Preventative Crop and Pest Management Strategies for Farming Systems Involving Potatoes (The Wallendal Project - Final Report)

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Background:

Production of potatoes, *Solanum tuberosum* L., in Wisconsin and throughout the North Central region has typically relied on the intensive use of pesticides, fertilizer, and irrigation water. This extensive reliance on external inputs coupled with environmental associated with potato production were the driving forces behind the development of a comprehensive integrated crop and pest management program for Wisconsin growers. Computer software, Potato Crop Management (PCM), was developed with support from the North Central Region IPM program and released to the potato industry in 1989. The program was based on component and integrated research related to many aspects of pest management and crop production. PCM integrates crop and pest management into a systems approach that encompasses both preventative and therapeutic strategies designed to best manage the potato crop.

PCM is a comprehensive program, but by design, is targeted at only a portion of the total farming enterprise, the potato crop. This project provided much of the background information for crops commonly grown in rotation with potatoes, and has been incorporated into the upgraded computer software, WISDOM. Potato production in Wisconsin usually includes a two or three year rotational sequence involving marketable commodities (snap beans, sweet corn, field corn, soybeans, peas) and non-harvested cover crops (alfalfa, red clover, sorghum-sudan, rye). Both types of rotational crops have advantages to the overall farming enterprise. Cover crops may serve to hold the soil and nutrients in place, act as trap crops for insect pests or as reservoirs for natural enemies, and have allelopathic effects on weeds and diseases. Most cover crops do not provide short term economic incentives to growers, but may promote long term benefits such as sustainability. In contrast, marketable rotational crops provide short term benefit to the grower in the form of income, and may also provide some additional long term benefits.

The current research was initiated to investigate the short and long term benefits and risks of six specific rotational sequences involving marketed and non-marketed crops grown in rotation with potatoes. From this research, factors dependent upon the rotational sequences are being identified which may contribute or interfere with the preventative management of pests in the potato crop.

Research Progress:

This project was designed as a long term (six year) experiment to investigate six specific two and three year rotations involving potatoes. Plots were established near Grand Marsh, WI in 1991 on a 25 acre grower field with center pivot irrigation. The land was donated for the duration of the experiment by Wallendal Supply, Inc. Each crop included in each of the six rotations was planted each year to minimize seasonal influence on the experiment. A total of fifteen treatments was thus planted each year (table 1 and figure 1). The location of each plot is permanently marked to ensure the integrity of each rotation.
over time. Crops planted each year include potato, snap bean, sorghum-sudan, sweet corn and red clover.

The cultural methods employed in this field experiment are identical to the production practices used by Wallendal Supply in their farming operation and potato crop management decisions were based on recommendations from the PCM program. Comprehensive records were maintained for each crop and rotation. This trial used the potato cultivar ‘Russet Burbank’, a cultivar grown on approximately 60% of the acreage in Wisconsin.

Research was conducted in 1991-92 to establish baseline data on the effect of each rotation on factors related to crop productivity and pest populations. In 1993, the first cycle of two year rotations (rotations 1, 2, 3) was completed and in 1994, the first cycle of three year rotations (rotations 4, 5, 6) was completed. During 1994 to 1996, a cycle of both two and three year rotations was completed each year.

A) Evaluation of biology and ecology of insect pest complexes in each rotation.

Populations of insects were monitored each week within each rotation. The PCM program was used to predict the developmental stages and optimal timing for control of the Colorado potato beetle. Established economic thresholds were used to determine pesticide applications for the other potato insect pests (potato leaf hopper and green peach aphid). Beneficial insects were identified and quantified in each rotation. Plots planted to sorghum-sudan or red clover were found to have a much higher diversity and abundance of naturally occurring parasites and predators than the plots with harvestable commodities where pesticides were regularly used. Because of the proximity of plots and their relatively small size, migration of beneficial insects prevented us from observing any rotational effects in their populations. Plots with cover crops, however, tended to have a higher population of these insects.

B) Evaluation of weed populations in each rotation and the change in weed seed bank in the soil.

Weed populations were evaluated each year within each rotation. Data on weed species and density were collected. Herbicides were applied to each cropping rotation at the minimum effective rate in agreement with best management weed control practices established through past and ongoing component research. In addition, properly timed cultivation correlated to crop stage and weed emergence were utilized for weed control to further reduce the reliance on herbicides. Soil samples were collected each year and are currently being analyzed for changes in the soil weed seed bank. The particular crop present within a rotation would in some instances, dictate the predominant weed species present. Although this may have been due to limitations in control strategies for a particular weed within a particular crop, the resulting differential seed rain will undoubtedly have long term implications. One example of such a troublesome weed was wild proso millet in the sweet corn plots. Extensive reliance on mechanical devices is needed to keep this weed under control. Timing of these controls is critical to effectively manage this weed. Although wild proso millet is relatively easy to control when rotating back to potatoes, its dormant seeds could prove to be a nuisance in other rotational crops for many years to come.

Another problem encountered in weed management strategies was the higher than normal populations of redroot pigweed and common lambsquarters in potato plots following red clover. Red clover was used as a green manure crop, so herbicide applications were kept to a minimum. This resulted in high populations of weed seed being produced in these plots. This response was not however seen in plots which utilized sorghum-sudan as a green manure crop. Apparently the more competitive nature of sorghum-sudan was enough to hold weed populations to a minimum.

C) Evaluation of pathogens as affected by each rotation.

A compilation of daily air temperatures, relative humidity, irrigation, and rainfall was used to predict the appearance of potato early and late blights via the PCM disease module. The initiation and subsequent timing of fungicide applications were scheduled using the PCM program. Data on incidence
and severity of potato early and late blight was recorded at weekly intervals during each growing season. In addition, data on white mold and early dying symptoms were recorded on the potato crop at timely intervals.

The snap bean cultivar used in the trial has field tolerance to bacterial brown spot and root rot, but is susceptible to white mold. Incidence and severity of white mold were recorded at harvest. At the conclusion of each growing season, soil samples were collected for assay of plant parasitic nematodes, *Verticillium dahliae*, and root rot potential of snap bean. The soil samples allowed us to assess the impact of each rotation over time, on a range of economically important plant pathogens.

A trend of increased early blight infection in rotations with sorghum-sudan has been distinctly noticed. This may be due to the interaction of early blight progress and fertility levels of the crop. Early blight has been shown to increase rapidly when nitrogen levels are deficient. Sorghum-sudan when plowed down as a green manure can act as a sink for N as it is decomposing in the soil the following year. Having an excessive level of sorghum sudan decomposing in the soil may decrease the level of nitrogen available to the crop.

D) Monitor the inorganic soil nitrogen and crop removal of N for each rotational sequence.

Fertilizer applications were made according to the University of Wisconsin Soil Test Recommendations to insure adequate nutrition for each crop in the rotation. During the growing season, potato petioles were sampled to determine the nitrogen status of the crop and the need for supplemental N. Component research included in this field trial focused on refining the petiole nitrate test for use on Russet Burbank potatoes. At the conclusion of each season, soil samples were taken to determine the soil nitrogen.

Soil sample cores were taken to a depth of 5 feet (one foot increments, 3 cores per plot) in mid-October from all plots planted to potatoes or snap beans that particular year. As expected, some differences were evident due to the current crop with potatoes having a greater proportion of the NO₃-N in the top two feet and the snap beans showing more N at depths of three to five feet. This might be expected since the snap beans were harvested in early August and the potatoes were not harvested until late September. Regardless of any differences noted, the actual quantity of NO₃-N is quite low, and because of the very sandy nature of the soil in this area, the plots will be almost devoid of inorganic N by the beginning of the next growing season.

E) Comparison of the long and short term benefits of each rotational sequence.

All previously mentioned data are being compiled each year and analyzed to determine the benefits of each rotation. These data will be used to compile information for growers on possible impacts of each type of rotational crop on the farming enterprise. The information will include cultural and rotational options for improved pest control, as well as the limitations and problems associated with certain rotational sequences. This final compilation is expected to be completed during the Spring of 1997.

F) Analysis of the long term economics of each rotational program.

Complete records are being maintained on all costs (fixed and variable), total gross returns, and net returns for each rotation. The multiple starting dates of each rotation will allow direct comparisons between rotations without the risk of yearly market effects. This final compilation is also expected to be completed during the Spring of 1997.