

Virulence of brown planthopper (*Nilaparvata lugens* Stål) against differential resistant and certified rice varieties in the major irrigated rice-growing areas of Thailand

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According to records of rice production, several major outbreaks of the brown planthopper (BPH) (*Nilaparvata lugens* Stål) have occurred in the lower northern, central, and eastern regions of Thailand's major irrigated rice-growing areas. The release of susceptible varieties RD7 and RD11 in 1975 was associated with more than 171,930 ha of rice damaged in 1980-81. However, the resistant varieties RD21, RD23, and RD25, introduced in 1981, may have maintained BPH populations at lower levels. When the susceptible variety Suphanburi60 was introduced in 1987, 368,000 and 608,000 ha of rice fields were destroyed in 1989 and 1990, respectively. Later, in 1991-94, the release of resistant varieties Chainat1, Suphanburi1, and Suphanburi90 was associated with BPH populations returning to lower levels. Ten years later, BPH outbreaks were reported over areas of 534,400 ha and 262,400 ha in 1998 and 1999, respectively. Resistant variety Pathumtani1 was introduced in 2000; however, the continuous planting of Pathumtani1 for many years may have led to severe BPH outbreaks in 2009 in Angthong Province. Also, continuous planting for a long time of the resistant variety Chainat1 may have led to heavy BPH outbreaks in the lower northern region in 2009. BPH destroyed 381,760 ha of rice fields in 2009. These trends indicate that farmers' choice of rice varieties may have a significant effect on BPH outbreaks. However, the role of differences in BPH virulence in different areas of Thailand is still in doubt. Differences in virulence have been found between BPH populations from areas 200 km apart in Indonesia. Therefore, the aim of this research was to find out if there were differences in virulence of BPH populations from different areas in damaging a set of standard resistant and certified rice varieties.

A differential set of 10 standard resistant varieties was tested with 72 BPH populations that were caught from 71 different districts in 13 provinces in the lower northern, central, eastern, and western regions of the major irrigated rice-growing areas. Also, a set of 9 certified rice varieties was tested with 81 different BPH populations caught from 80 districts in 16 provinces. The set of 10 standard resistant varieties with known resistance genes were Mudgo (*Bph1*), ASD7 (*bph2*), Rathu Heenati (*Bph3*), Babawee (*bph4*), ARC 10550 (*bph5*), Sawarnalata (*Bph6*), T12 (*bph7*), Chin Saba (*bph8*), Pokkali (*Bph9*), and IR65482-4-136-2-2 (*Bph10*) and the set of 9 certified rice varieties were Pathumtani1, Chainat1, Suphanburi1, Suphanburi3, Suphanburi90, Phitsanulok2, RD31, RD23, and RD7. Varieties were screened using seed box tests. Twenty-five germinated seeds of each rice variety were planted in rows in each seed box. From 6 to 8 third-instar BPH nymphs were inoculated on each plant when seedlings were 7 days old. Reactions of the rice varieties to BPH populations were scored by using the Standard Evaluation System for Rice described by IRRI. Each variety was scored for BPH reaction when 90% of

the susceptible check TN1 died or 7 days after BPH inoculation. Populations were grouped according to virulence using cluster analysis.

Results indicated significant differences in virulence among BPH populations from different areas. The 72 BPH populations could be grouped into 11 clusters (coefficient 0.87) based on their reactions to the set of standard resistant varieties (Fig. 1), and the set of standard resistant varieties was divided into 6 groups based on the reactions of the 72 BPH populations (Fig. 2). Similarly, the 81 BPH populations could be divided into 20 groups (coefficient of 0.84) based on reactions to the set of certified varieties (Fig. 3), and 9 certified varieties were individually significantly different based on the reactions of the 81 BPH groups (Fig. 4).

Cluster analysis showed that Rathu Heenati (*Bph3*) was highly resistant (HR) and resistant (R) to most of the BPH groups in Thailand. Significantly different BPH reactions among districts within a province were also found. Mudgo (*Bph1*) was moderately resistant (MR) to only four BPH populations from four districts. Rathu Heenati showed high resistance to BPH from 18 districts in 6 provinces from the lower northern, central, and eastern regions. Rathu Heenati also showed resistance against 33 BPH populations from 33 districts in 5 provinces, and moderate resistance to 12 BPH populations from 12 districts in 6 provinces. Babawee (*bph4*), ARC10550 (*bph5*), Sawarnalata (*Bph6*), Chin Saba (*bph8*), Pokkali (*Bph9*), and IR65482-4-136-2-2 (*Bph10*) were moderately resistant to 9, 3, 8, 13, 3, and 22 BPH populations, respectively. ASD7 (*bph2*) and T12 (*bph7*) were susceptible to all BPH populations.

Differences in reactions of 9 certified rice varieties to 81 BPH populations were also found. Pathumtani1, which was resistant when first released, was only moderately resistant to 17 BPH populations from Prachinburi, Nakornnayok, Ayuttaya, and Sakao provinces. RD31 was moderately resistant to 29 BPH populations from 29 districts in Pitsanuloke, Pijit, Prachinburi, Nakorn Nayok, Ayuttaya, Petburi, Ratchaburi, Sakao, and Anghong provinces. SPR1, SPR3, SPR90, CNT1, and PSL2 were resistant and moderately resistant to 32, 49, 14, 32, and 61 BPH populations, respectively (Table 1).

In conclusion, significant differences in virulence of BPH populations from different areas of Thailand were found. BPH populations from different districts within each province also significantly differed. It is recommended that farmers plant certified rice varieties that are resistant to the specific BPH populations within their particular region to help prevent BPH outbreaks and reduce population densities. Plant breeders should use Rathu Heenati (*Bph3*) as a BPH resistance gene donor effective against most BPH populations in Thailand. These results for 9 certified rice varieties in 16 provinces were used to determine the most suitable rice varieties that were then distributed to farmers in 13 provinces during BPH outbreaks in 2009-10.

Table 1. List of certified rice varieties that were resistant to brown planthopper in the northern, central, eastern, and western regions of Thailand.

Certified rice varieties	Province	District (Amphur)	
		Moderately resistant	Resistant
PTT1	Prachinburi	Srimahapo, Srimahosot, Prachantakram	
	Nakorn Nayok	Muang	
	Phranakorn Sri Ayutthaya	Thareau, Uthai, Bangpa In, Bangshai, Maharat, Bangban, Pakhai, Bangpahun, Sena, Bangchei	
	Sakao	Kao Chagun, Arunyapathed, Wang Somboon	
RD31	Phitsanuloke	Wangthong	Wat Boat
	Pijit	Muang, Paprathubchang, Tapanhin, Wang Sraipune	
	Prachinburi	Srimahapo, Srimahosot, Nadee	
	Nakorn Nayok	Muang, Ongkaruck	
	Phranakorn Sri Ayutthaya	Thareau, Uthai, Banphak, Maharat, Bangban, Pakhai, Bangshai	
	Petburi	Muang	
	Ratchaburi	Muang	
	Sakao	Kao Chagun, Arunyapathed, Wang Somboon, Muang	
SPR1	Phisanuloke	Bangrakam, Nearn Maprang, Muang	Wangthong
	Pijit	Wangsaipoon, Banmoonak, Tabcloe, Samngam, Potala	Tapanhin
	Prachinburi	Srimahapo, Srimahosot, Nadee	
	Pathumtani	Muang	
	Nakorn Nayok	Muang, Ongkaruck	
	Phranakorn Sri Ayutthaya	Thareau, Uthai, Maharat, Sena, Bangban, Pakhai	
	Petburi	Muang	
	Ratchaburi	Muang, Patharam	
	Sakao	Wangsomboon, Wangnamyen	
	Angthong	Sawangha, Muang, Pamok, Wisetchaichan, Chaiyo	
SPR3	Phitsanuloke	Wat boat, Prompiram	Muang, Wangthong
	Pijit	Samngam	Tapanhin, Muang

			Wangsaipoon
	Chainat	Muang	Sankaburi
	Lopburi	Banmi	
SPR3	Saraburi	Nongdone	
	Prachinburi	Bansang, Phrchantakam	Srimahapo, Nadee, Srimahosot
	Pathumtani	Muang	
	Nakorn Nayok	Muang, Ongkaruck, Pakphae	
	Phranakorn Sri Ayutthaya	Uthai, Bangchei, Banprak, Maharat, Bangban, Pakhai. Bangpahun, Nakornluang, Sena, Wangnoi, Bangshai	Thareau, Bangpa in
	Angthong	All Amphur	
	Petburi	Muang	
	Ratchaburi	Muang, Paktoe	
	Sakao	Kao Chagun, Arunyaprathed, Wangsomboon, Wangnamyen, Muang	
	CNT1	Phitsanuloke	Prompiram
Piji		Tapanhin, Muang	Bangmoonak
Chainat		Muang	
Prachinburi		Srimahapo, Srimahosot, Nadee, Prachantakam	
Pathumtani		Muang	
Nakorn Nayok		Muang, Ongkaruck	
Phranakorn Sri Ayutthaya		Thareau, Uthai, Bangchei, Pache, Ladbualueng, Maharat, Bangshai	
Sakao		Kaochagun, Wangsomboo, Wangnamyen, Muang	
Angthong		All Amphur	
PSL2		Phitsanuloke	Bangrakam, Nearnmaprang, Prompiram
	Pijit	Bangmoonak, Tabcloe, Muang, Samngam, Pratomchang	Tapanhin, Potala, Wangsaipoon
	Chainat	Hunca	Sankaburi
	Lopburi	Mahason, Tawhong, Banmi	
	Saraburi	Nongdone	
	Prachinburi	Bansang	Srimahapo, Nadee, Srimahosot, Prachantakam
	Pathumtani	Muang	
	Nakorn Nayok	Muang, Ongkaruck	
	Phranakorn Sri	Uthai, Bangpa in,	

	Ayutthaya	Pache, Banpak, Landbualuang, Sena, Bangbahun Phranakorn Sri Ayutthaya, Wangnoi, Bangshai		
PSL2	Petburi	Muang, Banlad		
	Ratchaburi	Muang, Banpong, Potaram, Pakto		
	Sakao	Kaochagun, Wangsomboon, Wangnamyen		
	Angthong	All Amphur		
	Supanburi			Songpenong, Daem Bang Nang Buad, Samchuk, Sriprachun,
Nakorn Pathom		Banglane, Kompangsaen		
Chashaeng Sao		Bangpo, Bangnampaew		
SPR90	Pijit	Samngam		
	Prachinburi	Bansang, Srimahapo, Srimahosot		
	Nakorn Nayok	Muang, Ongkaruck		
	Phranakorn Sri Ayutthaya		Thareau, Bangchei, Maharat, Phranakorn Sri Ayutthaya, Bangshai	
	Sakao	Wangnamyen, Watthananakorn		
Angthong	Chaiyo			

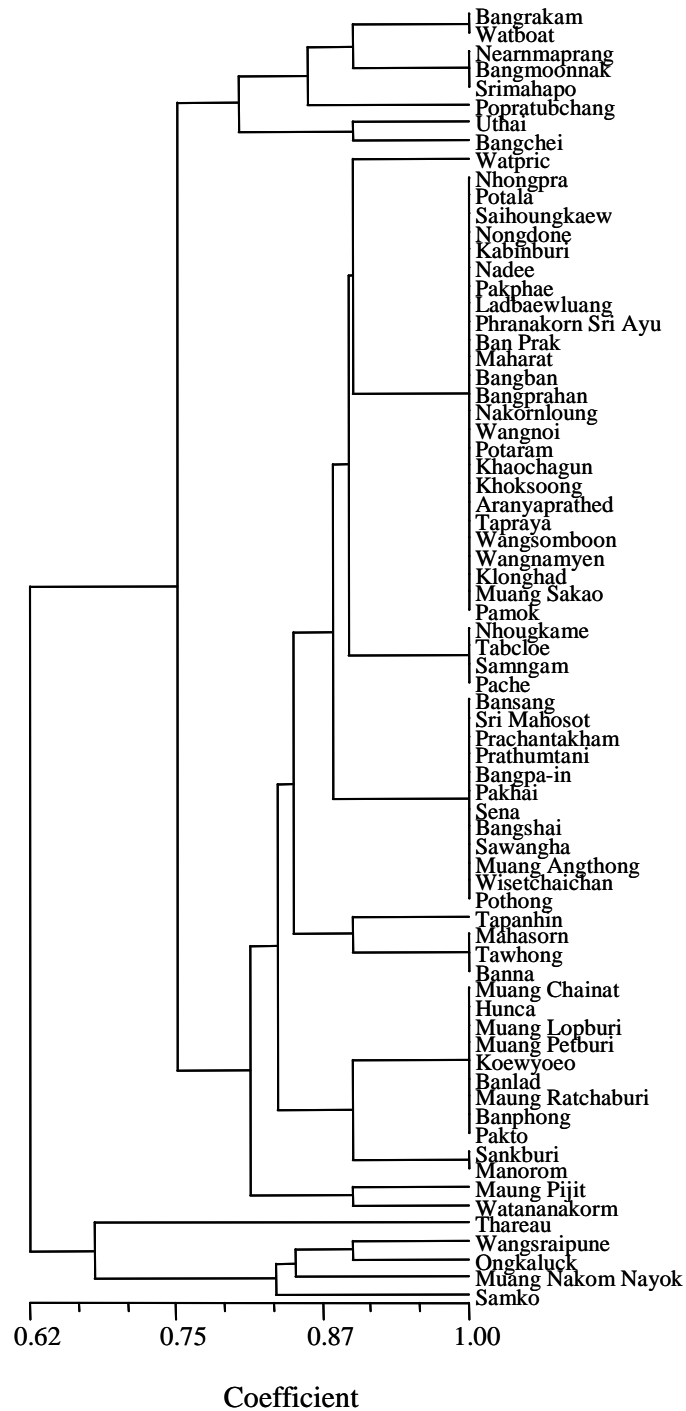


Fig. 1. Cluster analysis of 72 BPH populations based on data obtained from reactions of a differential set of BPH-resistant varieties carrying different BPH resistance genes.

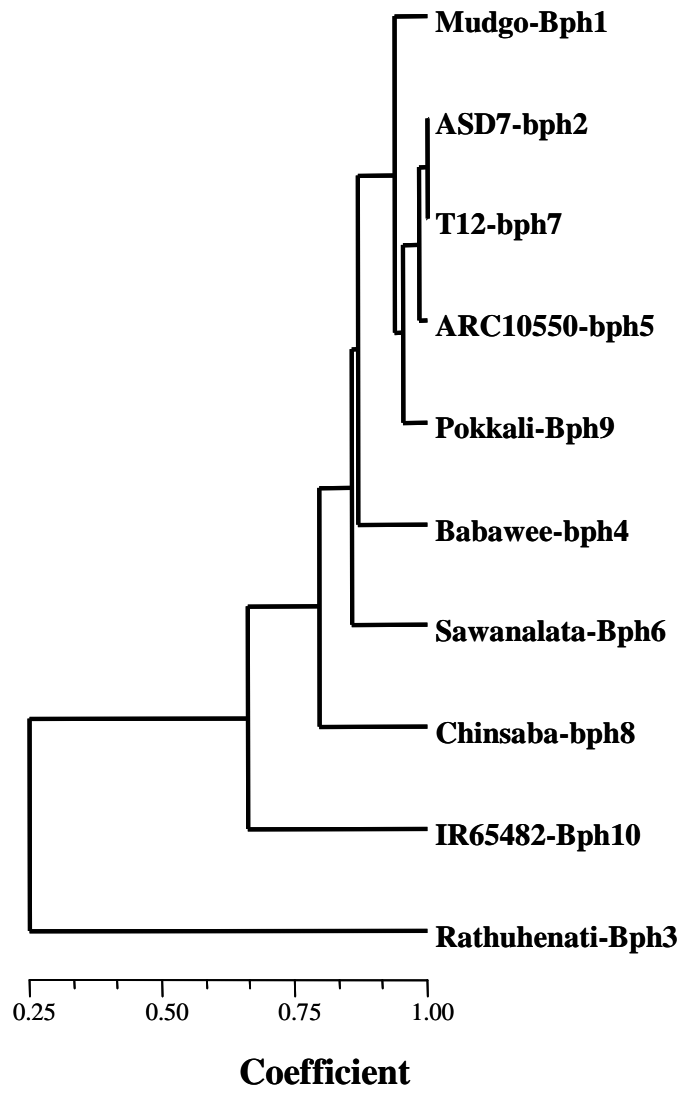


Fig. 2. Cluster analysis of a differential set of BPH-resistant varieties based on data obtained from the reactions of 72 BPH populations.

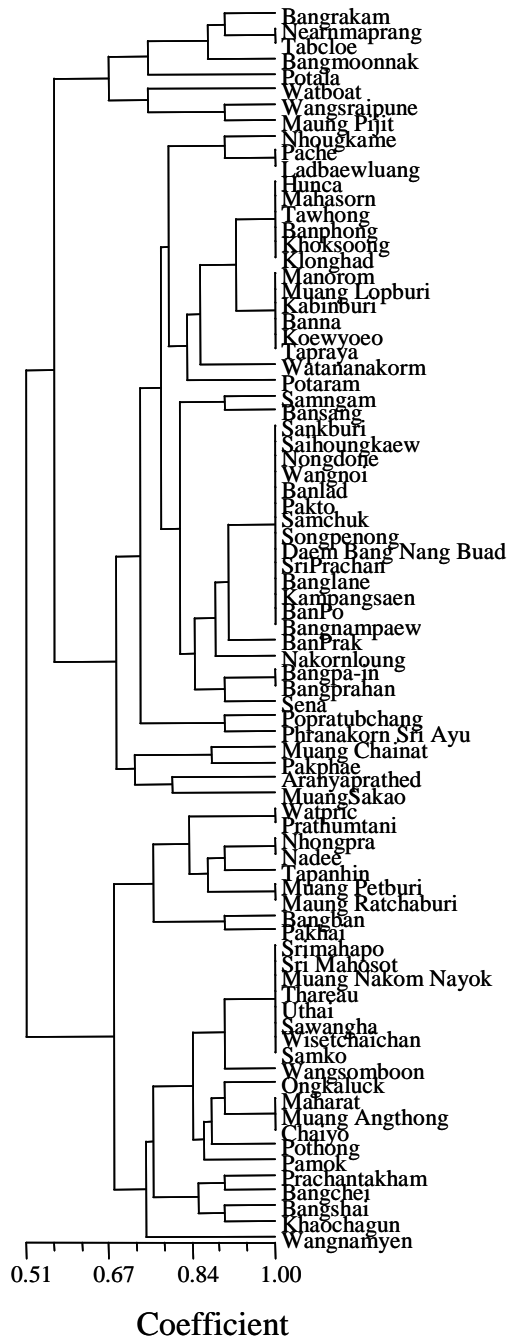


Fig. 3. Cluster analysis of 81 BPH populations based on data obtained from reactions of a set of 9 Thai certified rice varieties.

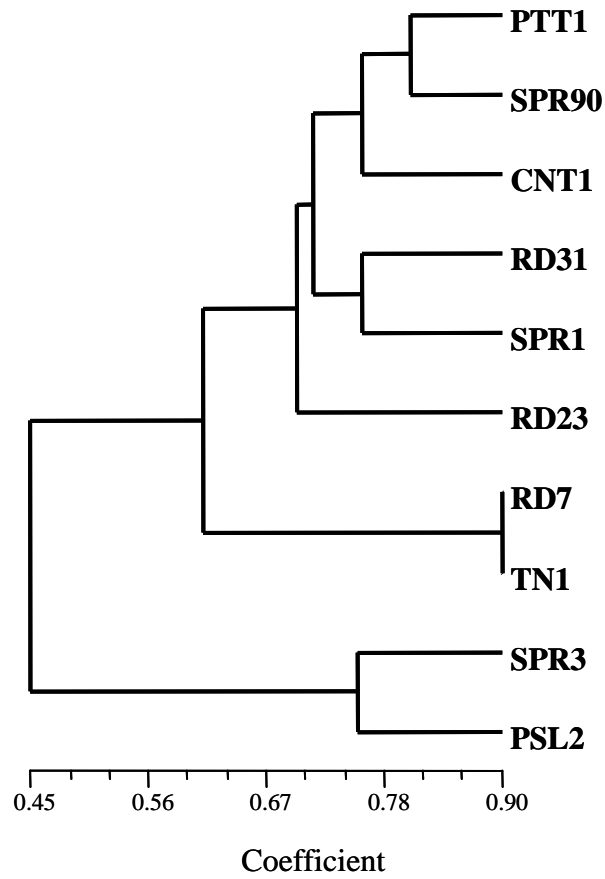


Fig. 4. Cluster analysis of a set of 9 Thai certified rice varieties based on data obtained from reactions of 81 BPH populations.