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ABSTRACT

Brown planthopper (BPH), *Nilaparvata lugens* Stall, is one of important insect pests of rice plants in the tropics. Many attempts have been done to control this insect in rice fields. The use of pesticide has so far been regarded as environmentally harmful. The logical approach to control BPH, thus, is the use of resistant varieties as a part of an integrated pest management program. Researches on breeding rice plants for BPH resistance in Indonesia especially for that using mutation breeding methods have been carried out since 1974. Screening methods and some results of the research are presented in this paper.

ABSTRAK

Wereng coklat, *Nilaparvata lugens* Stall, merupakan salah satu hama padi penting di daerah tropis. Telah banyak upaya dilakukan untuk mengendalikan hama ini di pertanaman padi. Penggunaan pestisida untuk memberantas hama selama ini dianggap dapat mencemari lingkungan. Suatu pendekatan logis untuk mengontrol hama wereng coklat adalah dengan penggunaan varietas padi tahan hama sebagai bagian dari program pengendalian hama secara terpadu. Penelitian mengenai pemuliaan tanaman padi untuk ketahanan hama wereng coklat di Indonesia, khususnya yang menggunakan metoda pemuliaan mutasi, telah dilakukan sejak 1974. Metode skrining dan beberapa hasil penelitian yang telah diperoleh disajikan dan dibahas dalam makalah ini.

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INTRODUCTION

Brown planthopper (BPH), *Nilaparvata lugens* Stall, is one of important insect pests of rice plants in the tropics. In South East Asia countries, the damage or economic loss caused by this insect pest has increased dramatically within the past 25 years. The damage appears because BPH feeds on rice plants. Its nymphs and adults can inhibit the base parts of rice plants and suck the phloem sap so that it can significantly reduce rice yield potential. Severe attack of this insect pest can cause complete drying of rice plants, a symptom known as "hopperburn". Beside direct danger of the pest, BPH may also transmit virus diseases to rice plants that often cause more severe yield reduction than the feeding damage. Grassy stunt virus (GSV) and rugged stunt virus (RSV) are those among viruses that may be transmitted by BPH (Harahap, 1979; IRRI, 1985).

In Indonesia, BPH attack was firstly reported in 1931 at Darmaga village of Bogor, West Java, and then in Mojokerto (East Java) in 1939 and Yogyakarta in 1940 (P3TP, 1995). BPH has markedly become major rice pest since 1975 following the introduction of high yielding varieties which are usually treated with high rate fertilizer (Harahap, 1979). Outbreaks of BPH was reported in Java in 1969/70 and then in North Sumatra in 1972/73. The epidemics was recorded in 1974/75 in North Sumatra, West Java, Central Java, and East Java. More than 450,000 ha rice growing areas were attacked by BPH in 1976/77, causing the economic loss of about USD 100 million (P3TP, 1995). The last epidemics was reported to occur in Java in 1994/1995.

The use of insecticide is sometimes considered as a practical method to prevent rice plants against insect damage. However, the high cost of the insecticide and the feeding habit of the insects (the insects feed on base parts of rice plants) make pesticides seem not to be effective to control this pest. Besides, it can give a negative impact to the environment for it may kill natural enemies of the BPH. Because natural enemies are always present in paddy fields, their actions may reduce the BPH population if they are properly managed (Chin, 1979). The logical approach to control BPH is the use of resistant varieties as a part of an integrated pest management program. The use of resistant varieties is relatively cheap, not polluting the environment, and generally it is compatible with other pest control tactics. Researches on breeding rice plants for BPH resistance in Indonesia especially for that using mutation breeding methods are summarised in this paper.

SCREENING METHODS FOR BPH RESISTANCE

Activities in screening rice mutant lines for BPH resistance involve mass rearing BPH, insect infestation on tested seedlings, data collection and evaluation. A greenhouse and rearing cages are the major items required for rearing BPH. Both insect rearing and screening rice for resistance are done in the greenhouse. The greenhouse itself should be well lighted and should provide a suitable environment for rearing insects and growing plants throughout the year.

Mass Rearing BPH

Mass rearing BPH is essential for mass screening plant mutants. The insects are usually mass reared on susceptible rice variety namely Taichung Native I (TN-I) or Pelita I/1. The original colony is started by caging a pair (male and female) virus-free adult insects on rice plants. The insects are reared on 40-50 day-old plants inside a cage with size of 50 x 120 x 80 cm. The bottom and the door of this standard cage is made of wood. The roof and the two sides are covered with glass and the remaining two sides are covered with nylon cloth. Each cage can accommodate several potted plants which are needed to support lives for 2000 - 3000 late instar nymphs. Some eggs of about the same age are obtained by placing the plants overnight in a cage containing adult insects. Rearing on old potted plants provide a continuous supply of test insects.

Screening Procedures

Before infestation, the test insects and plants must firstly be prepared. The test varieties and some mutant lines being screened are seeded in 20 cm rows of 5 cm apart in a 60 x 45 x 10 cm seedling box. The test varieties are TN-1 or Pelita I/1 for susceptible check variety, IR-26 for resistant check variety of biotype-1, and IR-36 for resistant check variety of biotype-2. Seeds of mutant lines being screened and the check varieties are sown randomly in rows in each seedling box, usually 20-30 seedlings per row. Seven days after sowing, the seedlings are infested with BPH by scattering a large number of insects on them. The heavily infested plants from the mass rearing cage are gently tapped over the seedlings. The insects should be scattered on the seedlings as uniformly as possible and second or third instar nymphs are used for infestation. An average of 5 insects/seedling constitutes an optimum population to differentiate the resistant and susceptible plants.

Seven to ten days after insect infestation or when about 90% of the susceptible check variety are killed by insects, final damage rating is taken by using the Standard Scoring System of 0-9 (Table 1). Data for each plant line being screened are recorded and then evaluated for selection. The selected lines resistant to BPH are grown in the next generation. This procedure of screening is done consecutively until homozygote plants are obtained.

MUTATION BREEDING FOR BPH RESISTANCE IN INDONESIA

Rice induced mutation breeding in Indonesia was started in 1972, initially in an attempt to improve protein content of rice grain. This research activity was carried out under the IAEA Research Coordination Program (Ismachin and Hendratno, 1972). Since 1974, the rice mutation breeding activities have been focused to selecting plant mutants resistant to BPH. The materials from gamma irradiated Pelita I/1 and plant mutant No. A-23/PsJ were screened for BPH. The gamma irradiation dose, population size, and mutation frequency of resistance are presented in Table 2 (Mugiono, 1990). Following subsequent selection process for resistant plants, a number of mutant lines resistant to BPH were obtained (Table 3). Some of the promising lines were then tested for their yield potential at several locations.

In 1982, the plant mutant No. 627/4-214/PsJ and 627/10-3/PsJ were submitted for official release, however, only the former mutant line received approval for release as a new variety called **Atomita-1**. This Atomita-1 had a better grain quality, early maturing, high yielding, resistant to BPH biotype-1 and green leaf hopper. However, it was not resistant to BPH biotype-2 (Table 3). Therefore, this variety was not grown widely in the country because of the endemic situation of BPH biotype-2 in the field. The mutant line No. 627-5/PsJ was also released as a new variety called **Atomita-2**. Besides resistant to BPH biotype-1, this variety had better grain quality and tolerant to salinity.

In 1984, Atomita-1 and mutant line No. 627/10-3/PsJ were irradiated with 0.2 and 0.3 kGy of gamma rays, for improving their resistance to BPH biotype-2. As a result, some mutant lines resistant to biotype-2 were obtained (Table 4). After further selections and evaluations, mutant line No. 1066-E/PsJ was finally released as new variety called **Atomita-3** in 1990. This variety had a good grain quality and high yielding potential but it was not quite acceptable to farmers due to its rather late in maturity (Mugiono and Hendratno, 1995).

In 1987, a local variety Cisadane was treated with 0.2 and 0.3 kGy of gamma irradiation. An early maturing mutant line No. Obs-208/PsJ was obtained from this work. This line had relatively higher yield potential than the other lines and the original variety Cisadane (Table 5). This line was released as new variety called **Atomita-4** in 1991. This variety became more popular to farmers because of its resistance to BPH biotype-2. Besides, this variety has shown higher yield potential, good cooking quality, and earlier maturing than the original variety, Cisadane.

Research on mutation breeding of upland rice was also done in Indonesia. A local rice variety Seratus Malam had been treated with gamma irradiation with the dose up to 0.5 kGy in 1982. After successive screening for resistant to BPH and blast disease, some resistant mutant lines were identified and one resistant mutant line No. MG-4/PsJ had been released as a new variety called **Situgintung** in 1992. Beside resistant to BPH biotype-1 and biotype-2 and blast disease, this variety had a relatively higher yield potential in upland condition than the other lines (Table 6).

Meanwhile, a semidwarf mutant No. SM-268/PsJ was selected from 0.2 kGy treatment of irradiated Seratus Malam. This mutant line was then crossed with IR-36 and selection for early maturing plants was done in the F2. In the F3, an early maturing line Obs-1647/PsJ was obtained. This line was then tested for its resistance to BPH and yield potential. Results indicated this line was resistant to BPH biotype-1 and biotype-2 but susceptible to biotype-3 (Table 7). Also, this line had relatively higher yield potential than the other lines (Table 8). In July 1996, the Indonesian Ministry of Agriculture released this line as new variety called **Cilosari**. This variety is suitable for irrigated areas or lowland condition in Indonesia (Mugiono, 1997), and it is very popular to farmers especially in West Nusa Tenggara and Bengkulu province.

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TABLES

Table 1. Standard scoring of damage by brown planthopper (IRRI, 1980).

Score of Damage	Symptom	Rating
0	No visible damage	Highly Resistant
1	Partial yellowing of first leaf	Resistant
3	First and second leaves partially yellow	Moderately Resistant
5	Pronounced yellowing and some stunting	Moderately Susceptible
7	Wilting and severe stunting	Susceptible
9	All test plants dead	Highly Susceptible

Table 2. Mutation frequency for BPH resistance resulted from induced mutation using gamma irradiation treatments on rice variety Pelita I/1 and line No. A-23/PsJ.

Year of irradiation	Originated variety/line	Irradiation dose (kGy)	Generation at selection	Population size	Freq. of resistance
1974	Pelita I/1	0	-	3,400	0
		0.2	M4	9,654	$7x10^{-3}$
1977	Pelita I/1	0	-	7,982	0
		0.1	M1	7,910	0
		0.2	M1	6,624	0
		0.3	M1	6,500	0
		0.35	M1	5,472	$2x10^{-4}$
		0.4	M1	4,896	$2x10^{-4}$
1978	A-23/PsJ	0	-	2,730	0
		0.1	M1	2,610	0
		0.2	M1	2,490	$16x10^{-4}$
		0.3	M1	2,460	$8x10^{-4}$
		0.4	M1	1,950	$35x10^{-4}$
		0.5	M1	1,560	0
1978	A-23/PsJ	0	-	5,190	0
		0.1	M2	10,519	$22x10^{-3}$
		0.2	M2	6,395	$10x10^{-3}$
		0.3	M2	15,799	$12x10^{-3}$
		0.4	M2	4,158	$59x10^{-3}$
		0.5	M2	1,798	$70x10^{-3}$

Table 3. Reaction of some rice mutant lines derived from gamma irradiated Pelita I/1 and mutant line No. A-23/PsJ to BPH.

No.	Line No.	Origins	BPH Reaction		
			Biotype-1	Biotype-2	Biotype-3
1	627/4-214/PsJ	Pelita I/1	3	6.2	5
2	627-10-3/PsJ	Pelita I/1	3	7	5
3	627-5/PsJ	Pelita I/1	3	7	5
4	627-4-C/PsJ	Pelita I/1	3	7	7
5	A-227-2/PsJ	A-23/PsJ	3	6.2	5.5
6	A-227-3/PsJ	A-23/PsJ	3	7	5.5
7	A-227-5/PsJ	A-23/PsJ	3	7	5.5
8	713-D/PsJ	Pelita I/1	3	7	7
9	713-E/PsJ	Pelita I/1	3	7	7
10	A-23/PsJ	Pelita I/1	5.5	9	9
11	Pelita I/1	-	9	9	9
12	TN-1	-	9	9	9
13	Mudgo	-	2	9	1.5
14	ASD-7	-	8.5	3	8.5

Note:
Reaction is based on the 0-9 Standard Scoring System where 0 denotes highly resistant and 9 is highly susceptible.

Table 4. Reaction of some rice mutant lines derived from gamma irradiated Atomita-1 and mutant line No. 627-10-3/PsJ to BPH.

No.	Line No.	Origins	BPH Reaction		
			Biotype-1	Biotype-2	Biotype-3
1	1063-D/PsJ	627-10-3/PsJ	3	3/5	7.5
2	1066-E/PsJ	627-10-3/PsJ	3	3	7
3	1067-F/PsJ	627-10-3/PsJ	3	5	7.5
4	1076-G/PsJ	627-10-3/PsJ	3	7	9
5	1090-H/PsJ	627-10-3/PsJ	3	7	9
6	1100-Y/PsJ	627-10-3/PsJ	3	3	9
7	69/645/PsJ	Atomita-1	3	3	9
8	84/765/PsJ	Atomita-1	3	5	9
9	77/72/PsJ	Atomita-1	3	3	9
10	627-10-3/PsJ	Pelita I/1	3	9	9
11	627-4-214/PsJ	Pelita I/1	3	6.3	9
12	TN-1	-	9	9	9
13	IR-42	-	2.5	3	9
14	Rathu Heenati	-	2.5	3	3

Note:
Reaction is based on the 0-9 Standard Scoring System where 0 denotes highly resistant and 9 is highly susceptible.

Table 5. Average yield (ton/ha) of mutant lines derived from gamma irradiated local rice variety Cisadane.

No.	Lines/Variety	Yield (ton/ha)	
		1988/89	1989/90
1	Obs-297/PsJ	4.83	4.93
2	Obs-306/PsJ	4.75	4.73
3	Obs-18/PsJ	5.25	4.54
4	Obs-330/PsJ	5.59	4.91
5	Obs-208/PsJ	5.69	5.43
6	Cisadane	5.09	5

Table 6. Average yield (ton/ha) of mutant lines derived from gamma irradiated local rice variety Seratus Malam.

No.	Line No.	Yield (ton/ha)	
		1985/86	1986/87
1	MG-1/PsJ	1.31	2.19
2	MG-2/PsJ	1.59	2.25
3	MG-4/PsJ	2.13	2.28
4	MG-27/PsJ	1.29	2.02
5	MG-6/PsJ	1.18	2.45
6	MG-16/PsJ	1.42	2.19
7	MG-19/PsJ	1.45	2.09
8	MG-20/PsJ	1.45	2.43
9	MG-23/PsJ	1.43	2.23
10	Sentani	1.38	2.06

Table 7. Reaction of rice line No. Obs-1647/PsJ and other lines/varieties to brown planthopper (BPH).

No.	Lines/Varieties	Brown planthopper *)		
		Biotype-1	Biotype-2	Biotype-3
1	SM-268/PsJ	S	S	S
2	IR-36	R	R	S
3	Obs-1647/PsJ	R	R	S
4	IR-64	R	R	S
5	Membramo	R	R	R
6	Rathuhenati	R	R	R

*) S = Susceptible
R = Resistant

Table 8. Average yield (ton/ha) of rice mutant line No. Obs-1647/PsJ and other lines/varieties in dry and rainy season of 1992/93.

No.	Lines/Varieties	Yield (ton/ha)	
		Dry season	Rainy season
1	Obs-38/PsJ	5.80 ab	5.68 ab
2	Obs-300/PsJ	5.30 ab	5.10 ab
3	Obs-1067/PsJ	5.70 ab	6.24 ab
4	Obs-1647/PsJ	6.60 b	6.72 b
5	S-20-13/PsJ	5.80 ab	5.86 ab
6	S-20-18/PsJ	5.70 ab	4.50 a
7	S-20-34/PsJ	5.90 ab	5.96 ab
8	S-20-57/PsJ	5.60 ab	5.20 ab
9	S-20-76/PsJ	5.90 ab	6.08 ab
10	PIR-30-29/PsJ	5.80 ab	6.04 ab
11	Atomita-4	6.40 ab	5.08 ab
12	Cisadane	5.00 a	6.22 ab
CV (%)		7.9	11.04

Note: The same letters following numbers indicate no significant difference at 5 % LSD test.