USING BIOIPM TOOLS TO REDUCE CROP INPUTS FOR PROCESSING SNAP BEANS AND CARROTS

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Wisconsin continues to be a leader in the production of vegetables grown for processing, ranking first in the production of snap beans and third in carrot production. During the summer of 2003, we initiated a multiyear IPM program on carrots and processing snap beans with funding from EPA, The American Farmland Trust and the Midwest Food Processors Association. Project cooperators included carrot growers, snap bean growers, a prominent vegetable processor and an IPM consultant who provides IPM services to clientele. This project, focusing on pest management activities used in the production of carrots and snap beans, demonstrated changes in approaches to management of plant pests, the chemistry and amount of pesticides used, the cultivars being planted and use of disease forecasting tools used by growers. The project also highlighted areas where extension activities can further improve the adoption of IPM technology. More specifically the project documented that carrot growers have shifted from planting mostly disease susceptible cultivars to planting a wide array of disease resistant cultivars that contributed to a 43% reduction in toxicity scores for their pest management programs. Carrot growers also greatly reduced their use of FQPA pesticides while maintaining pest control at economic levels. Snap bean growers also greatly increased their adoption of advanced IPM tools, decreased the pesticide active ingredients being applied for pest control and significantly reduced their use of FQPA pesticides. Information from this study is helpful in identifying specific tools which growers will most likely adopt and which will most likely be supported by food processors. Information from this project will prove useful in moving the processing industry forward in the adoption of advanced IPM tools.

Specifics of the Project

Prior to the 2003 growing season we developed plans for evaluating advanced IPM techniques for both carrot and snap bean producers. In concert with Del Monte personnel, an IPM consultant and growers, we laid plans for large field scale evaluations to compare standard production practices with practices using advanced IPM tools. The following tables (Table 1 and 2) summarize the key differences between standard production practices currently used by the processing crop growers and what we termed the "Wisconsin Next Step" program that included the use of advanced IPM tools. At the outset of the project we proposed to work with at least two progressive growers representing at least 25% of the Wisconsin carrot acreage and two progressive snap bean growers. Plots were maintained on grower properties with their active participation in these research and demonstration trials. This active partnership fostered adoption of many of the practices we were testing on an expanded acreage as growers saw firsthand that these practices were effective in improving pest management with fewer and safer inputs.

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Table 1. Field activity plan for evaluation of IPM practices on carrots.

IPM Practice Category	Current Wisconsin Program	Wisconsin "Next Step" Program
Cultivar	Heritage, Fontana or Danvers	Bolero, Enterprise, Sirocco, Carson
Insecticide Program primarily for management of aster yellows	Asana sprays at AYI of 50 Scout weekly Infectivity assay every 2 weeks	Asana sprays at AYI of 75-100 Scout weekly Infectivity assay every 2 weeks
Fungicide Program primarily for management of Alternaria leaf blight and Cercospora leaf blight	Scout weekly from emergence Sprays begin when plants reach about 6" in height – calendar approach Spray weekly with fungicide Spray program consists of chlorothalonil each spray	Scout weekly from emergence Sprays begin at 1% disease Use TomCast Program – spray interval at 20 DSV, compare with 15 DSV for Heritage Alternate chlorothalonil and strobilurin chemistry beginning with chlorothalonil
Herbicide Program for management of broadleaf and grass weeds	Scout weekly Carefully timed sprays to coincide with crop growth and weed pressure	Scout weekly. Carefully timed sprays to coincide with crop growth and weed pressure

Table 2. Field activity plan for evaluation of IPM practices on snap beans.

IPM Practice Category	Current Wisconsin Program	Wisconsin "Next Step" Program
Cultivar	Standard cultivar selected by processor susceptible to white mold.	Pest tolerant (white mold, root rot, bacterial leaf blight) cultivar selected by processor
Biocontrol Program	No biocontrol applied	Treat field with Contans biocontrol at 2 lb per acre preplant and incorporate
Fungicide Program	Scout weekly from emergence Treat with with thiophanate methyl at 4-5 days after 10% bloom as precaution	Scout weekly from emergence Treat only if widespread white mold incidence in area (thiophanate methyl), but only as last resort
Insecticide Program Seed – SCM control	Treat seed with Lorsban	Treat seed with Gaucho or Cruiser - will also control PLH, BLB and aphids)
Plants	Foliar treatment is primary control	Foliar treatment to supplement seed treatment only if needed
PLH, BLB	Dimethoate, Asana – 1/sweep	Capture – low rate – 1/sweep
Aphids	Dimethoate - at winged aphid flight based on trap catch	Capture – at winged aphid flight based on trap catch and monitoring of soybeans at flowering for aphid alates, use of weather models to predict aphid flights
Pod Stage - ECB	Capture, Orthene - 30 to 7 dbh (days before harvest) (2 - 3 applications)	Capture – 30 to 7 dbh (days before harvest) (2 applications)
Herbicide Program	Scout weekly. Carefully timed sprays with options of Dual, Treflan or Eptam to coincide with crop growth and weed pressure	Scout weekly. Carefully timed sprays of Dual, Treflan, Eptam and/or Sandia (0.5 oz/A) to coincide with crop growth and weed pressure (Sandia application based on field history of pigweed and waterhemp)

Table 2 (continued).

Monitoring insect pests on snap beans	Aphids - Plant counts weekly – alates SCM - % stand / injury – early season BLB/PLH – weekly sweeps; PLH thresholds = ½ insect per sweep up to 1st trifoliate and 1 insect per sweep after 1st trifoliate; /BLB thresholds to be determined ECB – black light trap catches; scout field edge areas	Aphids - Plant counts weekly – alates SCM - % stand / injury – early season BLB/PLH – weekly sweeps; PLH thresholds = ½ insect per sweep up to 1st trifoliate and 1 insect per sweep after 1st trifoliate; /BLB thresholds to be determined ECB – black light trap (BLT) catches; scout field edge areas, several BLT's in area

SCM = seedcorn maggot; BLB = bean leaf beetle; PLH = potato leafhopper; ECB = European corn borer

Throughout the funding period, multiple meetings were held with individual growers and educational meetings were held where the findings stemming from this project were presented. Handouts and publications were prepared and distributed as additional educational materials.

Questionnaires were developed for the Wisconsin carrot and snap bean industry, based on the successful PPP (preventative practice points) questionnaire used to determine changes in farming practices by the WI potato industry. Questions were modified to reflect differences in production practices between potatoes, carrots and snap beans. Points were assigned to each practice and weighted to reflect low, medium and high value practices as these related to IPM adoption. Sections of each questionnaire included questions related to field and farm information, field scouting, weed control, insect control, disease control and soil fertility. The questionnaires also included a section asking for detailed information on pesticide use (products, rates and timing). Questionnaires were completed by snap bean and carrot growers prior to the start of the 2003 field trials to establish baseline levels of IPM adoption and pesticide use and at the end of the 2005 cropping season to determine whether changes in adoption of IPM practices and pesticide usage had occurred. During the process, all grower records pertaining to pesticide inputs were evaluated using the toxicity module included in the RealToolbox (SureHarvest) Farm Management Information System.

Carrot Production

Information related to the use and adoption of IPM practices indicated a PPP score virtually unchanged from the 2001 sampling period (Average score of 598 in 2001 vs. 586 in 2005) (Figure 1). Only one grower reported a sizeable increase in the PPP score during this period, but the remaining five growers reported slight reductions in the PPP scores. Since these scores are far from the expected increase of at least 20% for the reporting period, we took a closer look at the questions that seemed to play a critical role in the final PPP scores. This scoring system helped to simplify the evaluation of pesticide toxicity associated with pest management programs in each year.

Question 1 – List the carrot cultivars grown on your farm.

Cultivar Susceptibility	2001	2005
Susceptible cultivars	1221 acres (**70**% of acreage)	70 acres (**9**% of acreage)
Moderate susceptible to resistant cultivars	517 acres (**30**% of acreage)	1767 acres (**91**% of acreage)

Question 2 – Did you use a disease forecasting or weather based model to indicate fungicide applications according to environmental variables?

Response	2001	2005
Yes	0	4 (57%)
No	0	3 (43%)
Respondents	9	7

Question 3 – Did you block carrot varieties according to disease resistance?

Response	2001	2005
Yes	7 (78%)	5 (71%)
No	2 (22%)	2 (29%)
Respondents	9	7

Question 4 – Did you adjust fungicide programs according to disease resistance of cultivars?

Response	2001	2005
Yes	5 (56%)	6 (86%)
No	4 (44%)	1 (14)
Respondents	9	7

It appears that there were important shifts in the carrot cultivars grown for processing in Wisconsin during the reporting period. The cultivars grown today are much more likely to contain moderate to high levels of resistance to foliar diseases (Response to Question 1). In addition, over half of the growers are now using the relatively new innovation of a disease forecasting program to schedule fungicide applications (Response to Question 2). While the majority of growers block their plantings according to the perceived disease resistance of the cultivars (Response to Question 3), there was an increase in the number of growers who adjust their fungicide spray programs according to cultivar disease resistance (Question 4). Weather also had an important role in minimizing changes in the PPP scores. Weather in 2001 was much more ideal for disease development than weather in 2004 and 2005. Collectively, answers to these questions provide a better explanation for similar 2001 and 2005 PPP scores. As growers adopt more disease resistant cultivars and rely on disease forecasting programs, it appears that they use fewer IPM inputs such as intensive field scouting for disease and less intensive spray programs. In combination with years less favorable for disease development (2004/05), the total PPP scores remained unchanged while individual components of the PPP scores changed dramatically.

Significant changes occurred in pesticide use on carrots (Figure 2). Four out of six growers reported lower insecticide and fungicide use and 5/6 growers reported less total pesticide a.i. use. Growers reported a reduction of 0.07 lb ai insecticide, 2.33 lb ai fungicide and a combined 2.4 lb ai fungicide plus insecticide. This amounts to a 36% reduction of pesticide ai between the reporting years.

We also noted significant reductions in the toxicity of pest management programs between the two reporting years (Figure 3). Toxicity scores associated with insecticide use declined by 39.5 points while fungicide toxicity scores declined by 254.8 points. An overall reduction of 294.4 toxicity points (43% reduction) was observed when evaluating changes in fungicide and insecticide from 2001 to 2005.

Figure 1. Changes in the adoption of IPM practices between 2001 and 2005.

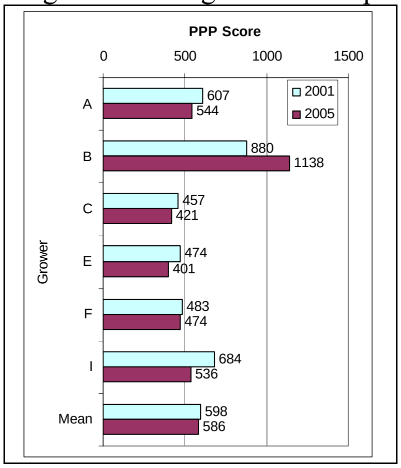


Figure 2. Changes in the use of insecticide and fungicide between 2001 and 2005.

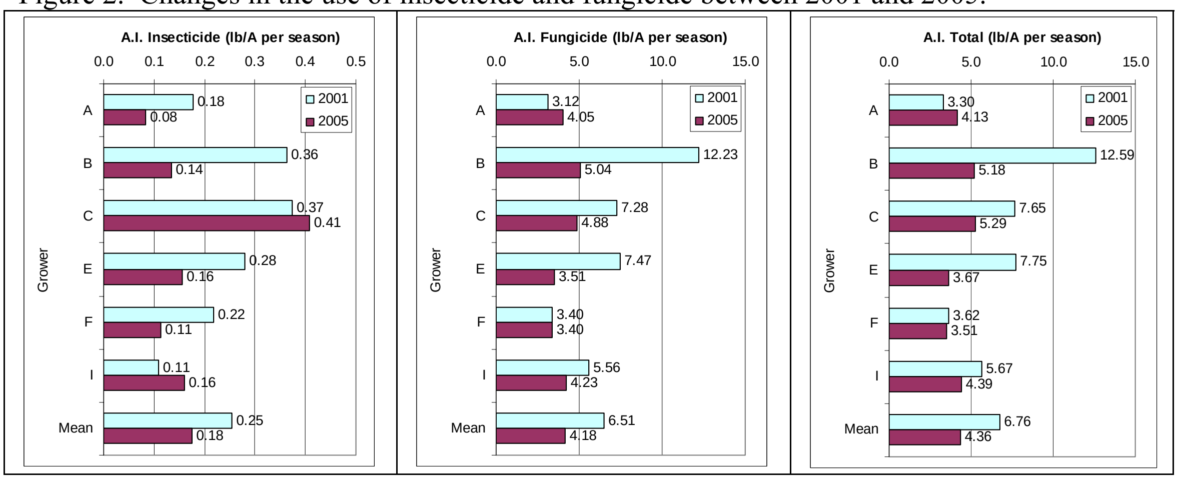
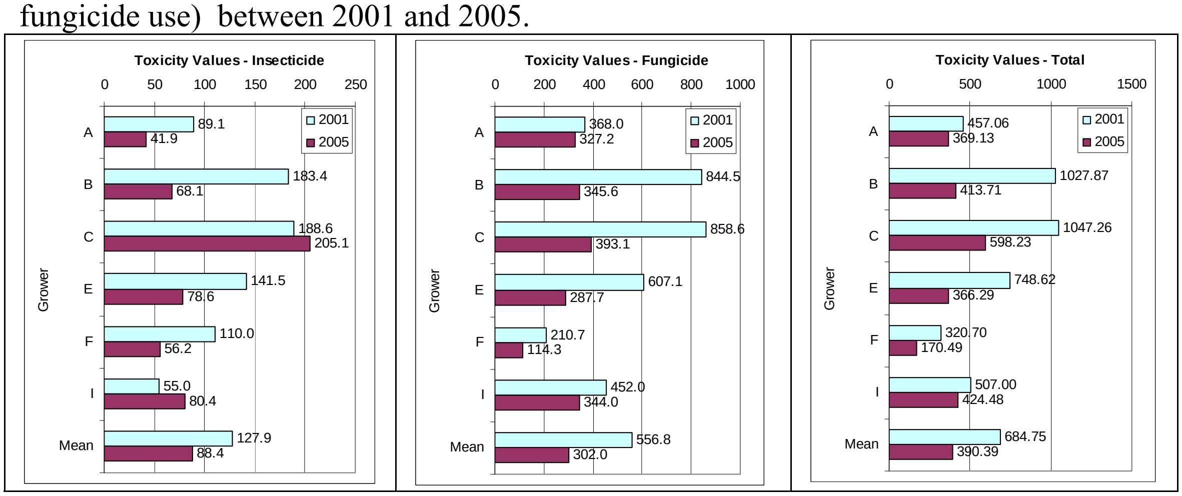


Figure 3. Changes in the toxicity of pest management programs (insecticide and fungicide use) between 2001 and 2005.



Snap Bean Production

Growers involved in our on-farm research and demonstration trials as part of this project appear to be altering their approaches to production activities. Table 3 compares the PPP score of a typical grower in 2003 with two growers in 2005. Provided with more information regarding black light insect catch data and local distribution of pest problems, growers appear to be taking a more active role in field scouting and pest management decisions. While the sample size is limited, the data provide a glimpse into how changes can occur at the local level for growers willing and interested in taking a more active role in the management of their crop. The PPP questionnaire provides information relative to how we could help growers improve their PPP scores even further.

Table 3. Summation of preventative practice points (PPP) for two typical snap bean growers in Wisconsin, comparing 2003 vs. 2005 production years.

Section	Grower A 2003	Grower B 2005	Grower C 2005
I: Specific Field Info	6 points	11 points	14 points
II: Field Scouting	30	309	450
III: Weed Control	8	22	20
IV: Insect Control	0	20	22
V: Disease Control	6	28	22
VI: Soil Fertility	4	4	4
TOTAL PPP Scores:	54	394	532

We were not able to calculate the toxicity factors for the pesticides used in snap bean production since much different chemistries are used on potatoes and carrots vs. snap beans. However we were able to evaluate the pesticides commonly used by the snap bean producers in 2003 vs.2005 and to calculate changes in the chemistries used and the amount of active ingredients applied (Table 4, 5 and 6). We observed a significant reduction in the amount of pesticide ai being applied in 2005 compared with 2003 and a change in the products used.

Table 4. Pesticide used in snap bean production on typical Wisconsin acreage in 2003.

Chemical	Formulation/acre	Formulation ai	Total lb ai applied
Eptam 7E	0.375 gal	7 lb/gal	2.625 lb ai
Dual II Magnum	1 pt	7.64 lb/gal	0.955
Capture 2EC	4.0 oz	2 lb/gal	0.062
Capture 2EC	6.4 fl oz	2 lb/gal	0.1
Benlate	1.5 lb	50%	0.75
			4.492

Table 5. Pesticide used in snap bean production on typical Wisconsin acreage (Grower B) in 2005.

Chemical	Formulation/acre	Formulation ai	Total lb ai applied
Roundup	1 gal	0.502 lb/gal	0.502 lb ai
Sandea	0.08 oz	0.75 lb/gal	0.06
Assure II	6 oz	0.88 lb/gal	0.041
Discipline 2EC	3 oz	2 lb/gal	0.046
Contans (Biological)	2 lb	5.3%	1.06
			1.66

Table 6. Pesticide used in snap bean production on typical WI acreage (Grower C) in 2005.

CHEMICAL	RATE	AI	LBS AI/ACRE
Contans	2 lbs	5.30%	1.06
Sandea	0.5 oz	75%	0.00225
Topsin M 4.5F	2.4 pt	45%	0.135
Discipline 2EC	2.5 fl oz	2 lb/gal	0.04
Dual II Magnum	1.3 pt	7.64 lb/gal	1.24
Sniper	2.5 fl oz	50%	0.0097
Poast	0.8 pt	18%	0.018
			2.504

Prior to the initiation of the project we anticipated that the adoption of advanced IPM methods would lead to sizeable reductions in several pesticides. Specifics of the observed reductions are shown below.

Carrots

Table 7 identifies significant reductions in the use of esfenvalerate (Asana replaced by Baythroid) (32.33% reduction in ai use), chlorothalonil (Bravo, Echo and Equus replaced by reduced risk materials Quadris, Cabrio and Endura) (55.92% reduction) and benomyl (Benlate no longer produced, registered on carrot or used by the carrot industry) (100% reduction).

Table 7. Change in use of pesticides by the Wisconsin carrot industry from 2001 to 2005.

Pesticides Applied – 6 Growers		LB AI Applied			
Chemical Name	Brand Name	2001	2005	Change	% Reduction
esfenvalerate	Asana	1.52	1.03	0.49	32.33
cyfluthrin	Baythroid	0	0.03	0.03	--
chlorothalonil	Bravo, Echo, Equus	30.97	20.90	10.07	32.51
benomyl	Benlate	0.50	0.00	0.50	100.00
fixed copper	Kocide, Champ	7.65	3.37	4.28	55.92
azoxystrobin, pyraclostrobin	Quadris, Cabrio	0.00	0.13	0.13	--
other - boscalid	Endura	0.00	0.59	0.59	--

As new safer materials are used in conjunction with improved IPM tools such as rapid identification of aster yellows phytoplasma using real time PCR, cultivars with resistance to aster yellows phytoplasma and leaf blight, biological controls and safer pesticide delivery technology, we expect to see additional reductions in pesticide use.

Snap Beans

Tables 4 to 6 identify reductions in the total pesticide ai used in the production of snap beans in Wisconsin. Some pesticides such as Eptam, Dual II Magnum and Benlate were eliminated from use by the reporting grower in 2005. Roundup and Sandea are used as herbicide substitutes for effective weed control. Benlate is no longer available for use in Wisconsin and while Topsin M could have been substituted for Benlate use, the reporting grower chose to use a biological control (Contans) to manage white mold. Several years of field research under a wide range of environmental conditions have convinced this grower to use Contans as a way to reduce pathogen survival of this soilborne pathogen. We have observed that application of Contans provides a level of white mold control equivalent in most years to a single fungicide spray at flowering. This same grower has now treated over 1,500 acres of a soybean/potato/snap bean rotation with Contans as a means to enhance white mold control on his entire farm. He remains encouraged by the performance of this product and serves as a “de facto” spokesman for use of this product. Within the foreseeable future, we expect to see snap bean acreage planted to snap bean cultivars with enhanced resistance to white mold. Host resistance combined with biological control of soilborne inoculum could very well make fungicide treatment of snap beans a method of the past.

Use of Project Information

Information related to this 2-year project was presented to multiple meetings attended by growers and processors since 2003. During this period there were a total of 17 presentations to state, regional, national and international audiences. In addition we published 17 articles in conference proceedings and on-line or printed publications. Examples of useful IPM information provided to carrot growers is exhibited in Figure 4.

Figure 4. Examples of carrot IPM information provided to the Wisconsin carrot industry.