IPM For Potatoes: A Multifaceted Approach to Disease Management and Information Delivery

WALTER R. STEVENSON, Professor, Department of Plant Pathology, University of Wisconsin, Madison 53706

Potato (*Solanum tuberosum* L.) production is an important element in the farm economy of Wisconsin. The crop is grown on approximately 27,500 ha; the 1990 production exceeded 1.05 million t and an estimated crop value of $120 million. Potato production involves intensive use of pesticides, fertilizers, and irrigation water. Ten years ago, typical production practices for the Russet Burbank cultivar on irrigated sand (over 60% of Wisconsin's total hectarage) included up to 12 applications of fungicide for control of early and late blights; a systemic insecticide at planting, plus up to four applications of insecticide after emergence for control of leafhoppers, aphids, cutworms, and the Colorado potato beetle; cultivation (hilling) plus at least one application of herbicide for control of broadleaf and grass weeds; 44 kg/ha of nitrogen; one or two applications of a growth regulator; one or two applications of a vine desiccant; and three irrigations per week, which often provided more water than the crop demanded. The crop is often grown in sensitive areas, where the risk of groundwater contamination by pesticides and fertilizers and where overspray and drift of pesticides are of particular concern. In addition, the intensity of pesticide application and types of pesticides used raise significant concerns related to food, environmental, and worker safety.

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History and Present Status of IPM for Potatoes in Wisconsin

The Wisconsin Integrated Pest Management (IPM) Program began in 1979 (3) with the goals of 1) improving pest control while reducing crop inputs such as pesticides, irrigation, and fertilizers to economic, environmentally safe and essential levels and 2) maintaining crop profitability. One of the crops receiving intensive research and extension focus was potato. To achieve these goals, a multidisciplinary team at the University of Wisconsin–Madison, comprising representatives from plant pathology, entomology, horticulture, soils, and meteorology, developed an integrated educational program that was closely tied to seasonal crop and pest surveillance and weather monitoring. After 3 yr of satisfactory program growth and development, the program was released to the private sector in 1983. Since that time, the potato IPM program has continued to grow in the private sector, and approximately 46% of Wisconsin growers now employ an IPM consultant to scout at least a portion of their hectarage and 97% either scout their own hectarage or employ a scouting service. The university continues to serve in a research and educational role to growers, IPM consultants, and agribusiness.

Use of computer technology played an important role in grower acceptance of IPM practices on potato in Wisconsin. Initial focus of software development was directed toward the improved management of early and late blights with fewer, environmentally timed applications of fungicide. Forecasting technology was initiated in 1980 with the use of BLITECAST (2,4) on a mainframe computer to schedule fungicide applications to control late blight, caused by *Phytophthora infestans*. Software entitled Potato Disease Management (PDM) was released in 1983 for use on a mainframe computer. The PDM program included a modified BLIGHTCAST approach (4) to late blight forecasting and control, plus a module to schedule fungicide applications for control of early blight, caused by *Alternaria solani*. The PDM program was used on 16 ha of commercial potatoes in 1983, 610 ha in 1984, and 7,300 ha in 1985. A microcomputer version of the PDM software running on IBM-compatible microcomputers was released in 1985 (7). By 1987, the program was used on at least 11,436 ha across a multistate area (Fig. 1, Table 1).

As potato growers and the IPM consultants serving them adopted computer technology, they asked for software enhancements to improve ease of use and integration of production components. Field testing began in 1987 to evaluate decision support software that used environmental and crop data to predict crop emergence, schedule irrigation, monitor insect development, and forecast and treat the crop for early and late blight control. On the basis of the success in large field plot evaluations, an integrated program, Potato Crop Management (PCM), was released for grower use in 1989 (5,6). Wisconsin growers, surveyed in 1990 to determine production practices, reported use of PCM software on approximately 12,140 of a potential 27,520 ha (1) (Fig. 1). There appear to be an additional 8,000–10,000 ha outside of Wisconsin that also benefit from use of this software.

The benefits from using disease prediction software depend on growers waiting until specific thresholds are exceeded before fungicide treatments are initiated (1). By carefully collecting environmental data in the field, entering these data into the computer program, and waiting until these thresholds are met, most growers report a savings of up to two fungicide sprays per season. A decrease in the total

amount of applied fungicide can be achieved by treating with fungicide according to program recommendations. These include spraying for early and late blight control at 10-day intervals when weather conditions do not favor disease development or starting with low rates of fungicide and gradually increasing the rates as the season progresses and disease pressure is likely to increase.

Cost savings from use of the PDM program in 1987 exceeded $350,000 for users in Wisconsin, Minnesota, and Illinois (Table 1). On the basis of current estimates of use for the PDM and PCM software, program users are saving an estimated $700,000–$900,000 per year for disease control (Fig. 2). Additional grower benefits from use of other modules in the PCM software have been identified. The PCM irrigation scheduling module reduces irrigation costs by 10–15% by matching the amount of irrigation to the needs of the crop. Improved timing of herbicide application through use of PCM improves weed control, lowers costs, and reduces the risk of crop injury. Better timing of insecticide applications through adoption of PCM improves control with minimum label rates of insecticide and reduces the number of applications compared with use patterns prior to adoption of PCM. While growers using the PCM program report cost benefits of $48/ha compared with conventional practices, benefits observed in field trials comparing the PCM program with conventional practices on the Russet Burbank cultivar exceeded $173/ha (1).

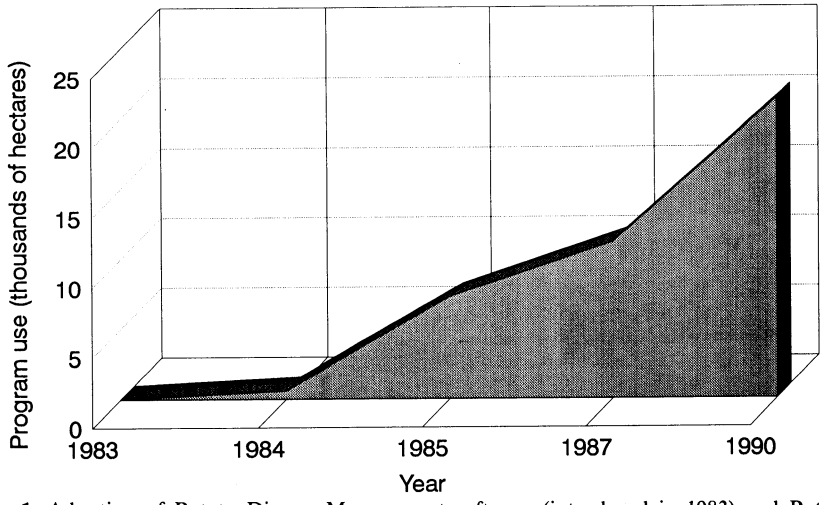

Fig. 1. Adoption of Potato Disease Management software (introduced in 1983) and Potato Crop Management software (introduced in 1989) by growers.

Table 1. Survey of use of the Potato Disease Management software by growers and pest management consultants in the midwestern United States during 1987

Site	PDM recommendations used (ha)	Cost of single spray ($/ha)	Sprays saved with PDM use[a] (no.)	Value of saved sprays ($)
Illinois	1,076	19.33	1.0	20,800
Minnesota-1[b]	1,448	18.12	1.5	39,375
Minnesota-2[b]	4,675	26.51	1.5	185,942
Wisconsin-1	190	19.33	4.0	14,720
Wisconsin-2	134	12.52	2.0	3,367
Wisconsin-3	273	18.30	3.0	14,989
Wisconsin-4[b]	3,640	13.29	1.5	72,600
Total	11,436			351,793

[a]Compared with a conventional calendar-based treatment program.
[b]PDM used on multiple farms by pest management consultants and corporate farm management.

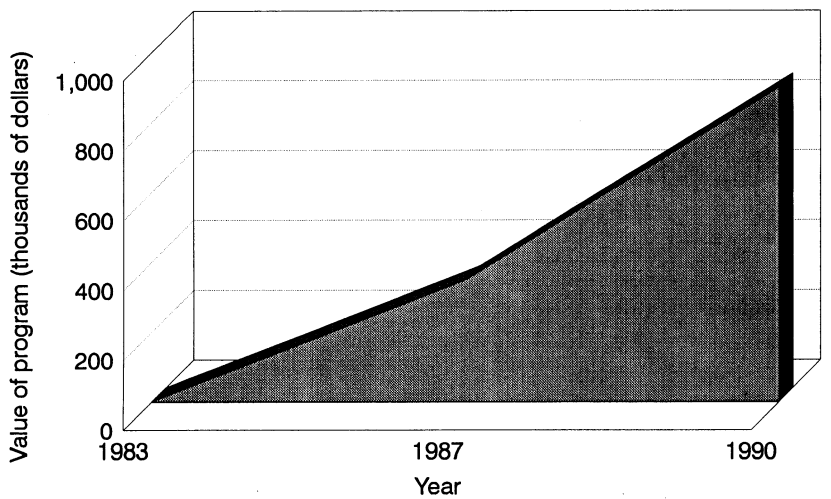

Fig. 2. Estimated savings in production costs to growers with use of Potato Disease Management and Potato Crop Management software.

Adoption and use of this form of IPM technology directly address the issue of farm profitability. One grower wrote that use of the PCM program during 1990 helped to eliminate three fungicide applications and saved approximately $12,000 on 178 ha. A neighboring grower reported reducing fungicide use in 1990 by approximately 50% of the amount applied in previous years. Still another grower reported a benefit of $22.24/ha due to savings in application costs, the application of 22,700 fewer kilograms of fungicide, and a modest increase in yield. This same grower estimated an increased income of $304,000 on 6,475 ha when an early version of the PCM program was used in 1989. These grower comments, combined with grower surveys, help to substantiate the dollar value of the PCM technology.

Other benefits from adoption of this technology, such as an improved understanding of the relationships between environmental conditions and pest development, are not as easily documented. Instead of simply spraying on the basis of crop development or calendar date, growers who use the PCM software commonly refer to severity value, P-Day, and degree-day thresholds when discussing the timing of pesticide applications. Adoption and successful implementation of PDM and PCM have facilitated the acceptance of other advanced technology by growers. Growers regularly suggest enhancements to the PCM program that would help them make more informed decisions. They also have requested PCM-like programming for crops traditionally grown in rotation with potato, such as field and sweet corn and snap beans. The technology used in delivery of the PCM program appears to have aided the acceptance and application of IPM philosophy, and vice versa. Further refinements in this technology coupled with successful application by growers may enhance the adoption of IPM practices. Developing first-class technology and combining it with novel delivery systems should foster greater grower

adoption of integrated pest management practices.

Future Directions

Component research continues on specific aspects of crop and pest ecology, management of specific pests with refined cultural techniques, and improved decision-making strategies. As individual research projects mature, new information is integrated into large field trials designed to evaluate integrated systems approaches on grower farms. The positive grower acceptance generated from the initial release of the PCM program has prompted further refinement and development in integrated crop/pest management software. Modules being developed for future incorporation into the PCM program involve: 1) seed piece decay and plant emergence, 2) emergence of weeds, 3) loss of herbicide efficacy, 4) potato canopy development, 5) economic decision aids, 6) soil fertility and plant nutrition, 7) yield prediction and protection, 8) pest identification, and 9) storage ventilation.

Enlargement of the PCM program is planned to include a broader coverage of the production challenges that growers normally encounter and rotational crops involved in a typical farming enterprise. Research is already under way to develop the information base needed for eventual encoding of software covering the management of snap beans and sweet corn, two crops commonly grown in rotation with potato in Wisconsin. These computer programs eventually will be linked with the PCM software to provide an integrated software approach to enterprise management.

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