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Brown Plant Hopper: A Red Flag for Rice Under Climate Change

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1.1: Introduction

Rice is cultivated extensively in the most diverse ecosystems of tropical and sub-tropical regions of the world. It is the staple food for people in 39 countries, which include 2.70 billion people in Asia alone. Rice plants provide an attractive and nutritious food source for many phytophagous insects. Among various biotic constraints of rice production, the insect pests are of prime importance and warm humid environment of the crop is also conducive for their survival and proliferation. Hundreds of insect species damage rice to various degrees, but only ~ 20 species occur regularly and cause major damage to rice. Amongst the different leafhoppers and planthoppers species the well-known pest Brown plant hopper (BPH), *Nilaparvata lugens* (Stal) has caused devastating damages to rice crop in China, Japan, Korea and Vietnam. In 2005 and 2008, China reported a combined yield loss of 2.7 million tons of rice due to direct damage by BPH, while a yield loss of 0.4 million tons in Vietnam was mainly due to two virus diseases, RGSV and RRSV, transmitted by BPH.

The hopper feeding interferes with the translocation of photosynthates from sources in leaves to sink in tiller buds or grains, thus affecting plant growth, development, and yield. The rice plant hoppers are common in rainfed and irrigated conditions. At the high population density of these pests, hopper burn or complete drying of the plants is observed, which may result in up to 40-70% yield loss. The infestation and hopper burn occurrence leads to severe yield losses up to the tune of 70-100%. Under future warming scenarios, BPH's overwintering boundaries in China are expected to shift northward. In India, highly suitable areas for BPH are predicted to increase, with temperature being the primary influencing factor. Future projections indicate varying impacts across different regions in India, with some areas experiencing increased BPH abundance. To develop a sustainable pest management system, it is important to find the

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right balance between breeding and management strategies to reduce the ecological fitness of BPH and to keep the pest under economic threshold levels. Host-plant resistance is the most effective and environment friendly approach to control the damage caused by insects and increase yield potential of cereal crops.

1.2: Factors responsible for BPH outbreaks:

- Wide spread planting of modern varieties
- Closer spacing
- Inadequate weed control
- Water stagnation for prolonged periods
- Increased use and excess dose of N fertilizers
- Indiscriminate use of insecticides especially, synthetic pyrethroids
- Temperature, relative humidity and prevailing wind direction determine the severity of incidence and spread of BPH

The following mentioned factors are to be looked upon under the climatic fluctuation's scenario for effective prediction of BPH outbreaks.

1.3: Symptoms of damage

The crop is targeted from the late vegetative stage to the grain hardening stage. Adults and nymphs gather near the plant's base above the water and draw sap from the tillers. The afflicted plant dries up and develops "hopper burn," a burned appearance. Typical signs of this pest include mature plant lodging and circular spots of drying. Their excretion called honeydew which invites sooty mould growth on the foliage. It is a vector of grassy stunt and ragged stunt diseases.

Fig 1: Hopper burn symptoms in rice field condition

Fig 2: Brown plant hopper on rice plant

1.4: Rice resistance genes against BPH

The changes of development of resistant against chemicals of BPH can be fatal which may lead to no reciprocal turn. The effective management option is the development of resistant rice varieties. The resistance of germplasm to BPH has been explored since 1969, resulting in the detection of 24 resistance genes, till date in cultivated *O. sativa* and wild species of rice including *O. australiensis*, *O. eichingeri*, *O. latifolia*, *O. officinalis*, *O. rufipogon*, *O. glaberrina*, and *O. minuta*. The loci of *Bph25*, *Bph26*, and *Bph27* have recently been shown to be the same as these of *Bph20*, *Bph21*, and *Bph18* . To date, 20 BPH resistance genes have been

Table 1: Genes from different species of paddy exhibiting resistance to brown plant hopper

Gene cluster	Chromosome	Gene	Marker	Source/variety	Reaction to biotypes of BPH			
					1	2	3	4
1	3S	Bph13	AJ09b230,AJ09c	*Oryza eichinger*	R	R	-	-
2	3S	Bph19	RM6083, RM3134	AS 20-1	-	R	-	-
3	3L	Bph 14	R1925	*O.offisinalis*	R	R	-	-
4	3L	Bph 11	G1318	*O.offisinalis*	-	-	-	-
5	4S	Bph16	-	*O. offisinalis*	-	-	-	-
6	4S	Bph12	RM261	*O.offisinalis*	-	-	-	-
7	4S	Bph15	C820, R288	*O.offisinalis*	R	R	-	-
8	4S	Bph17	RM8213	*O. offisinalis*	R	R	-	-
9	4S	Bph 20	MS10	*O. minuta*	R	-	-	-
10	4L	Bph 6	RM6997, RM5742	swarnalata	S	S	S	R
11	6S	Bph 4	C76A	Babawee	R	R	R	R
12	6S	Bph22	RM858, RM225, RM584	*O. glaberimma*	R	R	-	-
13	6S	Bph 3	RM589	Rathu Heenati	R	R	R	R
14	7L	Bph7	RM542, RM500	T12	S	S	S	R
15	12L	Bph2	RM463, RM7102	ASD7	R	R	R	-
16	12L	Bph10	RG242	*O. australiensis*	R	R	S	S
17	12L	Bph21	RM3726, RM5479	*O. minute*	R	-	-	-
18	12L	Bph 9	RM463, RM5341	kaharmana	R	R	R	-
19	12L	Bph18	RM463, 7312.T4A	*O.offisinalis*	-	-	-	-
20	12L	Bph1	BpE 18-3	Mudgo	R	S	R	S
21	-	Bph5		ARC10550, Col 5 Thiland	S	S	S	R
22	-	Bph 8		Col 11 Thiland,Chin saba	S	S	S	R
23	-	Bph 23		*O.minute*	R	R	-	-
24	-	Bph 24		*O. rufipogon*	-	-	-	-

located on the rice chromosomes. The relationships between BPH resistance genes and the biotypes of BPH have been shown to be gene-for-gene, but are not as specific as the relationships found in disease resistance.

1.5: Conclusion:

Brown planthopper (*Nilaparvata lugens*) is one of the important economic pests of rice. It is a serious pest that is considered a threat to rice production. Understanding the ecology and biology of this pest is a prerequisite for developing and implementing effective control measures. The control strategy that has been proven effective against brown planthopper is integrated pest management (IPM). IPM programs are usually eco-friendly and oriented towards minimum use of synthetic pesticides. Climate change will impact BPH populations differently across regions, necessitating location-specific monitoring and management strategies. Integrated pest management combining alleyways, optimal nitrogen application, alternate wetting and drying, and targeted insecticide use has shown effectiveness in reducing BPH incidence and improving yields. Surveillance and monitoring are crucial for timely interventions. Future management approaches should consider resource availability, economic factors, and the complex interplay between BPH, rice ecosystems, and changing environmental conditions.

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