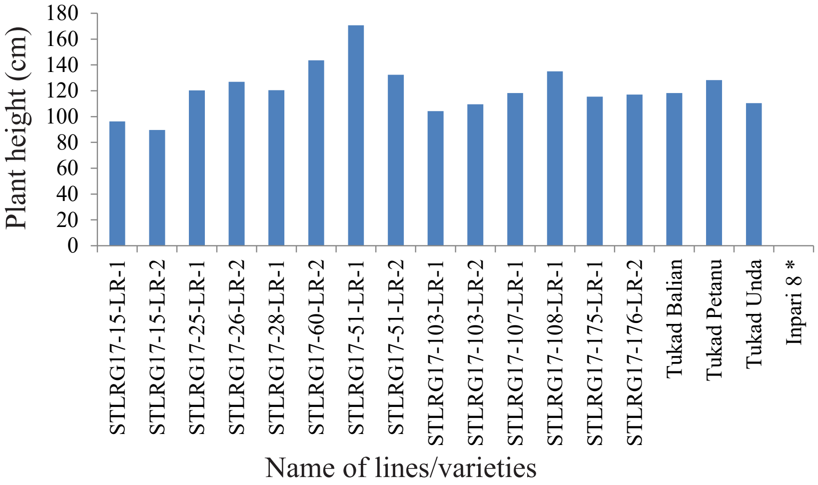

Figure 4. Plant height in test lines of tungro virus-resistant rice at the experimental farm of Tungro Disease research Station Lanrang, South Sulawesi.

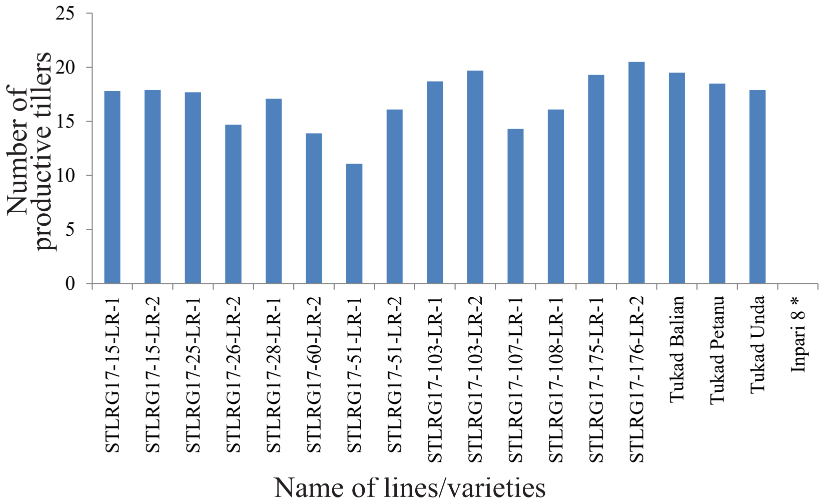

Figure 5. Productive tillers in test lines of tungro virus-resistant rice at the experimental farm of Tungro Disease research Station Lanrang, South Sulawesi.

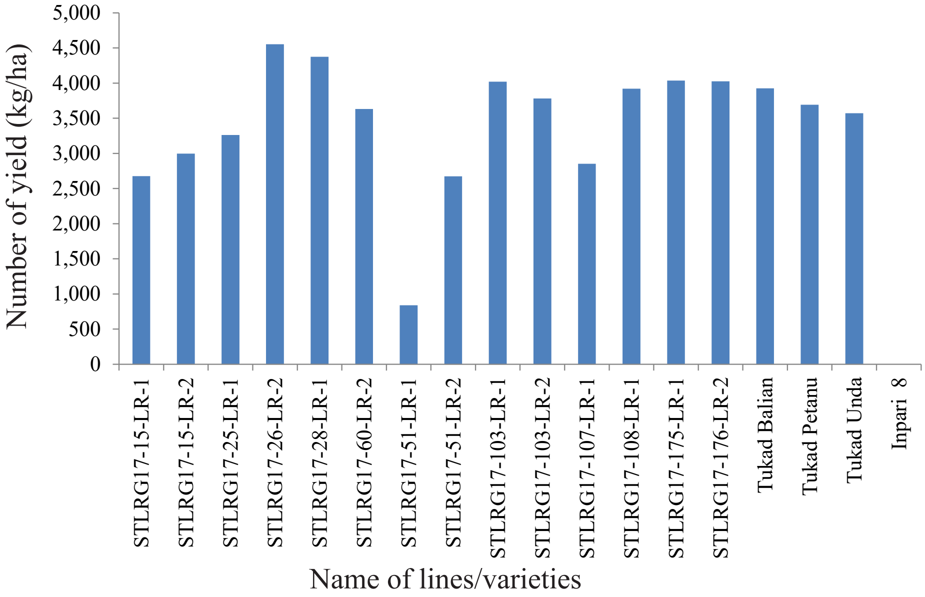

Figure 6. Yield in test lines of tungro virus-resistant rice (kg/ha) at the experimental farm of Tungro Disease research Station Lanrang, South Sulawesi

Balian (19.5), namely STLRG17-103-LR-2, and STLRG17-176-LR-2.

The yield of the test lines in Figure 6 ranged from 840.1–4553.5 kg/ha. There were five lines that had better yield potential than the comparison varieties, namely STLRG17-103-LR-1, STLRG17-176-LR-2, STLRG17-175-LR-1, STLRG17-28-LR-1, and STLRG17-26-LR-2 with an average yield of 4021 kg/ha. The highest 1000 seed weight was found in the STLRG17-176-LR-2 line (25.1 g) and the lowest was STLRG17-51-LR-1 (17.6 g).

The lines infected with the tungro virus had relatively low yield productivity, because they damaged plant cells and tissues so that they were stunted and the plant's metabolic system was disrupted. If rice is attacked by tungro, it is not able to recover, it will die. On the other hand, lines that were resistant to tungro virus attack will have good vegetative growth, have a lot of productive tillers and will produce high yields.

CONCLUSION

This study revealed that there were five lines that had favorable and consistent performance comprised of their weight of 1000 seeds, higher yields, productive tillers, plant height, and resistance to the tungro disease than the compared varieties, namely STLRG17-175-LR-1, STLRG17- 176-LR-2, STLRG17 -175-LR-1, STLRG17-28-LR-1, and STLRG17-26-LR-2. Fifth test lines are recommended for further testing.

ACKNOWLEDGMENTS

Thank you to the field technicians who have helped carry out the research at the experimental farm of Tungro Disease research Station.

FUNDING

Our research funding sources that support these activities come from the state budget for Tungro Disease Research Center, Center for Research and Development of Food Crops, Agency for Research and Development of Food Crops, Ministry of Agriculture in 2020.

AUTHORS' CONTRIBUTIONS

AM (initial name) considered and planned the experiment. M and AM carried out the research fild test including rearing of Nephotettix vierescens and Tungro's dissease test. M performed field test and collect data with AM. M was collected data on the plant damage area caused by Nephotettix vierescens, vegetative and generative fase's data as well as weather data. AM performing analysis and interpreting the plant damage and weather data. M and AM prepared the manuscript. The authors provided response and comments on the research flow, data analysis and interpretation as well as shape of the manuscript. All the authors have read and approved the final manuscript.

COMPETING INTERESTS

As authors we declare there is no competing interest regarding our publication. There is no competing interest such as financial or non-financial interests, professional or personal relationships that are directly or indirectly connected to the work submitted for publication.

REFERENCES

Baihaki A. 2000. *Teknik Rancang dan Analisis Penelitian Pemuliaan* [*Research Design and Data Analysis of Breeding*]. Fakultas Pertanian, Universitas Padjajaran. Bandung.

Daradjat AA, Widiarta IN, & Jumanto. 2004. Prospek perbaikan varietas tahan virus tungro dan wereng hijau [Prospects of improvement of varieties resistant to tungro virus and green leafhoppers]. In: Hasanuddin A, Widiarta IN, & Sunihardi (Eds). *Proceedings of the National Seminar on the Status of the Tungro Research Program Supporting the Sustainability of National Rice Production.* pp. 23−35. Cereal Crops Research Institute, Makassar.

Hasanuddin A. 2009. *Status tungro di Indonesia Penelitian dan Strategi Manajemen Masa Depan* [*Status of tungro in Indonesia Research and Future Management Strategies. Retirement Oration Papers*]. Center for Food Crops Research and Development. Bogor.

Kumar G, Jyothsna M, Valarmathi P, Roy S, Banerjee A, Tarafdar J, Senapati BK, Robin S, Manonmani S, Rabindran R, & Dasgupta I. 2019. Assessment of resistance to rice tungro disease in popular rice varieties in India by introgression of a transgene against Rice tungro bacilliform virus. *Arch. Virol.* 164(4): 1005−1013. https://doi.org/10.1007/s00705-019-04159-3

Mansur, Pakki S,Tando E, & Oktavia Y. 2011. Uji ketahanan galur-galur padi terhadap penyakit tungro di daerah endemic [Resistance test of rice lines against tungro disease in endemic area]. *Prosiding Seminar Nasional BPTP Bengkulu*. https://bengkulu.litbang.pertanian.go.id/eng/images/dokumen/tanaman-pangan/mansur.pdf. Accessed 18 September 2021.

Muliadi A, Nasrullah, Sumardiyono YB, & Trisyono YA. 2014. Kendali ketahanan genetik padi terhadap penyakit tungro [Genetic control of rice resistant to tungro disease]. *JPPTP*. 33(2): 87−92. http://dx.doi.org/10.21082/jpptp.v33n2.2014.p87-92

Praptana RH, Ladja FT, Muliadi, Bastian A, & Burhanuddin A. 2005. Kesesuaian tetua padi tahan virus tungro [Compatibility of parental rice varieties resistant to tungro]. *Diklat Fungsional Peneliti Tingkat Pertama Angkatan XVII.*

Praptana RH & Muliadi A. 2013. Durabilitas ketahanan varietas padi terhadap penyakit tungro [Varietal resistance durability on rice against tungro viruses]. *Jurnal Iptek Tanaman Pangan*. 8(1): 15−21.

Suprihanto, Susamto S, Sedyo H, & Trisyono YA. 2016. Preferensi wereng batang coklat terhadap varietas padi dan ketahanan varietas padi terhadap virus kerdil hampa [Brown planthopper preference to rice varieties and the resistance of rice varieties to rice ragged stunt virus]. *JPPTP.* 35(1): 1−8. http://dx.doi.org/10.21082/jpptp.v35n1.2016.p1-8

Stajner N, Radisek S, Mishra AK, Nath VN, Matousek J, & Jakse J. 2019. Evalluation of dissease severity and gloval transcriptome response included by Citrus bark cracking viroid, hop latent viroid, and their co-infection in Hop (*Humullus lupulus* L.). *Int. J. Mol. Sci*. 20(13): 3154. https://doi.org/10.3390/ijms20133154

Said YM & Adnan AM. 2008. Tersedianya teknologi pengendalian penyakit tungro dan pemanfaatannyaoleh petani [Availability of tungro disease control technology and its utilization by farmers]. In: Widiarta IN, Said Y, & Sunihardi (Eds.). *Proceedings of the National Seminar on Tungro Disease Control Strategy to Support Increased Rice Production*. pp. 82–89. Center for Food Crops Research and Development. Agricultural Research and Development Agency, Makassar.

Steel RGD & Torrie JH. 1995. *Prinsip dan Prosedur Statistika* [*Principles and Procedures of Statistics*]. PT. Gramedia Pustaka Utama, Jakarta.

Wang C, Yasui Y, Yoshimura A, Zhai H, & Wan J. 2004. Inheritance and QTL mapping of antibiosis to green leafhopper in rice. *Crop Science.* 44(2): 389–393. https://doi.org/10.2135/

cropsci2004.3890

Wenhua W, Zhou L, Chen J, Qiu Z, & He Y. 2018. GainTKW: A measurement system of thousand kernel weight based on the android platform. *Agronomy.* 8(9): 178. https://doi.org/10.3390/agronomy8090178

Widiarta IN, Yulianto, & Hasanuddin A. 2003. Pengendalian terpadu penyakit tungro dengan strategi menghilangkan peran virus bulat [Integrated control of tungro disease with the strategy of eliminating the role of round virus]. In: Suprihatno B, Makarim AK, Widiarta IN, Hermanto, & Yahya AS (Eds.). *Rice Policy and Rice Technology Innovation.* pp. 513–527. Research and Development Center. Balitpa.

Widiarta IN, Kusdiaman D, & Hasanuddin A. 1999. Dinamika populasi *Nephotettix virescens* pada dua pola tanam padi sawah [Population dynamics of *Nephotettix virescens* in two rice planting patterns]. *JPTI.* 5(1): 42−49.