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ipmPRiME.org: Making Informed Pesticide Use Decisions Based on Risk

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Pesticides and IPM

Farmers' capacity to make wise and informed decisions and adapt to changing circumstances determines the success of their businesses. The same can be said of a grower's integrated pest management (IPM) program. Many IPM strategies and tools support profitable production of safe food, feed and fiber, including the sensible use of selective and broad-spectrum pesticides. **U.S. laws governing the use of pesticides are the most stringent in the world, including the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) and Food Quality Protection Act (FQPA) that ensure a reasonable certainty of no harm from pesticide residues in food and the environment.** One reason for this remarkable safety record is the extensive toxicity studies conducted by agrochemical companies to support EPA product registration, which include tests of a pesticide's effects on soil organisms, birds, small mammals, fish, other aquatic species and worker/bystander health and safety. While pesticides are regulated to ensure their safe use, and are an important and practical component of IPM programs, IPM practitioners understand that pesticides may affect organisms that pose no threat to agricultural yields or public health, including pollinators and natural enemies (Jepson 2009, McGlaughlin and Mineau 1995). Growers and pest managers consider many factors when choosing a pesticide, including efficacy, price, spectrum of activity, residual, market restrictions, re-entry times, pre-harvest intervals and more. **Another factor to consider, within an IPM context, is the extent to which a specific application (or indeed, a season-long program) may adversely affect non-target organisms.** Selective pesticides are designed to affect certain pests, leaving non-target organisms unharmed.

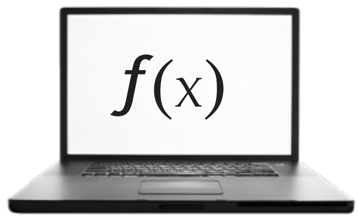
ipmPRiME.org is a free decision-support tool for growers and pest managers which calculates the site-specific probability of harm to 8 types of non-target organisms, based on toxicity data developed by product registrants and independent studies. Hosted by the Integrated Plant Protection Center (IPPC) at Oregon State University, ipmPRiME.org is a peer-reviewed, science-based tool for quantifying and mitigating pesticide environmental impacts on non-target organisms. It can be used to document the low or negligible pesticide risks of IPM programs (Guzy et al. 2014). An individual pesticide might be hazardous; however, **by implementing mitigation procedures on a site-specific basis, a grower can lower risks, increase safety, and maintain this pesticide as part of their overall IPM strategy.** Risks might be mitigated, for example, by selecting a different product, formulation, or application method, by adding a buffer zone, or by spraying at a time when non-target organisms are not likely to be present.

Scientific Basis of ipmPRiME.org

ipmPRiME.org is designed to ***connect*** critical doses and concentrations from lab studies **to** adverse effects of pesticides observed in field studies **by way of** a statistical model ***that***

connects critical doses & concentrations
from **Lab Studies** to adverse effects of pesticides

using a Statistical Model



to **Predict** the potential for **ecological injury**

predicts the potential for ecological injury from pesticide treatments.

Although IpmPRiME.org ranks pesticides based on their calculated risks, it does not provide an absolute measure of environmental harm. IpmPRiME.org computes risk of harm in the field as a function of pesticide toxicity, application rate, application method, and site characteristics. The lbs. active ingredient/acre rates of products are transformed to a uniform "toxicity units" scale so that different active ingredients are comparable. Scaling factors come from chemical-specific Species Sensitivity Distributions (SSD; Postuma et al. 2002). SSD extend the concept of standard test species (e.g. the mallard) to all similar species that may not have been tested in the lab (Luttik et al. 2005, Forbes and Calow 2002, Posthuma et al. 2002, Wheeler et al. 2002). The ipmPRiME method combines lab and field toxicity data to account for chemical breakdown and movement as well as non-target organism behaviors (Jepson et al. 2014, Mineau 2002, Mineau et al 2006, Mineau et al. 2009, Cardwell et al. 1999). This method is statistically robust, because the species groupings are created to both minimize within-group and maximize between-group variations with respect to sensitivities to a broad range of chemicals and modes of actions (Von Der Ohe and Liess 2004, European Commission 2002). The SSD method is appropriate across a diversity of climates, cropping systems, and non-target species (Rico et al. 2010, Rico et al. 2011). ipmPRiME has been extensively peer reviewed and is based on extensive lab and field data generated in thousands of studies.

Risk is a multi-dimensional quantity. A specific application may have a high probability to harm fish, for example, but poses negligible risk to birds. This is why ipmPRiME.org results are always presented for all risk indices simultaneously. Simplifying these statistics by aggregation into a single number with the intent of simplifying comparisons from year-to-year or site-to-site is not a scientifically valid approach. Aggregate scores (e.g., as in the Environmental Impact Quotient pesticide risk tool, Kovach et al. 1992) hide extremes, create information loss, and reduce flexibility in grower assessments of their individual practices (Peterson and Schleier 2014).

Table 1 summarizes details of the risk indices in ipmPRiME.org

Index	Adverse Effect	Risk Score is based on	Comments
Aquatic Invertebrate	≥ 10% of species experience ≥ 70% reduction in population (count)	Probability of adverse effect	Probability calibrated to results from mesocosm or pond studies of pesticide's impacts
Algal Acute	≥ 20% of species experience ≥ 70% reduction in population (count)	Probability of adverse effect	Probability calibrated to results from mesocosm or pond studies of pesticide's impacts
Fish Chronic	Population level effects on reproductive success	Proportion of the reproduction period (30 d) where **MATC*** values are exceeded	Based on laboratory studies of reproductive effects as well as modeled estimates of exposure
Small Mammal	Population level effects on reproductive success	Probability of adverse effect	Based on field studies measuring impact versus consecutive days when daily ingested residues exceed a threshold
Avian Acute	At least one pesticide related bird death detected in the treated area	Probability of adverse effect	Based on field studies of bird mortality in response to a variety of pesticides of differing toxicities
Avian Chronic	Population level effects on reproductive success	Proportion of breeding season (90 d) when insect residue levels will be above the critical level that results in a dose expected to interfere with reproduction	Based on laboratory studies of reproductive effects of exposure
Earthworm	≥ 35% mortality of earthworms	Probability of adverse effect	Based on field studies of pesticide's impacts that show 35% loss of live earthworm (by weight) in the upper soil layers cannot be recovered within a year
Bystander Inhalation	Short term dose in excess of **PAD***	Probability pesticide concentration in air exceeds a threshold	The threshold is based on an EPA reference concentration for harm to a one year old child exposed for eight hours

***Abbreviations: MATC** (Maximum Acceptable Toxicant Concentration); **PAD** (EPA Population Adjusted Dose, including uncertainty factors).

Using ipmPRiME.org

IpmPRiME.org estimates pesticide risk based on product, site (e.g., soil characteristics and proximity to water) and application methods used. Steps for using ipmPRiME.org:

1. User creates **a web account** by establishing user name and password.
2. User enters data to **define the site** (field or fields) to be managed. If desired, ipmPRiME's GIS-based mapping tool can be used to locate and map U.S. cropping areas, sensitive areas, mitigation zones and/or areas at high risk for runoff.
3. User **enters a pesticide application** or a season-long pesticide regime, selecting from ipmPRiME's database of nearly 3,000 products, and enters rates, application methods, dates and times of applications.
4. User **reviews the risk summary** generated by ipmPRiME. A user can compare risk profiles of products used or view cumulative risk for an entire season's applications.
5. Based on the results, users may view outcomes for alternative products, application methods, buffer zones, etc., to mitigate potential risks.

ipmPRiME calculates a "Risk Score" from 0 to 1 for each of 8 risk indices (figure 1). In most cases this number represents the probability of an adverse effect or, in the case of chronic risk indices, the proportion of the breeding season where reproduction may be reduced (Table 1). For example, as the adverse effect for the avian acute index is bird mortality in and around a crop field, then a score of 0.1 means that there is an estimated 10% chance that the pesticide application will kill at least one of the birds in the field. Scores below 0.10 are within the margin of error of the risk models and are interpreted as low risk category, where no risk mitigation is needed. Scores between 0.10 and 0.50 represent moderate risk and Scores above 0.50 fall into the high risk category. For moderate to high risk results, mitigation is recommended, if

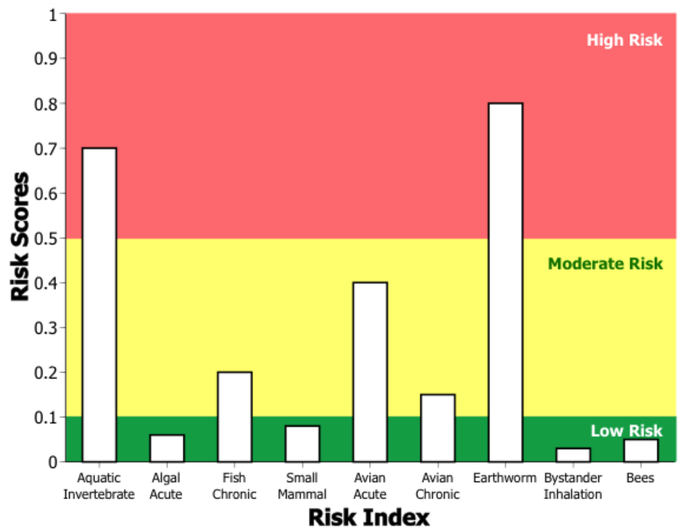


Figure 1. Example of a risk profile for a fictional pesticide application that shows high risk scores for two indices (Aquatic Invertebrate & Earthworm), moderate risk scores for four other indices, and low (i.e., statistically negligible) risk scores for four three indices.

feasible and practical.

For some active ingredients, ipmPRiME.org does not calculate risk for a given index because its database is missing chemical or physical properties or the toxicity values necessary for the risk index. If no calculation is made, instead of a risk score, the tool issues a warning statement indicating insufficient data for a risk calculation. For some active ingredients where data are lacking—and an expert judgement presumes low risk based on available hazard and / or exposure information, the tool issues a "pass code" signifying the presumed safety of the chemical. The current version of ipmPRiME.org produces risk rankings that are subject to change in response to scientifically defensible updates to the underlying toxicity, physical-chemical, or other parameter or functional values.

Why Use ipmPRiME.org?

Pesticide products, sites of application, and application methods can result in varying levels of risk to the environment. IPM seeks to lower risks of all kinds: economic risks to growers as well as environmental and human health risks of pests and pest management practices. IpmPRiME.org empowers growers and pest managers to **identify pesticide uses that are potentially safer for the environment on a site-specific basis, or to consider mitigation measures that may help preserve the use of any pesticide in an improved IPM program, or to seek substitutions that further the goals of protecting economic, environmental and human health interests of farmers and society.**

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