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Grant Project Final Report

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Grant Project Title: Evaluation of Dairy Manure Use in Potato Production Systems

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Wisconsin Department of Agriculture, Trade & Consumer Protection
Agricultural Development and Diversification Program
2001 Grant Project Progress Report

Date: 15 July 2002 WDATCP Contract No.: **16024**

Project Title: Evaluation of Dairy Manure Use in Potato Production Systems (Year 2)

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Progress Report For: 1 April 2002 to 30 June 2002

This report is submitted in fulfillment of Appendix A of the contract. The reports should summarize project activities and key results for the reporting period, and describe project activities and results expected during the next phase of the project. (Attach additional pages of information, if needed).

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This project was established to evaluate the use of dairy manure as a nutrient source within potato production systems. Specifically the objectives of this study are:

1. To determine the availability of manurial nutrients, especially N and P to potatoes;
2. To determine the influence of manure on incidence and severity of potato common scab;
3. To evaluate the effect of time after manure applications on common scab incidence and severity;
4. To determine the interaction of varietal susceptibility to the common scab pathogen and manure applications;
5. To evaluate the relative movement and accumulation of N and P from manure and fertilizer sources; and
6. To determine if potato production practices can be defined which allow for the integration of the potato and dairy industry.

This experiment was initiated in the fall of 1999 and has continued with a new set of plots for the 2001 growing season. These plots were created as four distinct field plot experiments at the Antigo Airport Potato Research Facility (Experiments 1a, 1b, and 2) and at the Rhinelander Agricultural Research Station (Experiment 2). Specific details on the conduct of these experiments during the 2001 cropping season, the sampling protocols followed, the crop yield and quality, and the post-harvest soil test results have been reported previously. This report presents data heretofore not reported from these experiments for the 2001 growing season, summarizes the overall results for the 2 years of work, and describes the establishment of new plots at each of these locations for the 2002 season.

Recent Progress

Completion of 2001 Data – Experiment 1A and 1B —

The April to July period has been used to complete the various analyses on the plant tissue, soil and water samples that were collected during the 2001 growing season. All analyses for 2001 are now complete. Most of the data for Experiment 1a (Evaluation of manure N availability to potatoes) has been presented previously. However, Table 1 shows the effect of manure or fertilizer N treatments on soil NO_3-N levels throughout the season. This table replaces Table 3 from the 7 April 2002 report. It seems apparent that except at lower fertilizer rates N was not limiting. Although the mid-season soil levels (6 August) for the manure treatments are quite low, the petiole NO_3-N (Table 2, 7 April 2002 report) showed more than adequate N in the plant.

Table 2 shows the results of the ICP analyses of the harvested tubers from Experiment 1a. The individual plot samples were combined across replications to reduce costs; therefore statistical analyses cannot be performed on thee data. Interestingly, the addition of N fertilizer did seem to increase P and K concentrations in the tubers, but had little effect on the other nutrients. The analyses were conducted to insure that no major problems existed or were created by the manure treatments.

Tables 3 to 7 present the remaining data from Experiment 1b (Evaluation of manure P avail-ability to potatoes). Results of the petiole P analyses (Table 3) show small but significant responses to P addition from both fertilizer or manure at the first and last sampling dates. Based on these data, one would conclude that fertilizer P is much more effective at getting P into potatoes than is manure. Leaflet and petiole P analyses (Table 4) was not able to distinguish a treatment difference. Other nutrients were also not affected by treatments. Phosphorus levels within the harvested tubers were also increased more by fertilizer than manure. Although some statistical significance may exist due to treatment for the other nutrients, there is little logical pattern and the actual differences are small.

Table 6 shows the calculated P uptake by the tubers and it is clear that although fertilizers or manure did get more P into the crop, the recovery rate of applied P was very low from either source (–3%).

Although there appears to be more P showing up in the suction-cup lysimeters (Table 7) where manure is applied compared to fertilizers, these differences are not statistically significant for most of the sampling dates. These results are similar to those obtained in 2000.

Completion of 2001 Data – Experiment 2 —

Table 8 shows the results of the preplant and post-harvest soil test results at both locations for Experiment 2 (Effect of manure rate on potato yield, quality and disease for several varieties). As expected, the manure treatments tended to increase soil pH compared to fertilizer but few other parameters were affected.

Tissue analytical results from Rhinelander are shown for mid-season leaflet and petiole samples (Table 9), pre-vine kill whole plant samples (Table 10), and harvested tissue samples (Table 11). The first two samplings had individual plots combined across replications to reduce costs. Leaflet and petiole results show a higher N concentration where fertilizer was the nutrient source. This may be the consequence of not estimating manurial N equivalency very well. Few

differences are seen for the other nutrients.

Results from the analysis of the harvested tubers (Table 11) show that nutrient concentrations in the tubers were affected by both nutrient source and variety, and for the macronutrients the interaction was significant. In most cases, the nutrient concentrations increased for Norkotah Russet and W-1151R as the proportion of manure increased, but for Snowden and Superior, little change was seen. This is likely due to a tendency for decreased yields and more scab with the former varieties and thereby less dilution of nutrients (see Table 7; 28 December 2001 report). Differences between varieties appear to exist, but may be related to total uptake as the concentrations tend to be highest in W-1151R, which was the lowest-yielding variety.

Table 12 gives the post-harvest soil NO_3-N levels in the top 1 foot of soil. Clearly there was little N left in this very sandy soil at the end of the season. Values at Antigo were 20 times higher (see Table 17; 7 April 2002 report) in spite of the fact that the manure was applied in the spring at Rhinelander versus the previous fall at Antigo.

The remaining data from Experiment 2 at Antigo are presented in Tables 13 through 21. Table 13 is a replacement for Table 10 of the previous report that now provides the N data for all of the plant parts sampled on 24 July 2001. Table 14 through 19 show the results of the ICP analyses of the various plant parts sampled at several times through the season (21 June, 5 July, 24 July, 6 August, 16 August, and 28 August). These data will be combined with th dry matter data reported previously to develop curves showing the pattern of nutrient uptake throughout the season. Although these data have been collected, much needs to be done to put them into a usable and interpretable form. In all cases, the ICP analyses were done on samples where the individual plots were combined across replications to reduce costs.

Table 20 presents the ICP results from the leaflet and petiole sampling (again combined across replications). Few differences are obvious between using manure or fertilizer as a nutrient source; however, it is clear that some varieties accumulate more nutrients than do others. Similar data and results are presented for the harvested tubers in Table 21.

Completion of 2001 Data – Experiment 3 —

Experiment 3 (Effect of manure application time on potato growth and disease incidence) was conducted for the first time in 2001. The post-harvest soil test results (Table 22) show the greater acidifying effect of fertilizer compared to manure, the apparent greater impact of fertilizer P in raising soil test P than manurial P, the double K treatment on the manure plots from the broadcast K on the whole field plus the manure, and the apparent addition of Mg with the manure treatment. With the exception of the increase in soil test Mg, all of these results are explainable and expected. Apparently, the manure is serving as a significant source of Mg, but we have not tested the manure for Mg.

As shown in Table 23, the manure applied immediately before potato planting showed much less NO_3-N in the top 1 foot of soil. This was likely due to some denitriifcation of the immediately available N and the less complete mineralization of the organic N fraction.

Table 24 and 25 present the results of the ICP analyses of the leaflet and petiole samples and the harvested tuber samples from Experiment 3. Few differences between times of

application are obvious; however, some differences are apparent between varieties.

Summary of 2001 Experimental Results

Results of our second year clearly showed that manure can be an important source of nutrients to potatoes. Although the apparent N fertilizer replacement value of the manure seems to be slightly lower when raising potatoes than corn, our preliminary data show some yield, grade, and size grade advantages when manure was included in the system. In both Experiment 1 and 2, the manure-treated plots resulted in the highest yield and grade except where manure was spring-applied at Rhinelander. Results of the soil and plant tissue analysis have helped confirm the appropriate equivalency of manurial N and P to potatoes. Tuber solids, however, were significantly lower when manure was the nutrient source compared to an approximately equivalent amount of available nutrients from commercial fertilizer. Experiment 3 showed us that timing of the manure application prior to planting potatoes is important because for some varieties, application in the spring ahead of potatoes results in significantly lower yield and increased levels of scab.

A more complete summarization of our work to date was presented in the Dawson and Kelling paper presented at the February 2002 Wisconsin Potato Meetings. This paper was appended to our 7 April 2002 report. Ms. Dawson is currently writing her thesis, which will provide a very complete and more succinct summary of the first 2 years of work. A copy of her thesis will be provided when available (November or December 2002). The major conclusions are enumerated below:

1. Nitrogen availability from manure to potatoes may be slightly lower than if corn is used as a succeeding crop.

2. Based on yield and plant nutrient content, average N availability is 27.5% compared with long-term average availability to corn of about 35%.

3. Apparent P availability from manure to potatoes could not be estimated from yields as the manure plots always out-yielded the fertilizer plots. However, using plant tissue analysis results showed about 80% availability in 2000 but less than 20% in 2001.

4. Measurement of N and P in the soil water at 3 ft below the fertilizer and manure treated plots showed differences in N from the control only where both manure and fertilizer were used. No P movement was detected.

5. Overall potato yields were enhanced where manure was applied and this benefit could not be overcome with additional fertilizer. Apparently manure is resulting in some heretofore unspecified advantage such as improved soil physical condition, stimulation of soil biota, or addition of other nutrients.

6. Where manure was applied immediately ahead of planting potatoes, yields of some, but not all, varieties decreased and scab levels increased. It may be best (safest) to apply manure as one rotates out of potatoes rather than in preparation for planting potatoes.

7. The use of manure generally depressed tuber solids. This has important implications

for growers raising processing potatoes.

Establishment of the 2002 Crop Year Experiments

A third year of corp experiments was established at both Antigo and Rhinelander following similar protocols and treatments as those used in previous years. As in the past, the manure treatments from a portion of Experiment 2 at Antigo in 2001 were used to evaluate the influence of time of manure application prior to potato planting on potato diseases in 2002. A complete description of the activities and timing of work for 2002 will be presented in our October report.