Chlorpyrifos Summary

Chlorpyrifos is a commonly used organophosphate insecticide. Many formulations contain various solvents as inert or active ingredients. It is often formulated in combination with other active ingredients such as allethrin, dichlorvos, and resmethrin.

Potential Contaminants

Technical chlorpyrifos is made by reacting different chemicals together. One method of reaction is carried out in an organic liquid such as acetone, dimethylformamide, or carbon tetrachloride. The technical grade compound may contain impurities analogous to dibenzodioxins.

Environmental Fate

The persistence of chlorpyrifos in soil varies considerably (half-life 11 - 141 days). It is not expected to leach significantly. A major degradation product, 3,5,6-trichloro-2-pyridinol (TCP), is mobile and sufficiently persistent in soil to be considered a potential groundwater concern.

The half-life of chlorpyrifos indoors is over 30 days. It is moderately residual on plant surfaces and quite residual on inert surfaces such as wood. Airborne concentrations after a crack and crevice application ranged from 1100 to 300 nanograms per cubic meter.

Toxicity

Acute

Technical grade chlorpyrifos is acutely toxic. It has caused severe cholinesterase inhibition in all species tested and by all routes tested. In a human study, the lowest effect level was 0.10 mg/kg. EPA requires a 24 hour reentry interval, due to lack of adequate dissipation, exposure, and acute inhalation data. Chlorpyrifos was reported as the seventh most common cause of hospitalized pesticide poisoning in California. The main source of the poisonings was use in the workplace, typically office buildings.

Chronic

Although one carcinogenicity study has not been completed, the existing study did not find any carcinogenic effects. The results of mutagenicity tests are equivocal. Positive results such as sex chromosome loss and nondisjunction and sister chromatid exchange

have been seen in some tests, but not in others. The California Department of Food and Agriculture summarized their findings on chlorpyrifos as: no adverse effect when testing for gene mutation or chromosome aberrations but possible adverse effect for DNA damage. The only effects seen in developmental testing were minor skeletal variations at maternally toxic doses. Reproductive effects (fewer hatched ducklings per successful nest) were seen in mallards. A separate avian study found locomotor dysfunction and significantly reduced reproductive potential. Two rat reproductive studies at similar doses (up to 1.2 mg/kg/day) have had mixed results -- one negative, one with slight increase in neonatal mortality.

TCP is a major metabolite and degradation product of chlorpyrifos. It is not as acutely toxic as chlorpyrifos. Mutagenic tests have been negative. However, in a teratology mouse study with TCP, an increased number of fetuses and litters were reported to have hydrocephaly (increased accumulation of fluid in the brain) or hydrocephaly/dilated cerebral ventricles.

Nontarget effects

Chlorpyrifos is extremely toxic to fish, birds, and wildlife. Studies suggest hazard to aquatic invertebrates at expected exposure levels. Maximum bioconcentration factors in fish ranged from 1290x to 3903x in one study.

Conclusions

Using the established review criteria, chlorpyrifos fails for several reasons. For interior applications, the concerns would be persistence, developmental effects in one of the breakdown products, possible reproductive effects, cholinesterase inhibition in county employees reentering treated buildings, and skin/eye irritation. Although not documented, given the available information, contaminants may also be a toxicological issue.

If intended for outside use, additional concerns would be persistence of chlorpyrifos, persistence and mobility of a major degradate (TCP), bioaccumulation, acute toxicity to fish, and nontarget effects on fish, aquatic invertebrates, birds, and wildlife.