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RESEARCH PAPER

Evaluation of tungro-resistant lines based on tungro disease severity and agronomic characteristics

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ABSTRACT

Tungro disease severity and agronomic characteristics of tungro-resistant lines. Tungro is one of the diseases problem in rice production. The simplest approach to solve the problem is to use the resistance tungro variety, which is made of tungro resistance lines. At present, the character of the new type of rice becomes a preference by the formation of a variety. The line with the character of Agronomy is a decisive factor in the choice of a variety by farmers. The aim of this study was to evaluate the potential tungro resistant lines according to severity and agronomy. The research was carried out in the dry season of 2015 in Polewali Mandar, West Sulawesi. Fifty promising tungro lines and four reference varieties were tested using the Augmented Design with five blocks as replicates. Variables observed were green leafhopper population density and the presence of tungro disease. Agronomic character variables observed included clump shape, productive tiller at 90 DAT, flowering age 50%, the weight of 1000 grains, filled and unfilled grain, and grain yield of kg/ha. The results showed that there were several lines that had significantly higher yield potential , i.e. BP3734A-3-15-LRG-5-8-2-5, BP3770A-1-218-LRG-2-3-1-9, BP3840A-6-253-LRG-8-6-2-8, BP3862A-21-1054-LRG-5-1-1-6, BP3866A-4-1207-LRG-9-3-2-7, BP3870A-4-1357-LRG-2-3-1-7 and BP3870A-4-1363-LRG-8-1-1-7. All of these lines have the potential to be processed to the next phase.

Key words: green leafhopper, population, promising lines, rice, tungro-resistant lines

INTRODUCTION

Tungro disease is one of the main problems in rice production, especially in disease-endemic areas such as South Sulawesi and West Sulawesi. Polewali Mandar has been reported as the center of rice production in West Sulawesi and one of the tungro endemic areas along with Sidrap, Pinrang and Luwu regencies (Burhanuddin et al., 2006; Praptana et al., 2013).

Tungro was caused by a complex infection of two types of viruses (Burhanuddin, 2008). Tungro viruses are spiral-shaped (RTSV) and bacillus-shaped (RTBV) and transmitted by green leafhoppers (*Niphotetix virescens*) semi-persistent (Hibino & Cabunagan, 1986). The tungro virus causes symptoms that can be easily recognized such as stunted plants, the color changes in young leaves to yellow-orange starting from the tip of the leaf, young leaves curl, and the number of tillers is reduced (Ladja & Pakki, 2010). The disease has been reported to cause a decrease in productivity and can even cause crop failure (Ladja & Widiarta, 2012). The three main causes of tungro transmission are the availability of a source of viral inoculum, the presence of infectious insects, and sensitive plants (Praptana & Yasin, 2008).

The use of tungro-resistant varieties is the most effective way of controlling tungro (Hasanuddin, 2008). Efforts to control tungro disease have been carried out and a number of resistant lines/varieties have also been obtained. In Indonesia, research on tungro disease has been widely carried out. Muliadi et al. (2015) reported three best lines comparative to the comparator varieties of the six tested varieties, among others i.e OBSTG02-137, OBSTG02-124, OBSTG02-154, and OBSTG02-130. Asrori et al. (2014) tests on several lines and general varieties resulted in the Inpari 13 variety classified as resistant varieties as a result of testing in the greenhouse. Rosida et al. (2013) described the resistance of the lines to tungro disease and produced nine resistant strains in two different locations. However, there are still insufficient studies on the resistance of rice varieties/lines to tungro disease in relation to the agronomic character of the plant.

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So far, the establishment of superior varieties in Indonesia is orientated to the IRRI (International Rice Research Institute) program as the International Rice Research Institute. In 1989, IRRI designed and assembled rice with a new architecture which was later known as the new plant type of rice (NPT) or new type of rice (NTR) (Abdullah et al., 2008). NTR has important characteristics such as few productive tillers (8−10 stems), dense panicles (200−250 grains/panicle) and pithy, medium plant height (80−100 cm), upright leaves, thick and dark green, medium age (110−130 days). Rice varieties must also have the traits that farmers expect, such as pest resistance and disease primary, and shortage (Suprihatno et al., 2009).

In this study, 50 tungro resistant rice lines constructed by Indonesian Centre for Rice Research were investigated on their resistant level and agronomic characteristics. The 50 lines used in this study were the selected lines from disease resistance screening test for tungro disease for four seasons in tungro station in Lanrang South Sulawesi. However, these 50 tungro disease resistance lines need to be evaluated to confirm their superior characteristics, especially on their susceptibility to the infection of tungro virus, green leafhopper (known as vector of tungro virus) and their agronomic characters.

MATERIALS AND METHODS

Research Site. The research was carried out at Polewali Mandar, West Sulawesi at dry season.

Inoculation Method and Field Design. The inoculation method was natural inoculation, considering that the research location is an endemic area of tungro. This experiment used an augmented design, consisting of five blocks. Each block consisted of 10 test lines and four comparator varieties. So, there were 70 experimental plots in total. Blocks were used as comparators for the IR 64, Ciherang, Inpari 9, and Tukad Unda varieties.

Tungro-Resistant Rice Lines. A total of 50 tungro-resistant lines that passed the screening test were evaluated for susceptibility to infection of tungro virus also green leafhopper (vector of tungro virus) and their agronomic characters. Four varieties commonly cultivated by farmers were also included for comparator, namely IR 64, Ciherang, Inpari 9, and Tukad Unda. Seeds from each line and control variety were tested in rows/plots with a size of 1 × 5 m, with a spacing of 25 × 25 cm, and 50 cm between rows.

Fertilization and Plant Maintenance. The first fertilization was applied 10 days after transplanting (DAT). The fertilizer contains nitrogen, phosphorus, kalium and sulfur with a dose of 300 kg/ha (main elements N, P, K in a ratio of 15% nitrogen, 15% phosphorus, 15% potassium) and 100 kg/ha Urea. The second fertilization was applied on 40 DAT with a dose of 100 kg/ha Urea. Plant maintenance was carried out regularly by regulating the availability of water and weeding.

Population of Green Leafhopper (GLH) and Disease Incidence of Tungro. Population density of the tungro vector (green leafhopper) was observed by the sweep net method with ten double-swings. The GLH were collected from each tungro-resistant line and placed into a 1-L plastic jar containing chloroform saturated in a cotton ball to knock down the leafhoppers. The leafhoppers were sorted, identified, and counted in the laboratory. The presence of tungro disease was observed by counting the number of individual plants infected with tungro. Both observations were conducted at 15, 30, 45, and 60 DAT. The disease incidence was calculated using criteria according to SES (IRRI, 2013), i.e. 1= no symptoms; 3= plant height is shorter by 1–10%, leaf color changes from yellow to unreal yellow orange; 5= plant height 11–30% shorter, change in leaf color from yellow to unreal yellow-orange; 7= plant height 31–50% shorter, change in leaf color from yellow to real orange-yellow; 9= shorter plant height >50%, change in leaf color from yellow to real orange-yellow.

Agronomic Characteristics. Observations on the agronomic characters was performed on (a) clump shape, (b) productive tillers at 90 DAT, (c) 50% flowering age, (d) 1000 grain weight, (e) filled grain/clump (f) empty/clump, and (g) grain yield kg/ha. Observation of the shape of the clump was carried out during the vegetative period before entering the flowering phase (60 DAT). Observations of productive tillers were carried out during the generative period (90 DAT), the flowering age after entering the generative phase of flowering was around 50%. The weight of 1000 grains was performed by calculating filled grain and empty grain per clump. Each sample was collected from the five clumps per clump plot. The grain yield variables were carried out by harvesting each plot by leaving the plant border.

Data Analysis. The data were analyzed by ANOVA to determine the significance of the treatment on the

observed parameters using the SAS 9.1 application and further testing with LSI. Furthermore, the results of the control data analysis were used as the basis for the comparison test to determine the comparison of the mean line value with the control mean value (IRRI, 2003) using the LSI (Least Significant Increase) method.

RESULTS AND DISCUSSION

The anova of comparator varieties showed that block (on augmented design) had the variety result, and it became a reference for fifty lines. In the augmented design, replications were only found in the comparator varieties, while the test lines were not repeated in blocks. On the population character of GLH insects, the incidence of tungro and agronomic characters observations were conducted in all experimental units

Green Leafhopper Population and Disease Incidence of Tungro. Population density of GLH and disease incidence of tungro showed a variety of results when its analysis used Anova. The GLH population in four observations was not different. Meanwhile, the disease severity of tungro showed a statistical difference in the second and fourth observations (Table 1).

The number of infected plants and population of GLH were at a low level. The average disease incidence of tungro was 0.5%. The highest population of GLH was observed on 60 DAT (4th observation) and 30 DAT (2nd observation), respectively, 3.2 GLH/ sweep net and 2.3 GLH/sweep net.

The highest population of GLH was found in line BP3862A-16-1005-LRG-4-3-1-9 (8 GLH on 2nd observation and 14 GLH on 4th observation) (Table 2).

From the observations that showed the highest population of green leafhoppers, there was a consistent line showing a high population of leafhoppers compared to other lines and against all resistant comparator varieties (with found more than 5 populations) were in lines BP3846A-7-425-LRG-10-3-1-9, BP3862A-16-1005-LRG-4-3-1-9, BP3862A-18-1026-LRG-7-10 -1-7 and BP3862A-19-1037-LRG-8-1-1-8. In fact for the average result

This indicates that the line has the potential to become a host of GLH or GLH has adapted, so it has no potential to be selected. The condition of the plant is trusted to affect the level of preference for green leafhoppers. The colony of GLH is considered to adapt to a certain resistance gene if these parameters on the cultivar carrying the gene are not significantly different from those on a cultivar without a resistance gene, such as TN-1 (Rosida et al., 2020).

Incidence of tungro in all lines ranges between 0–7% in all observations. A high incidence of tungro was found in the second observation (30 DAT) and third observation (45 DAT) at 1.4% and 1.5%. The observations result showed nineteen lines of the 50 tested lines were better than Inpari 9 as the resistant comparator variety and also to all comparator varieties. All of the comparator varieties were infected by tungro 0–5% on average. At leas, there were eleven lines not infected by tungro namely BP3762A-5-149-LRG-1-5-1-8, BP3846A-7-425-LRG-10-3-1- 9, BP3860A-2-842-LRG-1-6-1-7, BP3860A-2-842-LRG-1-9-1-7, BP3862A-21-1054-LRG-5-1-1-6, BP3864A-6-1131-LRG-2-5-1-8, BP3866A-3-1193-LRG-5-5-2-3, BP3866A-5-1213-LRG-5-2-1-7, BP3866A- 5-1219-LRG-1-3-2-4, BP3870A-7-1387-LRG-2-1-1-7, and BP3872A-1-1396-LRG-1-2-2-7.

During the observation time, We found some plants in the recovery process. It indicates disease

Table 1. Recapitulation ANOVA analysis of GLH population from control varieties in all observation

Observation time	MS Variety	Error	Effect of Variety	CV (%)
GLH Population				
I	0.18	0.53	ns	131.7
II	5.73	4.60	ns	82.5
III	2.45	1.10	ns	110.4
IV	9.78	9.08	ns	62.1
Tungro Incidence				
I	0.13	0.18	ns	209.2
II	40.20	3.53	**	75.1
III	1.25	2.45	ns	53.1
IV	6.60	1.38	*	130.29

ns = non signifikan ** = different in 0.01% * = different in 0.05%.

Table 2. Population intensity of green leafhoppers and tungro attack on tungro-resistant rice hope lines in Polewali Mandar

Lines/Variety	Population of GLH (DAT) (individu)				Mean	Disease incidence of tungro (DAT) (%)				Mean
	15	30	45	60		15	30	45	60	
BP3734A-3-15-LRG-5-8-2-5	0	7	0	1	2.0	0	0	0	2a	0.5
BP3736A-1-43-LRG-3-7-1-10	1	3	0	1	1.3	0	1	5	3b	2.3
BP3742A-3-97-LRG-8-6-2-8	0	0	2	7	2.3	0	1	2	2a	1.3
BP3744A-1-100-LRG-2-1-2-6	0	1	4	1	1.5	0	2	1	4b	1.8
BP3744A-1-104-LRG-5-2-1-7	0	2	0	6	2.0	0	0	2	1a	0.8
BP3744A-2-110-LRG-1-1-2-6	1	1	2	1	1.3	0	3	5	0cd	2.0
BP3762A-5-149-LRG-1-5-1-8	0	3	0	4	1.8	0	0	0	0cd	0.0
BP3762A-5-157-LRG-9-1-2-9	0	2	0	4	1.5	0	2	0	1a	0.8
BP3764A-3-185-LRG-8-5-1-8	0	1	0	0	0.3	0	2	1	0cd	0.8
BP3768A-2-214-LRG-8-10-2-7	0	0	2	0	0.5	0	2	0	0cd	0.5
BP3768A-2-214-LRG-8-10-2-7	0	3	3	0	1.5	0	1	2	0cd	0.8
BP3770A-1-218-LRG-2-3-1-9	1	1	1	2	1.3	0	3	2	0cd	1.3
BP3770A-1-219-LRG-3-5-2-8	0	2	2	6	2.5	0	2	2	0cd	1.0
BP3770A-2-234-LRG-8-1-1-9	2	4	1	2	2.3	0	4	0	0cd	1.0
BP3840A-6-253-LRG-8-6-2-8	2	5	1	6	3.5	0	0	0	0cd	0.0
BP3846A-8-428-LRG-3-3-2-6	3	3	0	0	1.5	0	6	2	2b	2.5
BP3856A-2-743-LRG-9-6-2-6	1	1	2	0	1.0	0	0	3	0cd	0.8
BP3860A-2-842-LRG-1-1-1-7	0	4	1	0	1.3	1	1	0	3b	1.3
BP3860A-2-842-LRG-1-6-1-7	3	1	3	2	2.3	0	0	0	0cd	0.0
BP3860A-2-842-LRG-1-9-1-7	4	0	1	0	1.3	0	0	0	0cd	0.0
BP3860A-4-853-LRG-2-1-1-7	1	4	2	1	2.0	0	2	0	1a	0.8
BP3862A-8-938-LRG-7-1-1-9	3	4	2	7	4.0	0	2	4	2b	2.0
BP3862A-15-999-LRG-8-1-1-8	2	2	0	8	3.0	1	2	2	0cd	1.3
BP3862A-16-1005-LRG-4-3-1-9	1	8	3	14	6.5	1	4	4	1a	2.5
BP3862A-18-1026-LRG-7-10-1-7	0	6	2	5	3.3	0	4	3	0cd	1.8
BP3862A-19-1037-LRG-8-1-1-8	0	5	0	7	3.0	0	0	1	0cd	0.3
BP3862A-21-1054-LRG-5-1-1-6	0	0	2	2	1.0	0	0	0	0cd	0.0
BP3862A-23-1078-LRG-9-6-2-7	0	2	0	6	2.0	1	1	2	0cd	1.0
BP3864A-6-1131-LRG-2-5-1-8	0	0	1	8	2.3	0	0	0	0cd	0.0
BP3864A-7-1146-LRG-7-6-2-6	0	1	0	2	0.8	0	2	0	0cd	0.5
BP3864A-8-1151-LRG-3-7-2-8	1	2	2	3	2.0	0	0	1	1a	0.5
BP3866A-1-1175-LRG-7-3-2-7	0	1	0	2	0.8	0	0	4	1a	1.3
BP3866A-3-1193-LRG-5-5-2-3	2	2	1	2	1.8	0	0	0	0cd	0.0
BP3866A-4-1200-LRG-2-5-2-7	1	2	1	3	1.8	0	2	2	0cd	1.0
BP3866A-4-1207-LRG-9-3-2-7	3	4	1	2	2.5	0	1	2	0cd	0.8
BP3866A-5-1211-LRG-3-8-1-7	5	1	1	3	2.5	0	2	2	0cd	1.0
BP3866A-5-1213-LRG-5-2-1-7	2	3	4	1	2.5	0	0	0	0cd	0.0

The numbers followed by the letters a, b, c, d were significantly higher/same as the varieties IR 64, Ciherang, Tukad Unda and Inpari 9.

Table 2. Continued. Population intensity of green leafhoppers and tungro attack on tungro-resistant rice hope lines in Polewali Mandar

Lines/Variety	Population of GLH (DAT) (individu)				Mean	Disease incidence of tungro (DAT) (%)				Mean
	15	30	45	60		15	30	45	60	
BP3866A-5-1219-LRG-1-3-2-4	1	1	1	0	0.8	0	0	0	0cd	0.0
BP3866A-6-1227-LRG-9-4-2-6	1	3	1	7	3.0	0	4b	1	0cd	1.3
BP3866A-8-1244-LRG-9-5-1-7	1	2	1	6	2.5	0	3b	0	0cd	0.8
BP3868A-5-1283-LRG-8-1-2-7	0	2	1	0	0.8	0	0	3	0cd	0.8
BP3868A-8-1307-LRG-2-2-1-7	0	1	1	2	1.0	1	0	7	0cd	2.0
BP3870A-4-1357-LRG-2-3-1-7	0	1	1	0	0.5	0	0	3	0cd	0.8
BP3870A-4-1363-LRG-8-1-1-7	0	2	0	0	0.5	0	2b	0	0cd	0.5
BP3870A-6-1383-LRG-8-1-1-8	2	3	2	1	2.0	2	0	1	0cd	0.8
BP3870A-6-1385-LRG-10-2-1-7	1	5	2	2	2.5	0	2b	0	0cd	0.5
BP3870A-7-1387-LRG-2-1-1-7	0	2	0	5	1.8	0	0	0	0cd	0.0
BP3872A-1-1396-LRG-1-2-2-7	1	0	0	7	2.0	0	0	0	0cd	0.0
BP3872A-3-1422-LRG-7-3-1-7	0	1	0	3	1.0	0	2b	0	0cd	0.5
BP3874A-2-1428-LRG-3-1-2-7	0	1	0	3	1.0	0	0	1	0ad	0.3
IR 64 (a)	0.8	2.6	1.2	6.4	2.8	0.2	6.4	3.6	1.2	2.9
Ciherang (b)	0.4	4	1.8	5	2.8	0.4	2.8	2.8	2.4	2.1
Tukad Unda (c)	0.2	1.4	0.2	5	1.7	0	0.4	3	0	0.9
Inpari 9 (d)	0.2	2.4	0.6	3	1.6	0.2	0.4	2.4	0	0.8
Means	0.9	2.3	1.1	3.2		0.1	1.4	1.5	0.5	

The numbers followed by the letters a, b, c, d were significantly higher/same as the varieties IR 64, Ciherang, Tukad Unda and Inpari 9.

intensity of tungro was low. The low level of incidence has relation to environmental conditions and genetic characteristics of the line. Tungro infections are dependent on the presence of GLH and the environmental condition that supports the development of GLH. According to Widiarta (2005), the rainy season is preferably for GLH reproduction, but this research was carried out during the dry season. Furthermore, virulence and resistance genes in each strain of the tungro virus and its vector have an effect on the level of disease incidence of tungro (Rosida et al., 2013).

Agronomic Character Evaluation. Agronomic evaluation of tungro-resistant lines was carried out in vegetative and generative phases. The results of the ANOVA test showed that there were significant differences in plant height, 50% flowering age, and character of grain content per panicle. Meanwhile, there was no significant difference between productive tillers, 1000 grain weight, and empty grain per panicle (Table 3).

The tested lines had passed the screening stage with a score of 1−3 based on the IRRI (2013) criteria. The assessment was performed by comparing their agronomic characteristics with the varieties cultivated by farmers.

All the tested lines showed various agronomic characteristics. Long and short plant life can be seen from the 50% flowering age variable which is calculated from the day after planting (DAT). The flowering age of the tested lines showed that the days of vegetative growth had changed in the generative growth. The flowering age of the test lines ranged from 73-91 days after planting. There was a BP3846A-8-428-LRG-3-3-2−6 line (Table 3) which had a flowering age of 73 DAP which was shorter than the flowering age of the comparator variety IR64, which was 80 DAP. The flowering speed of the test line showed potential as a short-lived line. According to Pramudyawardani et al. (2015), flowering age is correlated with early maturity character. Short-lived varieties provide opportunities to increase the cropping index. So that in one year you can harvest two to three times (Susanto et al., 2002).

Performance in the generative phase or the ripening phase of 85% or ready to harvest includes various forms of clumps, namely compact upright, scattered upright, and scattered drooping.

Plant height is one of the criteria in the selection of rice plants. Based on the results obtained, the BP3874A-2-1428-LRG-3-1-2-7 line was 69 cm lower than the comparator variety Inpari 9 (70.4 cm). While the highest line was 90.9 cm (BP3870A-6-1383-LRG-8-1-1-8). Referring to the characteristics of a new type of rice according to Fagi et al. (2001), the ideal plant height for new types of rice (PTB) is between 80−100 cm, while Abdullah et al. (2005) stated that the ideal PTB plant height is medium-short (110−100 cm). So, all lines had plant heights that matched the PTB criteria.

The number of productive tillers of the test line showed varied compared to the comparator variety. Two lines that had more productive tillers than the highest comparator variety (Inpari 9) were recorded, namely BP3734A-3-15-LRG-5-8-2-5 (22.6) and BP3770A-1-219- LRG-3-5-2-8 (22.2). The line that showed the lowest average tiller was BP3866A-5-1213-LRG-5-2-1-7 (9.7). The characteristics of PTB were having tillers and all of them were reproductive. However, the number of tillers has no standard, Las et al. (2003) said the number of tillers was small (7−12 tillers), Fagi et al. (2001) said the number of tillers was medium (8−10 tillers), and Abdullah et al. (2008) said the number of tillers was medium (12−18 tillers). By the standard criteria of PTB, the majority of the tested lines were included in the PTB criteria.

The line had good performance, being compact upright or scattered upright. Plant leaf about the plant's ability to receive and absorb sunlight. According to Abdullah et al. (2008), the forming of NTR has upright leaves, narrow, and V-shaped. Based on field observations, 60% (30 lines) have an upright clump, while the rest (20 lines) were compact clumps. So that the upright shape criteria for tungro resistance selection are taken into consideration.

The high number of empty grains caused low yields. Based on table 3, there are two lines that show low empty grain, lines BP3866A-3-1193-LRG-5-5-2-3 (151.7) and BP3868A-5-1283-LRG-8-1-2-7 (137.7). The empty grain is due to the imbalance between large sinks and few sources (Abdullah et al., 2008).

The highest grain in one clump was observed in the BP3866A-6-1227-LRG-9-4-2-6 line (2633.3 grains) and the lowest in the BP3870A-6-1383-LRG-8-1-1-8 line. (569.0). Meanwhile, the highest weight of 1000 grains was in the BP3866A-5-1219-LRG-1-3-2-4 line (27.3 g) and the lowest was in the BP3864A-8-1151-LRG-3-7-2-8 line (20.9 g). According to Sutaryo et al. (2005), the number of productive tillers and the high weight of 1000 seeds indicated high yields. According to Satoto et al. (2007) that one of the criteria for selecting good lines for rice is high yield potential, reaching 25−26 g (Abdullah et al., 2008). The component weight of 1000 grains, as well as the grain content, were important components of rice production that show the potential yield. However, the high number of tillers per clump caused the panicle to ripen not simultaneously, thereby reducing the productivity and/or quality of rice (Abdullah et al., 2008). Purohit & Majumder (2009) asserted that the characteristics that contributed the most to the yield were the number of productive tillers, the number of filled grains per panicle, and the weight of 1000 grains.

In addition not only texture and taste, but the main factor in rice cultivation by the farmer also yields. Farmers will cultivate the varieties with high potential yields. The observation result shows ten lines have a high yield compared to Ciherang and IR 64 (Table 4). Ciherang and IR 64 were commonly cultivated varieties by the farmer. So that were used as comparator varieties to lines BP3734A-3-15-LRG-5-8-2-5, BP3744A-1-104-LRG-5-2-1-7, BP3770A-2-234-LRG-8-1-1-9, BP3840A-6-253-LRG-8-6-2-8, BP3860A-2-842-LRG-1-9-1-7, BP3870A-4-1357-LRG-2-3-1-7,

Table 3. Recapitulation of ANOVA of control varieties for agronomic variables

Variable	MS Variety	Error	Effect of Variety	CV (%)
Productive tillers	33.21	15.45	ns	21.16
Plant height	374.83	171.75	*	11.30
50% of flowering	73.06	43.20	**	2.78
Weight of 1000 grains	1.583	1.736	ns	4.95
Empty grain	6.305	2.959	*	29.22
Filled grain	50.741	69.832	ns	58.18
Yield	18.353	10.114	ns	51.15

ns = not signifikan; ** = different in 0.01%; * = different in 0.05%.

Table 4. Average of plant height variables, 50% flowering age (DAT), clump shape, productive tillers, empty grain, filled grain, grain yield and weight of 1000 grains of tungro-resistant rice hope lines in Polewali Mandar

Lines/Variety	A	B	C	D	E	F	G	H
BP3860A-2-842-LRG-1-9-1-7	73d	77a-d	15.1	U	667.7	990cd	8000	24.7
BP3860A-4-853-LRG-2-1-1-7	76.5abd	77a-d	15.5	U	520.0	1533.3a-d	2900	24.5
BP3862A-8-938-LRG-7-1-1-9	74.8d	79a-d	15.2	U	449.3	1230cd	2100	25.0
BP3862A-15-999-LRG-8-1-1-8	79.9abd	77	12.6	U	623.3	1200cd	2200	24.6
BP3862A-16-1005-LRG-4-3-1-9	78.5abd	86a	14.2	U	378.3	1160cd	2200	26.1
BP3862A-18-1026-LRG-7-10-1-7	76.7abd	81a	14.3	U	421.3	1166.7cd	2500	25.9
BP3862A-19-1037-LRG-8-1-1-8	81.7abd	77	15.8	U	538.7	1280cd	2500	24.5
BP3862A-21-1054-LRG-5-1-1-6	75.6bd	79	16.3	U	316.7	900d	2400	24.1
BP3862A-23-1078-LRG-9-6-2-7	81.8abd	79	13.1	U	633.3	733.3	2700	21.8
BP3864A-6-1131-LRG-2-5-1-8	80.5abd	79	13.3	U	337.7	866.7d	2400	24.4
BP3864A-7-1146-LRG-7-6-2-6	74.5d	81a	13.1	U	390.7	1066.7cd	1200	24.6
BP3864A-8-1151-LRG-3-7-2-8	79.4abd	79	12.1	U	343.3	1850a-d	2200	20.9
BP3866A-1-1175-LRG-7-3-2-7	79.0abd	84a	15.8	U	299.3	1130cd	2100	25.4
BP3866A-3-1193-LRG-5-5-2-3	76.1abd	75	11.6	C	151.7	843.3d	2200	25.7
BP3866A-4-1200-LRG-2-5-2-7	790abd	79	17.0	C	297.3	836.7d	2000	25.5
BP3866A-4-1207-LRG-9-3-2-7	73.8d	81a	16.0	U	248.3	1586.7a-d	2000	25.1
BP3866A-5-1211-LRG-3-8-1-7	80.3abd	87a	14.1	C	391.7	1516.7a-d	2500	23.5
BP3866A-5-1213-LRG-5-2-1-7	77.9abd	75	9.7	C	337.3	1053.3cd	1700	24.1
BP3866A-5-1219-LRG-1-3-2-4	73.3d	79	13.7	C	377.3	933.3d	2800	27.3
BP3866A-6-1227-LRG-9-4-2-6	71.9d	87a	16.6	C	257.0	2633.3a-d	1100	22.9
BP3866A-8-1244-LRG-9-5-1-7	69.4	79	17.8	U	211.0	702.7	900	24.8
BP3868A-5-1283-LRG-8-1-2-7	81.6abd	77	13.8	U	137.7	1536.7a-d	2500	25.1
BP3868A-8-1307-LRG-2-2-1-7	81.2abd	90a-c	16.5	U	429.7	1016.7cd	2700	23.7
BP3870A-4-1357-LRG-2-3-1-7	90.9a-d	81a	15.8	C	319.3	1866.7a-d	3700	25.6
BP3870A-4-1363-LRG-8-1-1-7	81.4abd	75	16.3	U	403.3	1624.3a-d	3100	25
BP3870A-6-1383-LRG-8-1-1-8	90.9a-d	81a	16.7	U	456.7	569cd	1800	22.7
BP3870A-6-1385-LRG-10-2-1-7	82.1abd	85a	15.7	U	633.0	1324.3cd	1300	22.3
BP3870A-7-1387-LRG-2-1-1-7	74.1d	81a	14.3	U	566.7	1030cd	8000	23
BP3872A-1-1396-LRG-1-2-2-7	73.9d	85a	16.9	U	523.7	1093.3cd	500	23.2
BP3872A-3-1422-LRG-7-3-1-7	77.0abd	81a	18.1	U	502.3	982.7d	600	23.8
BP3874A-2-1428-LRG-3-1-2-7	69.8	84a	15.2	U	515.7	871.7cd	700	22.6
IR 64 (a)	75.8	80	19.7	C	437.6	1381.67	2660	23.7
Ciherang (b)	75.5	88	16.7	U	836.4	1410.67	1920	24.4
Tukad Unda (c)	90.5	88	15.5	U	1119.9	927.53	1800	24.8
Inpari 9 (d)	70.4	91	20.6	C	1035.3	769,	660	23.6

1). The numbers followed by the letters a, b, c, d were significantly higher/same as the varieties IR 64, Ciherang, Tukad Unda and Inpari 9. (A) Plant height (cm); (B) 50% of flowering (DAT); (C) Productive tillers; (D) Clump shape (U: upright, V: compact); (E) Empty grain; (F) Filled grain; (G) Yield (kg/ha); (H) Weight 1000 grains (g).
2). Comparison of lines with one of the comparison varieties to determine the letter code behind the number refers to the Least Significant Increase method.

BP3870A-4-1363-LRG-8-1-1-7 and BP3870A-7-1387-LRG-2-1-1-7.

From the results of the discussion by the scoring results of each variable, line BP3870A-4-1363-LRG-8-1-1-7 is the high number (8) and the lowest is line BP3866A-5-1211-LRG-3-8-1-7 (1). According to the results of various observational variables, the criteria for tungro symptoms and yield variables are the main criteria for determining the selected line. Lines with high score (above 5) with agronomic characteristic with plant new type criteria is the selected lines are lines BP3734A-3-15-LRG-5-8-2-5, BP3770A-1-218-LRG-2-3-1-9, BP3840A-6-253-LRG-8-6-2-8, BP3862A-21-1054-LRG-5-1-1-6, BP3866A-4-1207-LRG-9-3-2-7, BP3870A-4-1357-LRG-2-3-1-7 and BP3870A-4-1363-LRG-8-1-1-7.

CONCLUSION

Due to evaluation on incidence of tungro infection rate and agronomic characters result base on plant new type of the best lines was BP3734A-3-15-LRG-5-8-2-5, BP3770A-1-218-LRG-2-3-1-9, BP3840A-6-253-LRG-8-6-2-8, BP3862A-21-1054-LRG-5-1-1-6, BP3866A-4-1207-LRG-9-3-2-7, BP3870A-4-1357-LRG-2-3-1-7 and BP3870A-4-1363-LRG-8-1-1-7. From the evaluation results, these promising lines can be used as materials for assembling tungro-resistant rice varieties.

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AUTHORS' CONTRIBUTIONS

All Contributor are contributed to the research the start of the experiment up until the writing of the manuscript. However, KH and NR did contribute specifically on some processes. The design of the experiment was planned by NR and the observation and data collection were performed by all contributor. Other works, such as field assistance, data analysis, data interpretation, and manuscript writing were done by AG and NR authors. Then, all the authors have read and approved the final manuscript.

COMPETING INTEREST

No competing interest regarding to this publication manuscript such as financial or non financial interest also to personal relationships among authors and other.

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