IDAHO'S IPM STANDARDS FOR POTATOES

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GETTING STARTED — DEVELOPING IPM STANDARDS FOR IDAHO

In 2002 at a Pest Management Strategic Planning Workshop for PNW Potatoes, the Idaho producers recognized the importance of a developed Integrated Pest Management (IPM) approach for the future of potato pest management. Therefore, the Potato Growers of Idaho with the University of Idaho began working on a set of IPM Standards that could be utilized by growers to certify that their potatoes were produced with IPM practices.

We looked at the third party certification system used by Wisconsin potato growers. They worked with the World Wildlife Fund and Protected Harvest to develop a point system that scores the production system of the potato grower. The point values or "scores" determine if the crop was successfully produced with recognized and accepted IPM techniques and would then be considered "IPM Certified".

In order for a Certification Standard to be accepted by growers and the consumers, the development process must be open and transparent. The growers must have adequate, practical and cost effective pest management options, in order to maintain economic sustainability. Consumers demand credible, science based standards that have been developed in an open process, with unbiased data. The third party certifiers must accept the standards that have been developed and approve the criteria and quantitative scoring.

The Idaho Standards were modeled after these Wisconsin standards, incorporating Idaho practices, thresholds and pest spectrum and pressures. We also took into consideration Idaho's soil and climatic conditions. The criteria for scoring these IPM Standards is both quantitative and semi-quantitative. The IPM Standards encourage the use of more bio-intensive pest management practices and require the reduction of heavy reliance on older organophosphate and carbamate insecticides.

Wireworm and aphids are two of Idaho's most important economic insect pests. Both of these pests require intensive management and those management programs rely heavily on older organophosphate and carbamate insecticide applications. The bio-intensive approach is recognized as a desirable practice, which in the long run may provide a more sustainable cropping system and lower costs. However, the bio-intensive system will not provide the critical quick "knock-down" required to reduce diseases vectored by the aphids. Quick, effective aphid control is still necessary for Idaho potato production. The Idaho Standards will need to address the need for "emergency" applications, for both of these pests, using effective organophosphate and carbamate insecticides.

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PESTICIDES vs IPM STANDARDS — TOXUNIT APPROACH

One of the more controversial aspects about IPM certification programs is how to identify pesticides that are most compatible with pest management strategies. While it is easy to agree philosophically that a goal of IPM is to minimize adverse impacts of pest control tactics (especially pesticides) on human health, wildlife and the natural environmental, it is far more difficult to agree upon a credible quantitative measure that easily can be used to determine an individual grower's progress to that IPM goal.

Several numeric scoring systems have been developed to rank the comparative hazards that pesticides pose to non-target organisms and environmental quality. The general idea is to assign to each pesticide a numeric score that reflects its overall riskiness. As part of an IPM certification program, such a scoring system might be used to reward growers who use least-toxic pesticides or to disqualify from certification those growers who use unacceptably risky products.

One pesticide hazard scoring system is the ToxUnits approach, shorthand for toxicity-adjusted pesticide units. The term ToxUnit was coined by Charles Benbrook, an IPM policy consultant who collaboratively designed the system as a pesticide selection tool for the IPM certification program of the Wisconsin Potato and Vegetable Growers. Benbrook used published data from standard laboratory toxicity experiments to quantitatively describe four harmful effects of agricultural pesticides:

1. acute mammalian toxicity	immediate harmful effects caused by exposure to a single large dose (expressed as the oral LD_{50} value, the Lethal Dose that kills 50% of a population of rats or other test animals if ingested);
2. chronic mammalian toxicity	delayed harmful effects caused by long-term exposure to small, repeated doses of pesticides; chronic effects include cancer, birth and developmental defects, and immune system problems;
3. eco-toxicity	acute toxicity of pesticides to birds, fish, and aquatic invertebrates in the ecosystem;
4. IPM compatibility	acute toxicity of pesticides to beneficial bioagents (such as lady beetles and other insects that attack pest insects) as well as toxicity to honeybees;

Conceptually, toxunits express total potential harmful impacts by summing into a single number each of the four toxicity subcomponents. Algebraically, the toxunit value is computed on a per pound active ingredient (a.i.) basis as

(Equa. 1) $\text{toxunits per 1-lb active ingredient} = (w_1)(\mathit{acute})+(w_2)(\mathit{chronic})+(w_3)(\mathit{eco})+(w_4)(\mathit{IPM})$

where the *w* parameters are weighting factors that designate the relative importance of each of the four harmful effects, and *acute, chronic, eco* and *IPM* are the LD_{50} values (or other appropriate measures) from laboratory tests.* The larger the toxunit score, the greater the presumed risk the pesticide poses in terms of acute human and chronic harm as well as threats to wildlife and other non-targets.

* NOTE: detailed descriptions of toxunit calculations are given in Benbrook et al. 2002. *Developing a pesticide risk assessment tool to monitor progress in reducing reliance on high-risk pesticides*. American Journal of Potato Research 79:183-199.

Table 1 gives toxunit values for selected pesticides commonly used in Idaho potato production. As a group, herbicides generally are the least-hazardous pesticides – they have the smallest toxunit values on a per pound active ingredient basis. In contrast, insecticides generally are the most hazardous pesticides – they have the largest toxunit scores on a per pound active ingredient basis.

Table 1. Toxunit values for selected pesticides commonly used in Idaho potato production. SOURCE: American Journal of Potato Research (2002) 79:183-199

ToxUnits* – potato pesticides

herbicides		fungicides		insecticides	
Matrix	115	*Manzate,*		*Temik*	648
Sencor,		*Dithane*	185	*Thimet*	621
Lexone	114	*Maneb*	151	*Di-Syston*	549
Prowl	102	*Ridomil*	118	*Sevin*	384
Gramoxone		*Bravo*	82	*Furadan 4F*	368
Extra	80	*Tattoo*	48	*Monitor*	329
Eptam	68	*Quadris*	46	*Asana*	324
Poast	48	*Curzate*	42	*Mocap*	308
Roundup	37	*Acrobat*	39	*Thiodan,*	
Dual	22			*Phaser*	266
				Admire	159
				Success	128

* values per 1-lb active ingredient

The toxunits scores depend on the weighting factors used in equation 1. Wisconsin adopted the following values to best measure their desired IPM goals:

Wisconsin Risk Index = (0.5)(*acute*) + (1.0)(*chronic*) + (1.0)(*eco*) + (1.5)(*IPM*)

This equation deliberately emphasizes IPM compatibility by inflating this subcomponent of the total score by 1.5-times. The Wisconsin Index de-emphasizes acute toxicity by decreasing the numeric value of this subcomponent by one-half. There is no single set of correct values for multiplication weights. If protection of human health was the overriding goal, then large multiplication weights could be assigned to the acute and chronic subcomponents of equation 1 and smaller numeric weights would be given to the eco and IPM subcomponents. Clearly, weighting factors other than those used in the Wisconsin Risk Index would produce valid toxunit scores that differed substantially from those in Table 1.

Toxunits only can be used to make comparison among pesticides rather than to make definitive predictions about actual environmental impacts. For example, comparing from Table 1 the herbicides Matrix and Dual, one could state that Matrix is at least five-fold more hazardous than Dual because the toxunit value of 115 is more than five-times larger than 22; likewise, the insecticides Temik and Thimet are more than five times as hazardous as Matrix because their toxunit values of 648 and 621 are more than five-times greater than 115. But it is not correct to conclude that Dual never causes harmful impacts or that Temik and Thimet always cause harmful impacts. There is not a critical threshold value that separates harmless pesticides from harmful pesticides.

Because toxunit values are computed per 1-lb of active ingredient, one can measure the potential hazard for every pesticide in a given field during a growing season by multiplying the toxunit score for each chemical by its application rate in pounds active ingredient per acre:

(Equa. 2) seasonal toxunits per acre = pounds active ingredient applied per acre X toxunit value

Seasonal values for each pesticide then can be added together to determine a total score that reflects overall hazards from every pesticide used in a field.

The calculation process is shown in Table 2 for six representative pesticides used by Idaho potato producers. For example, many growers control wireworms by applying Thimet 20G insecticide at 15 lbs formulated product per acre. This application rate is 3 lb active ingredient (a.i.) per acre (i.e., each pound of Thimet 20G is 20% active ingredient [phorate] and 80% inert ingredients, so 15 lb of formulated product that contains 20% phorate converts as 15 X .20 = 3 lb a.i.). The toxunit score from Table 1 per 1 lb a.i. Thimet is 621. Equation 2 gives an 1863-toxunit seasonal value for Thimet as follows:

(3 lb a.i. Thimet per acre) X (621 toxunits per 1 lb a.i. Thimet) = 1863 seasonal toxunits per acre

These calculations are repeated for every pesticide used in a given field. The resulting total score of 2814 in Table 2 is the sum of the seasonal values for all pesticides applied.

Table 2. Example calculation of total seasonal toxunit scores for commonly used pesticides in Idaho potato production.

ToxUnits – computing seasonal values

= active ingredient per acre X toxunit value

pesticide	rate per acre	lb a.i. per acre	toxunits	total
Thimet 20G	**15 lb**	**3**	**621**	**1863**
Sencor DF	**0.75 lb**	**0.75**	**114**	**86**
Eptam 7E	**2 qt**	**3.5**	**68**	**238**
Bravo Ultrex WDG	**1.25 lb**	**1.03**	**82**	**84**
Dithane F45 Rainshield	**1.6 qt**	**1.6**	**185**	**296**
Monitor 4E	**0.75 qt**	**0.75**	**329**	**247**
			TOTAL TOXUNITS PER ACRE:	**2814**

Wisconsin potato growers established these standards for their IPM-certified potatoes:

1200 total seasonal toxunits (long-season potato crop)
800 total seasonal toxunits (short-season potato crop).

Fields that exceed these maximum values cannot qualify as IPM-certified. In the preceding example (Table 2), the crop would be disqualified from IPM certification because the realized seasonal toxunit score of 2814 exceeds the maximums permitted. Note in Table 2 that Thimet by itself accounts for 2/3 of the total seasonal score.

Certification standards in Wisconsin allow for several important exceptions to allowable toxunit maximums:

1. Fumigants applied before the growing season do not count towards seasonal toxunit totals

This exception is critical in Wisconsin because soil-borne pathogens cannot readily be controlled without fumigation, but to include fumigation in the seasonal total automatically would disqualify a field from IPM certification. In particular, the standard fumigant, Vapam 42% (4.26 lb a.i. metam sodium per gallon) applied at the labeled rate of 40-gal formulated product per acre, is equivalent to 170-lb a.i. per acre (i.e., 4.26-lb a.i. per gallon formulated product X 40-gal formulated product applied per acre = 170.4-lb a.i. per acre). Vapam has a toxunit score of 167 per 1-lb a.i., so a 40-gallon application contributes over 28,000 seasonal toxunits (170-lb a.i. per acre X 167 toxunits per 1-lb a.i. = 28,390 seasonal toxunits), nearly 24-times the 1200 maximum allowed for certification.

2. Toxunit maximums increase if unusually severe pest outbreaks significantly threaten yield

Wisconsin growers devised specific guidelines that allow for up to 50% additional toxunits when late blight epidemics require more fungicide than normal to prevent economically catastrophic losses in crop yield.

3. "Do Not Use" or "Use With Restrictions" pesticides

Special environmental and human-health concerns are used to disallow or otherwise restrict use of certain pesticides, regardless of their actual toxunit score. The Wisconsin "Do Not Use" list includes Ambush, Diazinon, Di-Syston, Furadan, Gramoxone, Guthion, Monitor, Pounce, Sevin, Temik, Thiodan, Thimet and Vydate. Pesticides on the "Use With Restrictions" list are Asana, Bravo, Dithane, Cygon, Maneb, Mocap, Polyram, Quadris, Sencor and SuperTin.

CONCLUSIONS — IMPLICATIONS FOR IDAHO

The objectives of using a third party IPM certification program is to: (1) document the use of IPM practices to consumers and the public; (2) to document the reduction of potentially harmful effects to human health and the environment. Growers will be able to record and score their production practices. This enables them to produce potatoes under an "IPM Produced" label, if they so desire.

The Benbrook toxunit system provides one useful model for measuring IPM progress towards reducing pesticide hazards. But, it is not without critics. Pesticide hazard depends not only on toxicity – how poisonous the pesticide is – but also on exposure – how much is the exposure, how long is the exposure and how frequent is the exposure. Yet the toxunit approach does not account for exposure; it instead uses toxicity as a substitute for hazard. The difference between the terms toxicity and hazard is not trivial. We are exposed every day to toxic chemicals – such as when we fill the tanks of our cars with gasoline – that in reality only pose minimal hazards because our exposure to them also is minimal.

But even if the Idaho potato industry decided to adopt the toxunit approach, the Wisconsin system cannot provide an immediately usable tool for IPM certification because the toxunit values described here were designed for Wisconsin. To quote Benbrook about toxunits, "*Values . . . reflect pesticide use patterns, soils and cropping systems in central Wisconsin and are not necessarily appropriate for other potato-growing regions.*" Any pesticide hazard-rating system must specifically account for how our own unique soil:weather conditions, pest complexes and cropping systems in Idaho determine pesticide risks to non-targets and environmental quality. Idaho is not Wisconsin!