

# Compatibility of insecticides with rice resistance to planthoppers as influenced by the timing and frequency of applications

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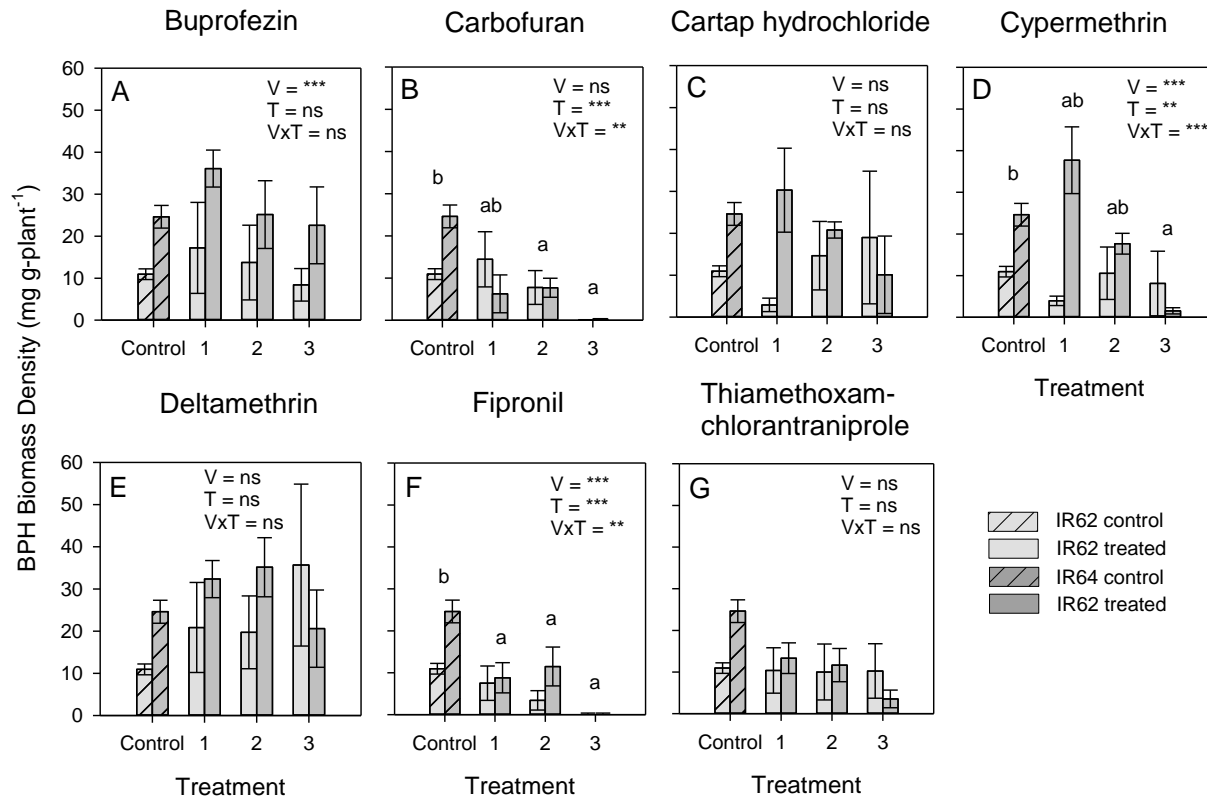
## Supplementary Information

**Table S1:** Planthopper density (number per g plant) on IR62 and IR64 rice plants treated with one, two or three applications of each of seven insecticides. Results for non-treated controls are also presented. The proportions of plants surviving are also indicated. All plants were infested with four gravid female BPH at 40 DAS and again with two gravid females at 60 DAS. Numbers are means  $\pm$  SEM

Variety and Insecticide	Number of Applications	Proportion of Plants Surviving <sup>1</sup>	Number of BPH per g of Plant <sup>1</sup>
IR62			
Buprofezin	1	0.60 $\pm$ 0.24 abc	127.65 $\pm$ 38.04
	2	0.60 $\pm$ 0.24	164.00 $\pm$ 61.64
	3	0.80 $\pm$ 0.20	102.19 $\pm$ 33.47
Carbofuran	1	0.80 $\pm$ 0.20 c	320.59 $\pm$ 211.83
	2	1.00 $\pm$ 0.00	372.38 $\pm$ 8.28
	3	1.00 $\pm$ 0.00	0.45 $\pm$ 0.39
Cartap hydrochloride	1	1.00 $\pm$ 0.00 abc	43.13 $\pm$ 37.06
	2	0.60 $\pm$ 0.24	31.58 $\pm$ 17.67
	3	0.60 $\pm$ 0.24	57.48 $\pm$ 42.85
Cypermethrin	1	1.00 $\pm$ 0.00 ab	72.51 $\pm$ 23.82
	2	0.60 $\pm$ 0.24	202.24 $\pm$ 172.39



linear models using the Addelman (1974) method are as follows: variety, 1; treatment, 6; applications, 2; V×T, 5; control, 1; denominator degrees of freedom are 170. Non-significant interactions are not presented.



**Figure S1:** Biomass density of brown planthopper (BPH) on IR62 (resistant) and IR64 (susceptible) rice plants with 0 (control), 1, 2 or 3 applications of A) buprofezin, B) carbofuran, C) cartap hydrochloride, D) cypermethrin, E) deltamethrin, F) fipronil, or G) thiamethoxam-chlorantraniprole. Graphs are redrawn based on data presented in Figure 1 of the main text to highlight control plants versus plants treated with each insecticide. Results of univariate GLMs for each insecticide are indicated as V (variety effect), T (treatment effect, including controls), and VxT (variety x treatment interaction). Ns = not significant, \*\* =  $P \leq 0.01$ , \*\*\* =  $P \leq 0.005$ . Lowercase letters indicate homogenous treatment groups. Standard errors are indicated. For further details of analyses, see Table S2.

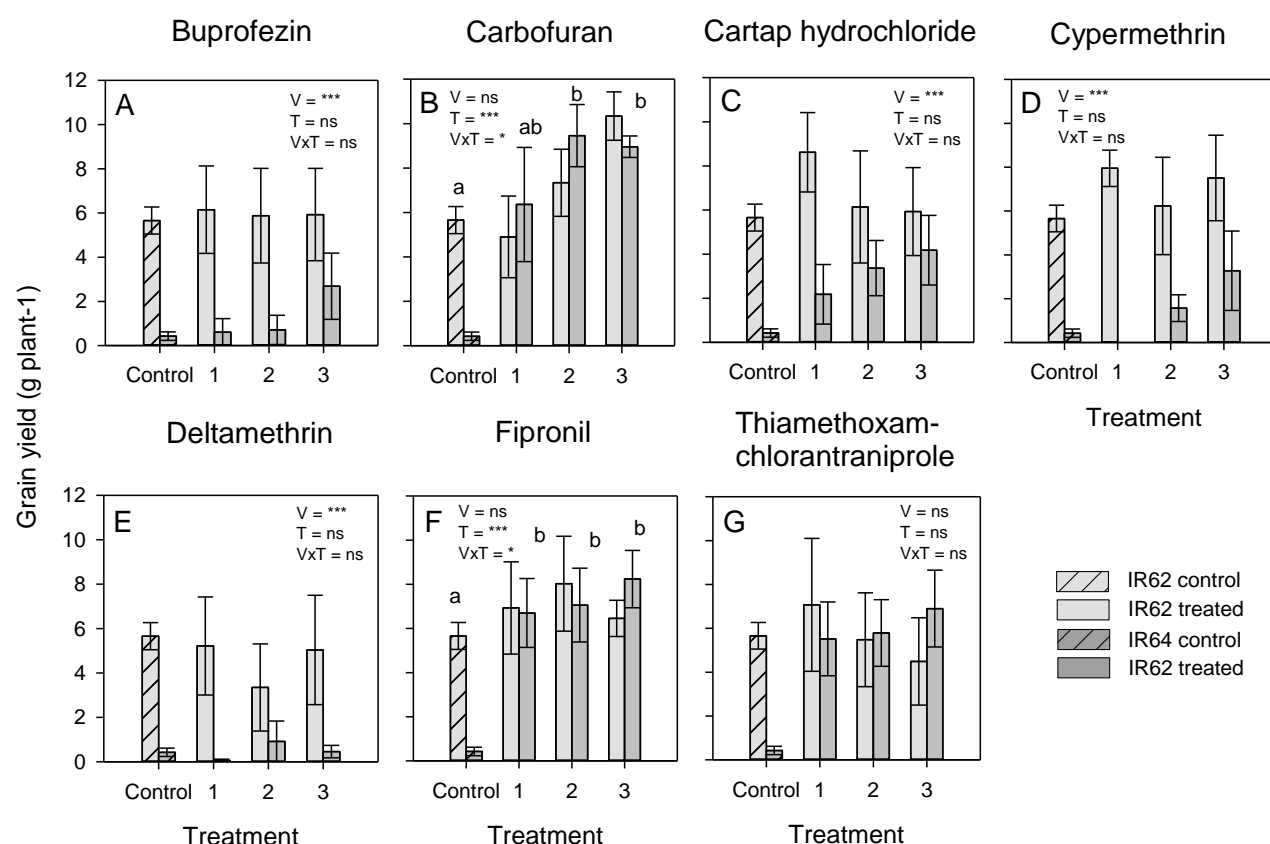
**Table S2:** Results from univariate GLMs for planthopper biomass density (biomass per g plant), and density (number per g plant). Results from analyses of plant survival and plant yields (weight of grain) are also presented. GLMs were conducted separately for each insecticide product. Results from comparative analyses of all seven insecticides are presented in the main text (Figure 1, Table 2)

Parameter <sup>1</sup>	Sources of Variation <sup>2</sup>	F-values <sup>3</sup>						
		Buprofezin	Carbofuran	Cartap Hydrochloride	Cypermethrin	Deltamethrin	Fipronil	Thiamethoxam + Chlorantraniprole
Biomass density (mg per g plant)	Variety (V)	10.020***	0.673ns	3.079ns	14.272***	1.120ns	11.474***	1.230ns
	Treatment (T)	0.953ns	9.848*** (LC***)	0.108ns	4.607** (LC***)	0.402ns	17.288*** (LC***)	2.529ns
	V×T	0.109ns	4.243**	1.751ns	6.399***	1.255ns	3.897**	2.213ns
Density (number per g plant)	Variety (V)	1.407ns	1.747ns	6.258**	2.752ns	3.049ns	0.317ns	0.630ns
	Treatment (T)	0.359ns	0.914ns	1.801ns	5.088**	1.169ns	3.569* (LC***)	0.596ns
	V×T	0.440ns	0.873ns	2.311ns	0.553ns	0.609ns	0.909ns	1.071ns
Plant survival (proportion)	Variety (V)	10.125***	5.738*	6.946**	34.290***	11.340***	5.833*	0.001ns
	Treatment (T)	0.458ns	2.678ns	0.868ns	0.744ns	1.260ns	3.967*	1.152ns
	V×T	0.792ns	3.290*	0.868ns	1.826ns	1.260ns	4.589**	5.070**
Yield (g per plant) - infested	Variety (V)	24.825***	0.559ns	14.587***	135.476***	19.177***	1.738ns	0.469ns
	Treatment (T)	0.330ns	8.668*** (LC***)	0.976ns	1.106ns	0.146ns	5.769*** (LC***)	1.251ns
	V×T	0.295ns	2.795*	1.044ns	0.816ns	0.439ns	2.790*	1.628ns

1: Means for density and plant survival are presented in Table S1; means for biomass density are presented in Figures 1 and Figure S1; means for yield are presented in Table 2 and Figure S2

2: Degrees of freedom for variety = 1,28; treatment = 3,28; and V×T interaction = 3,28. Block effects are not presented

3: ns = P > 0.05; \* = P ≤ 0.05; \*\* = P ≤ 0.01; \*\*\* = P ≤ 0.001; LC = significant linear contrast



**Figure S2:** Grain production (yields) for IR62 (resistant) and IR64 (susceptible) rice plants with 0 (control), 1, 2 or 3 applications of A) buprofezin, B) carbofuran, C) cartap hydrochloride, D) cypermethrin, E) deltamethrin, F) fipronil, or G) thiamethoxam + chlorantraniprole. Graphs are redrawn based on data presented in Table 2 of the main text to highlight control plants versus plants treated with each insecticide. Results of univariate GLMs for each insecticide are indicated as V (variety effect), T (treatment effect, including controls), and VxT (variety x treatment interaction). ns =  $P > 0.05$ , \* =  $P \leq 0.05$ , \*\*\* =  $P \leq 0.005$ . Lowercase letters indicate homogenous treatment groups. Standard errors are indicated. For further details of analyses, see Table S2

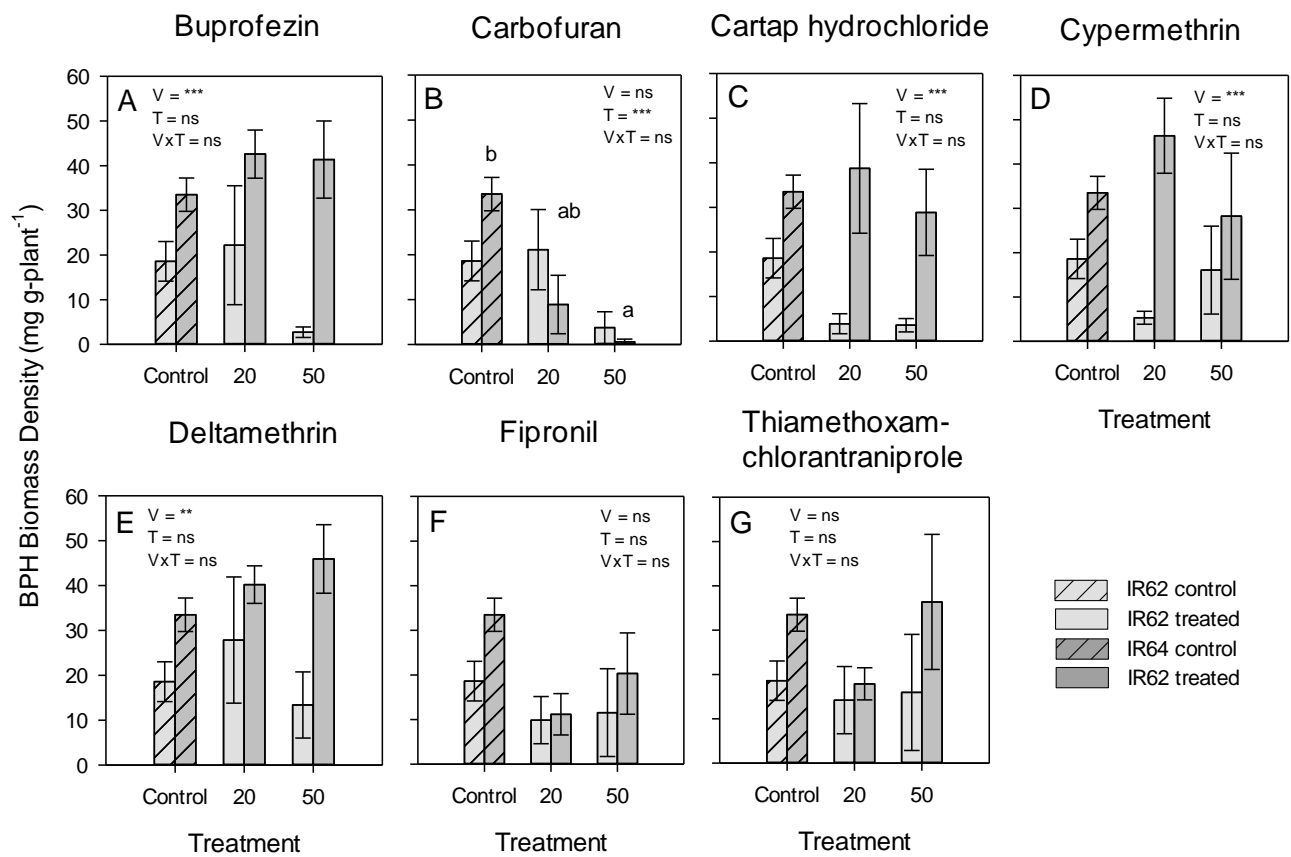












**Figure S3:** Biomass density of brown planthopper (BPH) on IR62 (resistant) and IR64 (susceptible) rice plants with 0 applications (control), and with applications at 20 and 50 DAS of A) buprofezin, B) carbofuran, C) cartap hydrochloride, D) cypermethrin, E) deltamethrin, F) fipronil, or G) thiamethoxam + chlorantraniprole. Graphs are redrawn based on data presented in Figure 1 of the main text to highlight control plants versus plants treated with each insecticide. Results of univariate GLMs for each insecticide are indicated as V (variety effect), T (treatment effect, including controls), and VxT (variety x treatment interaction). ns =  $P > 0.05$ , \*\* =  $P \leq 0.01$ , \*\*\* =  $P \leq 0.005$ . Lowercase letters indicate homogenous treatment groups. Standard errors are indicated. For further details of analyses, see Table S6.

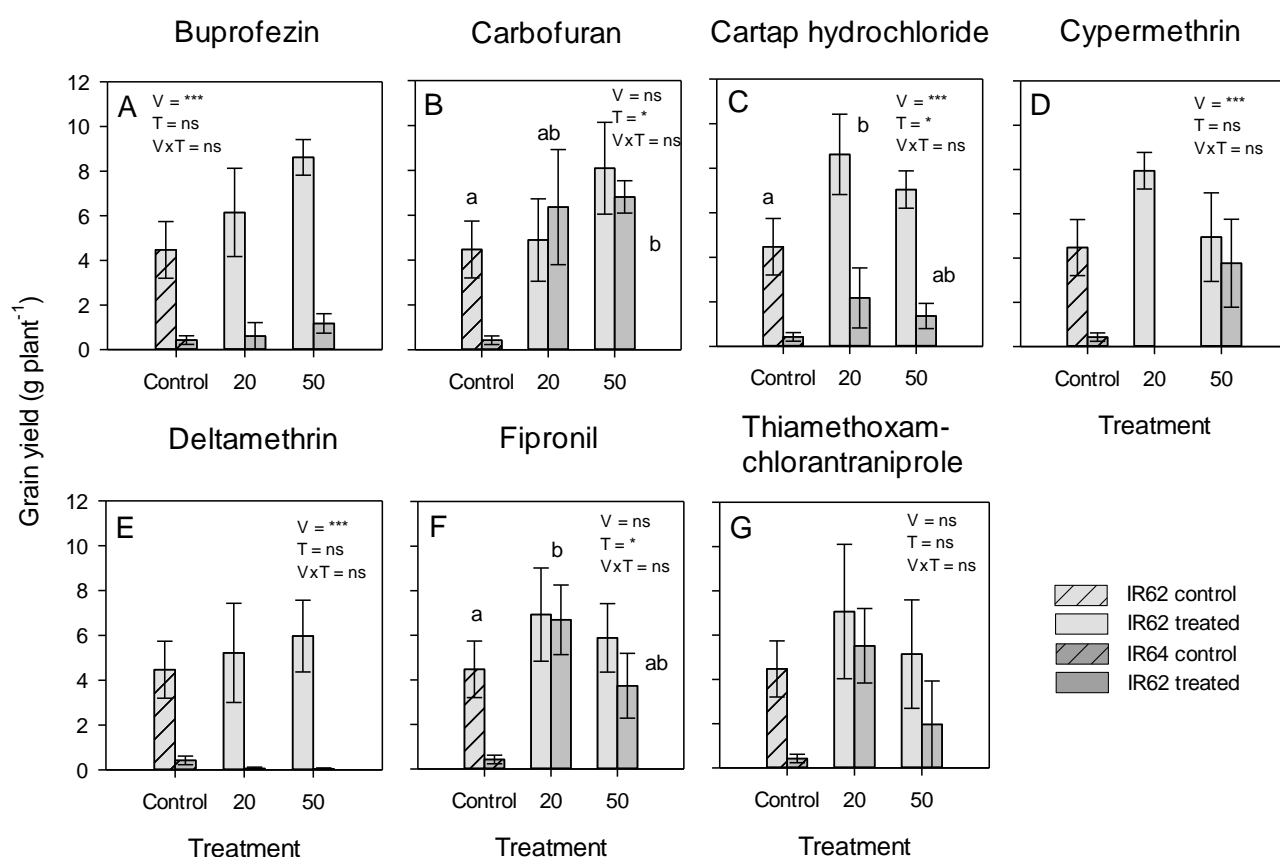
**Table S6:** Results from univariate GLMs for planthopper biomass density (biomass per g plant), and density (number per g plant). Results from analyses of plant survival and plant yields (weight of grain) are also presented. GLMs were conducted separately for each insecticide product. Results from comparative analyses of all seven insecticides are presented in the main text (Figure 3, Table 3)

Parameters <sup>1</sup>	Sources of Variation <sup>2</sup>	F-values <sup>3</sup>						
		Buprofezin	Carbofuran	Cartap hydrochloride	Cypermethrin	Deltamethrin	Fipronil	Thiamethoxam + chlorantraniprole
Biomass density (mg per g plant)	Variety (V)	20.791***	0.001ns	16.971***	10.750***	8.876**	2.218ns	2.614ns
	Treatment (T)	1.244ns	9.189***	0.874ns	0.135ns	0.476ns	2.649ns	0.696ns
	VxT	7.761ns	3.071ns	0.899ns	1.768ns	0.901ns	0.493ns	0.376ns
Density (number per g plant)	Variety (V)	10.868***	1.287ns	17.894***	4.329*	0.623ns	0.004ns	1.766ns
	Treatment (T)	0.379ns	2.827ns	0.520ns	0.963ns	1.331ns	1.550ns	0.407ns
	VxT	2.787ns	1.900ns	3.151ns	0.900ns	0.074ns	0.586ns	0.368ns
Plant survival (proportion)	Variety (V)	19.756***	0.192ns	96.000***	12.549***	13.913***	0.192ns	2.254ns
	Treatment (T)	3.171ns	7.115***	6.000**	1.765ns	0.217ns	5.192**	1.690ns
	VxT	0.732ns	2.500ns	6.000**	2.549ns	0.217ns	2.500ns	0.563ns
Yield (g per plant) - infested	Variety (V)	49.461***	0.799ns	34.694***	14.426***	22.893***	3.296ns	3.658ns
	Treatment (T)	3.109ns	4.129*	3.501*	1.009ns	0.096ns	4.560*	2.233ns
	VxT	1.488ns	1.222ns	0.599ns	2.874ns	0.270ns	0.868ns	0.230ns

1: Means for density and plant survival are presented in Table S5; means for biomass density are presented in Figure 3 and Figure S3; means for yield are presented in Table 3 and Figure S4

2: Degrees of freedom for variety = 1,20; treatment = 3,20; and V×T interaction = 3,20. Block effects are not presented

3: ns = P > 0.05; \* = P ≤ 0.05; \*\* = P ≤ 0.01; \*\*\* = P ≤ 0.05



**Figure S4:** Grain production (yields) for IR62 (resistant) and IR64 (susceptible) rice plants with 0 applications (control), and with applications at 20 and 50 DAS of A) buprofezin, B) carbofuran, C) cartap hydrochloride, D) cypermethrin, E) deltamethrin, F) fipronil, or G) thiamethoxam + chlorantraniprole. Graphs are redrawn based on data presented in Table 3 of the main text to highlight control plants versus plants treated with each insecticide. Results of univariate GLMs for each insecticide are indicated as V (variety effect), T (treatment effect, including controls), and VxT (variety x treatment interaction). Ns =  $P > 0.05$ , \* =  $P \leq 0.05$ , \*\*\* =  $P \leq 0.005$ . Lowercase letters indicate homogenous treatment groups. Standard errors are indicated. For further details of analyses, see Table S6.







