Phoxim acts as an environmental stress for insect parasitoid wasp

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Chemical insecticides play essential roles in controlling the agricultural insect pests during the past decades. However, more evidence indicates that the insecticides impose great stresses such as environmental pollution, pest resistance and human health. Although a plenty of researches well demonstrated the mechanism of pest resistance under insecticide stress (Ehler, 2010), its impact on non-target insects still receives less attention. Insect parasitic wasps are often used as biocontrol agents in agroecosystems to manager the increase of insect pest's population. On the other hand, they can easily encounter insecticides through direct exposure to spray droplets or residues on crop foliage (Jepson, 1989; Desneux et al., 2004), resulting in the failure of pest control of parasitoid wasps. As the natural enemies and non-target insects, the detail information of how parasitic wasps response insecticides stress still remains unknown.

In the present study, we chose the insecticide O, O-diethyl O-(alpha-cyanobenzylideneamino) phosphorothioate (phoxim) (Wang et al., 2013) and parasitic wasp *Meteorus pulchricornis* (Sheng et al., 2014) as the research system, aiming to evaluate the effect of phoxim on behavioral response and detoxifying system in *M. pulchricornis*. The behavioral tests revealed that after exposure to LC_{30} phoxim, female *M. pulchricornis* adults significantly shortened their patch residence time (Fig. 1). Meanwhile, the oviposition behavior (the number of oviposition) was also negatively affected by LC_{30} phoxim. By using RNA-Seq technology, we screened hundreds of differentially expressed genes and among these, seven detoxifying enzyme genes, including cytochrome P450 and esterase genes, were identified (Table 1). Interestingly, all these seven genes were down-regulated, suggesting the LC_{30} phoxim can inhibit the transcriptional levels of main detoxifying enzyme genes in *M. pulchricornis*. qRT-PCR validation also confirmed the RNA sequencing data.

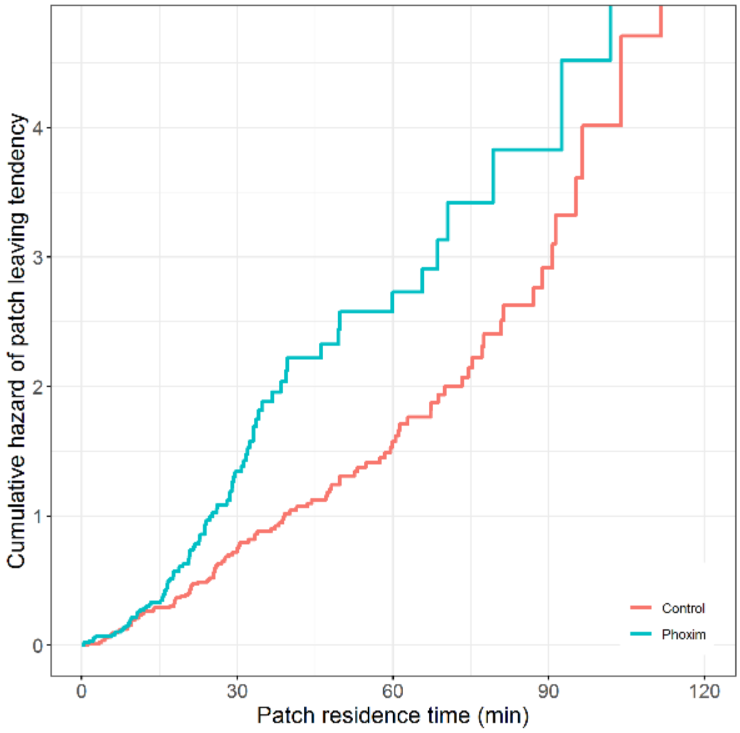

Fig. 1 Cumulative leaving tendency (hazard functions) of *M. pulchricornis* in response to phoxim

Table 1 The differentially detoxifying enzyme expressed genes in *M. pulchricornis* after they exposed to LC_{30} phoxim

Gene ID	Log_2fold Change	P value	Gene Description	Up/Down regulation
Cytochrome P450				
Cluster-6774.4984	-1.47	4.53E-48	carboxylesterase-6-like	Down
Cluster-6774.5536	-1.42	8.03E-08	cytochrome P450 6k1-like	Down
Cluster-6774.5564	-1.84	1.61E-09	cytochrome P450 4g15	Down
Cluster-6774.6700	-1.67	8.85E-18	cytochrome P450 4g15	Down
Cluster-6774.8625	-1.22	3.93E-05	cytochrome P450 4C1-like	Down
Esterase				
Cluster-6774.5376	-1.80	2.74E-27	esterase FE4	Down
Cluster-6774.7298	-2.0	3.35 E-5	esterase E4	Down

In conclusion, the present study demonstrated that the commonly used insecticide phoxim can act a strong environmental stress for the non-target and natural enemy parasitic wasp *M. pulchricornis* by lowering its behavioral efficacy and inhibiting the expression of detoxifying enzyme genes. Therefore, the application of phoxim must be cautious in the agroecosystem in the future.

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