Tamil Nadu, causing yield losses up to 85%. To study the influence of foliar sprays of macro- and micronutrients on the development of ShR, a pot experiment using IR20 was conducted at the Paddy Experiment Station, Ambasamuduram, in 1984-85. The nutrients were sprayed twice at 30 and 55 d after transplanting (DT), and the plants were inoculated artificially with *S. oryzae* by inserting a single infected rice grain between the leaf sheath enclosing the panicle and the culm of a tiller. Inoculation was done at 65 DT and the disease incidence recorded 30 d after inoculation. Five tillers from each hill were selected at random and graded for disease incidence by SES and the percentage disease index was calculated.

ShR incidence was significantly lower in $CaSO_4$, $ZnSO_4$, and KCl treatments (see table). $CaSO_4$ and $ZnSO_4$ gave the highest grain yield. Spraying with $CuSO_4$ also produced increased yield and decreased ShR incidence. Foliar spray with urea had no effect on disease incidence or grain yield.

Influence of foliar spray of macro- and micronutrients on ShR incidence and rice grain yield.[a]

Nutrient	Concentration (%)	ShR disease index (%)	Grain yield (g/hill)
Urea	2.0	36.6 d	9.8 c
KCl	1.0	21.0 a	10.5 b
K_2SO_4	1.0	25.8 b	10.2 bc
$CaSO_4$	2.0	18.5 a	11.3 a
$MgSO_4$	1.0	27.0 b	10.2 bc
$ZnSO_4$	1.0	20.4 a	11.2 a
$CuSO_4$	0.2	24.6 b	10.4 b
$MnSO_4$	1.0	30.6 c	10.3 bc
$FeSO_4$	1.0	32.4 c	10.0 c
Mixture (Zn: Cu: Mg: Fe: Mn = 10: 5: 2: 2: 1)	1.0	25.2 b	10.2 bc
Control	–	35.4 d	9.9 c

[a] In a column, means followed by a common letter are not significantly different at the 5% level by DMRT.

Pest Control and Management

INSECTS

Multiple allelism in brown planthopper (BPH) body color

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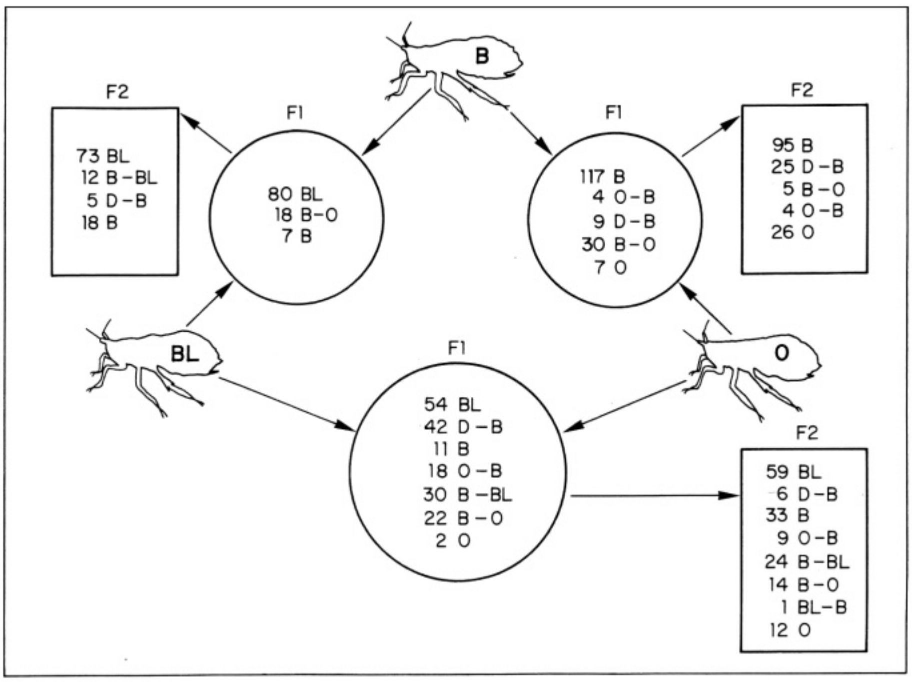
Adult BPH *Nilaparvata lugens* generally are brown. Occasionally, however, a few orange (O) and black (BL) variants appear in stock cultures maintained on rice plants. Crossbreeding these purified discrete color morphs and inbreeding their progenies have enabled the expression of intermediate color morphs that are dark brown (D-B), brownish orange (B-O), orange brown (O-B), blackish brown (BL-B), and brownish black (B-BL). To understand how BPH body color is inherited and to determine the influence of environment, we conducted breeding experiments involving at least two generations.

Parent insects came from pure breeding lines and were homozygous for body coloration. The figure summarizes the results of the hybridization experiments. Inheritance of color morphism had the following trends:



Hybridization scheme between brown (B), orange (O), and black (BL) BPH color morphs. F1 and F2 progenies comprising additional color morphs — dark brown (D-B), brownish orange (B-O), orange-brown (O-B), blackish brown (BL-B), and brownish black (B-BL) — are depicted within circles and rectangles. IRRI, 1985.

1. The BPH gene for color morphism exists in three allelic forms, although any diploid male or

female can carry no more than two alleles. Thus, body coloration exhibits multiple allelism. The three alleles can be designated as b^+ (brown or wild type allele), b^o (orange allele), and b^b (black allele). The results of backcrosses show BPH has six possible genotypes — three homozygotes: b^+b^+ (brown), $b^\circ b^\circ$ (orange), and b^bb^b (black), and three heterozygotes: b^+b° (brownish orange), b^bb^+ (blackish brown), and b^bb° (dark brown). These heterozygotes exhibited some other allelic interactions leading to further variations, such as $b^\circ b^+$ (orange-brown) and b^+b^b (brownish black), in the expressivity of body coloration; no allelic interaction occurred between b^b and b^o.

2. The six possible genotypes produced as many as eight different phenotypes, indicating that in this species, the relation between phenotype and genotype is not fixed. The observed phenotypes may result from an interaction between different genes or between genes and the environment. All possible color morphs were obtained in reciprocal crosses of black and orange BPH.
3. Crosses between B and O and B and BL individuals produced F2 frequency ratios that fit with monogenic inheritance or segregation of a pair of alleles at a single locus. B had some dominance over O, and B1 over B. No specific pattern of inheritance could be depicted between BL and O; however, B had partial dominance over O (see figure).
4. Intermediates between the extreme parents in the F1 and F2 of all the crosses were manifestations of certain variabilities that can be attributed to
   a. residual heredity or filial regression due to incomplete dominance, environment, and epistasis, or
   b. modifier genes that change the phenotypic effects of other genes in quantitative fashion through dilution or enhancement of major gene effects.

Ephydrid flies [Diptera:Ephydridae] of rice in the Philippines

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Rice whorl maggot (RWM) *Hydrellia philippina* Ferino is the only ephydrid rice pest recorded in the Philippines. RWM damages rice leaves at early vegetative stage all year in rainfed and irrigated lowlands.

We collected ephydrid flies by D-Vac suction machine, sweep net, and mylar plastic cone traps from 1977 to 1980 from different rice cultures in the Philippines. Cone traps were placed open-end-down over flies on plants. The mylar plastic cone trap caught more flies than D-Vac or sweep nets. Plants with leaf damage were dissected for larvae and pupae, which were reared to adulthood on leaf sections kept on moist filter paper in plastic dishes.

The ephydrid fauna of Philippine rice fields includes 10 genera and 18 species. Of the species, 12 are phytophagous, 5 are scavengers, and 1 is a predator (see table), as determined by P.J. Clausen, Entomology Department, University of Minnesota, USA, except *Ochthera.* Eleven species in seven genera are new Philippine records.

Ephydrid flies of rice in the Philippines.

Species	Rice culture[a]			
	Upland	Rainfed lowland	Irrigated lowland	Irrigated rice terraces
1. *Actocetor beckeri* de Meijere [be]	+	–	–	–
2. *Brachydeutera longipes* Hendel [c]	++			+[f]
3. *Discomyza maculipennis* (Weidemann) [be]	–	+	–	–
4. *Hydrellia griseola* (Fallen) [ce]	–	–	+[f]	+[f]
5. *Hydrellia philippina* Ferino [c]	–	+[f]	+[f]	–
6. *Notiphila latigenis* Hendel [ce]	–	+	+[f]	+[f]
7. *Notiphila similis* de Meijere [ce]	–	+[f]	+	–
8. *Notiphila spinosa* Cresson [c]	–	+	+[f]	+
9. *Ochthera* sp. [d]	–	+	+	+
10. *Paralimna lineata* de Meijere [c]	+	+[f]	–	–
11. *Paralimna picta* Kertesz [c]	–	+[f]	–	+[f]
12. *Polytrichophora brunneifrons* (de Meijere) [be]	–	+	+	+
13. *Psilopa flavimana* Hendel [ce]	–	–	+[f]	–
14. *Psilopa pollinosa* (Kertesz) [ce]	–	+[f]	+[f]	–
15. *Psilopa rufipes* Hendel [c]	–	–	+[f]	+
16. *Psilopa sorella* Becker [ce]	–	+[f]	–	–
17. *Scatella callisicosta* Bezzi [be]	–	–	+	–
18. *Scatella* sp. [be]	–	–	+	–
Total	3	11	13	8

[a] + = collected, – = not collected. [b] Scavenger. [c] Phytophagous. [d] Predator. [e] New Philippine record. [f] Reared from plants with leaf damage.

Three species live in uplands, 11 in rainfed lowlands, 13 in irrigated areas, and 8 in irrigated rice terraces. All but *Actocetor beckeri* de Meijere were recorded in lowland and irrigated areas, which suggests that ephydrid flies prefer aquatic or semiaquatic environments. The Banawe rice terraces, which have high elevation and low temperature, and produce two rice crops a year, had almost the same species as the rainfed and irrigated lowlands.

Twelve species belonging to the subfamilies Psilopinae and Notiphilinae (except *B. longipes*) emerged from the plants with whorl maggot leaf damage and were considered phytophagous (see table and figure). *Hydrellia Notiphila, Paralima,* and *Psilopa* are phytophagous genera from the rainfed