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of *Potato Virus Y* (PVY) in Seed Potatoes

by

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and David W. Ragsdale

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## Producers' Use of Crop Borders for Management of *Potato Virus Y* (PVY) in Seed Potatoes

by Kent D. Olson,<sup>1</sup> Thaddee Badibanga,<sup>1</sup> Edward B. Radcliffe,<sup>2</sup> and David W. Ragsdale<sup>2</sup>

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**Abstract:** *Potato virus Y* (PVY) is a very serious problem throughout most major seed potato producing states. Seed potato producers in Minnesota and North Dakota were surveyed in early 2005 to assess their perception of the profitability and risks associated with using crop borders to manage PVY in seed lots. Five of the 23 producers responding (a 25% response rate) said they had used crop borders in 2004. These 23 producers entered 152 seed lots into state seed certification programs. On average, producers had less than 0.1 seed lots rejected for PVY based on summer inspection. The average number of seed lots rejected in winter trials was 1.7. Of the 152 seed lots, these producers said they had entered into state seed certification programs, they reported detailed information on 108 lots. Generations 1 and 2 were the most likely generations to be protected by a crop border. Of these 108 seed lots, 104 passed summer inspection for PVY. Seventy-four percent of the 89 lots sent in for the winter test were reported to have passed. The use of crop borders was significant in explaining whether a seed lot had passed the winter test or not. Thirty-one (97%) of the 32 seed lots that were planted within a crop border passed the winter test while 31 (54%) of the 57 seed lots that were not planted with a crop border passed the winter test. No relationship was found between the choice of border crop and passing the winter test. Producers also were asked to state their agreement or disagreement with several statements regarding their knowledge and opinions on use of crop borders.

The commercial potato industry is dependent upon the availability of disease-free seed tubers. The focus of this report is the management of *Potato virus Y* (PVY).<sup>3</sup> Planting seed tubers with more than modest levels of virus infection (e.g., >10%) can result in yield and quality losses for the commercial grower (Killick 1979; Reestman 1970; van der Zaag 1987). If virus levels exceed tolerances, seed lots are downgraded to a more advanced generation or rejected outright if infection exceeds the tolerance for certified seed. Thus, infestations have an immediate impact on the price received for the seed tubers and thus seed producers' gross revenue.

PVY has, over the past 20 years, become a very serious problem throughout most major seed potato producing states. For example, seed lot rejections due to PVY in the winter tests of the Minnesota State Seed Potato Certification Program averaged 42.1% from 1998 to 2002 with a range 28.3 to 52.3%. Seed potato production has declined 50%, and the number of seed producers has declined by 40% in the region.

PVY is transmitted in a nonpersistent manner by numerous vector species (such as aphids), some of which are only transient visitors to potato (Boiteau et al. 1988; Harrington et al. 1986; Heimbach et al. 1998, Sigvald 1987, 1989; van Harten 1983). Since PVY is nonpersistent, the vector species lose their ability to spread the virus after a short period on non-infected plants. Thus, cultural methods have been proposed as alternatives to insecticides. Indeed, cultural methods have been shown to be more successful than insecticides in the control of PVY. Insecticides seldom kill quickly enough to prevent spread of PVY (Ragsdale et al. 1994).

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<sup>3</sup> PVY is one of two virus diseases that are of particular concern in seed potato production. *Potato leafroll virus* (PLRV) is the other important virus of seed potatoes.

Crop borders (i.e., barrier crops) are one cultural method that has been proposed and is being used by seed potato producers to control spread of PVY. If immigrating alatae (i.e., winged aphids) carrying PVY feed first on the crop border, they will probably lose their virus inoculum before moving into the potatoes since PVY is non persistent in the alatae (DiFonzo et al. 1996).

The use of crop borders to protect seed potatoes, especially high value, early generation seed, from PVY spread has been widely adopted by Minnesota and North Dakota producers. The recent emergence of soybean aphid as a major pest throughout the Midwest and the discovery that this insect is a capable vector of PVY has caused some producers to question the advisability of continuing to use soybean as a crop border. Thus a larger study<sup>4</sup> was undertaken to reassess the value of crop borders for controlling PVY.

As part of this larger study, seed potato producers in Northwestern Minnesota and Eastern North Dakota were surveyed to assess their perception of the profitability and risks associated with using crop borders to manage PVY in seed lots. This report presents the initial findings of that survey.

## **SURVEY METHODS**

Initial interviews with seed potato producers who already use crop borders were used to formulate questions on producers' use and nonuse of crop borders. The preliminary survey was tested by mailing to a small subset of producers. Based on their responses, the survey was finalized and mailed to every seed potato grower in Minnesota and North Dakota. A copy of the survey is attached to the end of this report. It was sent to 92 producers on February 23, 2005. The mailing list consisted of all the certified seed potato producers in Minnesota and North Dakota; 47 were in Minnesota and 45 in North Dakota. A reminder postcard was sent a week later, and another complete survey two weeks after that. Reminders were also sent by email from the North Dakota and Minnesota state seed potato producers associations. One grower responded saying all their potatoes were sent to the fresh market and did not return the survey. Twenty-three surveys were returned and deemed usable—a 25% return rate.

In one part of the survey, producers were asked to indicate their agreement or disagreement on a series of statements. Their answers were scored on a 5-point Likert scale. The average score was tested for differences from a neutral response using a one-tailed student's t-test (SAS Institute). The strength of relationships between producers' responses to one question compared to another question was tested using either the Chi-square test or Fishers' Exact test due to the small number of responses (SAS Institute).

## **SURVEY RESULTS**

Of the 23 respondents, 5 said they had used crop borders for their seed potato lots in 2004 and had used crop borders for an average of 4 years. The range was 2-5 years. Nine producers said they had used crop borders but had quit: 6 because it didn't appear to reduce PVY and 3 because of inconvenience or cost. Four said they had considered using crop borders but had decided against it. Five said they didn't have enough information to use crop borders.

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<sup>4</sup> The project, "Reassessment of Crop Borders for Management of Potato Virus Y in Seed Potatoes," was funded by the North Central IPM Regional Center.

## Producer Characteristics

Of the 23 producers who responded, 11 grew seed potatoes only in Minnesota, 10 grew only in North Dakota, and 2 grew seed potatoes in both states. Nineteen producers have been farming for more than 10 years, and 15 producers have been growing seed potatoes for more than 10 years (Table 1). Twelve producers said more than 25 percent of their total farm net income came from seed potatoes. Eleven producers said they had a debt-to-asset ratio of 5-40%. Ten of the producers had completed college, 6 had completed a trade or technical school, 2 had received some post high school education, and 2 had gone to or completed graduate or professional education. The 2 most common sources of information for making decisions on their farms were their own farm records and private companies, dealers, or their representatives (Table 2). Compared to other problems in seed potato production, 13 of the 23 producers said damage caused by PVY (or mosaic) infection was very important on their farm, 6 said it was important; 2 said it was somewhat important, and 1 said it was not important.

Table 1. Producer characteristics\*

	Less than 5 years	5 to 10 years	More than 10 years
Number of years farming	2	2	19
Number of years growing seed potatoes	7	1	15
	Less than 10%	10 to 25%	More than 25%
Percent of total net farm income from seed potatoes	5	5	12
	Less than 5%	5 to 40%	More than 40%
Debt-to-asset ratio	5	11	2

\*Number of producers out of 23 respondents. Some rows do not add to 23 due to non-respondents.

## Seed Certification

In 2004, these 23 producers entered 152 seed lots into state seed certification programs. The average number of seed lots was 6.6 per producer; the median was 4. Of these seed lots entered into the certification programs in 2004, the average farm had less than 0.1 seed lots rejected for PVY based on summer inspection. The average number of seed lots rejected in winter trials was 1.7. The median number of rejected seed lots was 0 in the summer and 1 in the winter.

For those producers who had less than 15 seed lots, the average number of seed lots was 4.9 with the median at 4. These farms had on average 0.1 seed lots rejected in summer inspections and 1.1 seed lot rejected in winter trials. For these farms also, the median number of rejected seed lots was 0 in the summer and 1 in the winter.

Table 2. Main sources of information for making decisions\*

Source:	Number of Producers
My own farm records	13
Private companies, dealers or their representatives	13
Other farmers	9
Extension meetings	7
Personal discussion with University staff	7
Newspapers, magazines, or trade journals	7
Private consultants	6
Personal discussion with staff from agencies such as NRCS, SWCD, DNR	0
Radio or television	0
Other	3

\* Producers were asked to indicate only their top three sources. These are the number of producers indicating each source. 22 respondents answered this question.

Of the 152 seed lots, these producers said they had entered into state seed certification programs, they reported detailed information on 108 lots. The most common varieties were Red Norland, Russet Burbank, and Dark Red Norland (Table 3). Use of crop borders was significantly related to the variety: 11 of the 14 Russet Burbank seed lots were planted within a crop border and 4 of the 19 Red Norland seed lots were so planted. One of the Dark Red Norland seed lots was planted within crop borders. Other varieties had 2, 1, or no lots planted within crop borders.

Table 3. Varieties used by responding producers

Variety	Frequency*	Percent
Red Norland	19	18%
Russet Burbank	14	13
Dark Red Norland	12	11
Dakota Pearl	6	6
Dakota Rose	6	6
Red Lasoda	6	6
Shepody	5	5
Chieftain	4	4
Norvalley	4	4
Sangre	4	4
Yukon Gold	4	4
Red Pontiac	3	3
*Frequency in and percentage of 108 lots reported. Five varieties were reported to be planted on 2 lots each: Irish Cobbler, Ivory Crisp, Norchip, and FL-1833. Eleven varieties were reported to be planted on 1 lot each: Atlantic, Bannock Russet, Cascade, FL-1867, FL-1879, FL1533, FL1867, N.D. 2470-27, ND 2470, Red Gold, and mixed variety seed lot.		

Ninety-three (or 86%) of the 108 reported seed lots were generations 1 through 4 (Table 4). Generations 1 and 2 accounted for 72% of the 32 seed lots planted within a crop border.

Of the 108 seed lots reported individually, 104 were reported to have passed summer inspection for PVY. Of the 89 seed lots for which winter test results were reported, 62 lots (or 74%) were reported to have passed the winter test for PVY (Table 5). Using the Chi-square test for relationship showed that passing the winter test was significantly related to the use of crop borders. Thirty-one (or 97%) of the 32 seed lots planted reported to be planted within crop borders passed the winter test compared to 31 (or 54%) of the 57 seed lots that reported winter test results but did not use crop borders. The use of a mineral or crop oil appears at first to have a positive impact on passing the winter test, but when combined with the use of crop borders, the impact of a mineral or crop oil application disappears (Table 6).

Table 4. Seed lot generation reported by producers

Generation	Frequency*	Percent of all 108 lots	Percent of generation planted within a crop border*
G1	13	12%	69%
G2	29	27	48
G3	22	20	5
G4	29	27	17
G5	2	2	0
Other**	13	12	25
Total	108	100%	---

\*Fisher's Exact test (for relationship) probability = 0.0001 so hypothesis of independence between use of crop borders and generation is rejected at  $p < 0.01$ .  
 \*\*Producers also reported planting cert., N, PF1, PF2, and Z generations.

Table 5. Frequency of passing the winter test compared to use of crop borders.\*

	Passed Winter test:		Total
	No	Yes	
Did NOT use crop border	26	31	57
DID use crop border	1	31	32
Total	27	62	89

\*Frequency of 89 lots with winter test results reported; results were not reported for 19 lots. The Chi-Square value of 17.5 has a probability  $< 0.0001$  so the hypothesis of independence between use of crop borders and passing the winter test is rejected at  $p < 0.01$ .

Table 6. Frequency of passing the winter test compared to use of a mineral or crop oil, a crop border, or both.\*

	Passed Winter test:		Total
	No	Yes	
Neither oil nor crop border	19	25	44
Only an oil application	7	6	13
Only a crop border	0	5	5
Both oil and a crop border	1	26	27
Total	27	62	89

\*Frequency of 89 lots with winter test results reported; results were not reported for 19 lots. The Chi-Square value of 18.1 has a probability < 0.0004 so the hypothesis of independence between use of crop borders and passing the winter test is rejected at  $p < 0.01$ .

## Production Methods

Of the 108 seed lots reported individually, the average lot size was 40 acres with a median seed lot size of 27 acres and a range of 0.2 acres to 350 acres over all seed generations, varieties, and locations. For the 54 lots on which number of rows was reported, the average number of rows was 173 rows in each seed lot with a median of 120 and a range from 8 to 676 rows. For the 24 seed lots reporting, the crop border averaged 26.6 feet with a median width of 20 feet and a range of 4 to 60 feet wide.

The most common border crop reported was winter wheat (10 seed lots). The next most common border crops were soybean and rye (7 lots); wheat and alfalfa (6); and sudan grass (4). Wheat alone and potatoes were also reported on one seed lot each. Since 28 seed lots passed the winter test of the 29 seed lots reporting the border crop used, no relationship between the choice of border crop and passing the winter test was found.

Forty-eight percent of the seed lots were treated using a mineral or crop oil (e.g., Aphoil), but the use of a mineral or crop oil did not have an impact of whether the seed lot passed the winter test (Table 6). Fungicide expenses averaged \$64 per acre with a median of \$62 and a range of \$10 to \$165. Fertilizer expenses averaged \$67 per acre with a median of 40 and a range of \$25 to \$245. Thirty-two percent of the seed lots were irrigated.

Over all generations, varieties, and lots, the average yield of seed potatoes was 255 cwt per acre with a median of 223.5 cwt and a range from 110 to 579 cwt per acre. For those who reported price, the average price received (or expected) was \$7.68 per cwt with a median price of \$7.50 and a range from \$3 to \$17 considering all generations.

Seventeen of the 23 producers said they had used the *Aphid Alert* newsletter to assist them in their aphid control decisions when it was available during 1998-2003. When asked whether they used early scouting information to assist in their aphid control decisions, 14 said they did for early season rouging, 16 for using pre-plant insecticides, 20 for using post plant insecticide sprays, 12 for using crop oils, and 16 for deciding to kill vines early.

The producers said 40 percent of the 108 seed lots were vine killed due to normal plant maturity. Twenty percent were vine killed for maximum yield potential. Eighteen percent were vine killed due to the potential for no certification. Twenty-two percent had other reasons such as to control size or excessive late season rain.

The producers' stated importance of damage caused by PVY (mosaic) infection was significantly ( $p \leq 0.10$ ) related to their use or lack of use of crop borders (Table 7). However, it



does not appear to be a simple relationship. While those who were using crop borders indicated that damage caused by PVY infection was “very important” relative to other problems in seed potato production. Most of the producers who had never used crop borders also said the damage was “very important.” Those producers who had used crop borders but had quit were more likely to say the damage was “important” than “very important.”

Table 7. Frequency of producers’ use of crop borders compared to their self-reported importance of damage caused by PVY (mosaic) infection on their farm.\*

	Very important	Important	Somewhat important	Not important	Total
Never used crop borders	6	1	1	0	8
Used crop borders but quit	3	5	0	1	9
Used crop borders in 2004	4	0	1	0	5
Total	13	6	2	1	22
*Fisher’s Exact test (for relationship) probability = 0.08 so hypothesis of independence between use of crop borders and reported importance is rejected at $p < 0.10$ .					

### Knowledge and opinions on use of crop borders

Producers were asked to state their agreement or disagreement with several statements regarding their knowledge and opinions on use of crop borders. When the producers’ disagreement and agreement were converted to scores, producers’ opinion were significantly different from neutral in only five statements when all respondents were considered, but, when responses were categorized by use or non-use of crop borders, different questions showed significant relationships between agreement and disagreement (Table 8). Two-thirds of the producers planned to be farming for more than ten years (question 35). Almost half of the producers disagreed with the statement that PVY control was easier using insecticides without crop borders (question 36). Just under half of the producers said the information about crop borders was very relevant for their farms (question 38). Over half of the producers disagreed with the statement that they did not know how to use crop borders in their seed potato production (question 40). Almost two-thirds of the producers agreed that using crop borders decreases the risk of PVY infection (question 41).

When considering all respondents, the producers’ opinions were not significantly different from neutral in the other five statements. These statements involved the supply, ease of access, and reliability and consistency of information on using crop borders (questions 32, 33, and 37); the impact of management complexity on the adoption of crop borders (question 34); and whether using crop borders fit their current production system very well (question 39).

In only four instances was the respondents’ agreement and disagreement with these 10 statements found to be related significantly to whether they have never tried to use crop borders, used them at one time but quit, or did use crop borders in 2004 (Table 8). Those producers who were using or had used crop borders disagreed with the statement that it was “very easy to obtain information on using crop borders” while those who had not used crop borders agreed with the statement (question 33). This counter-intuitive result is probably explained by considering that

those who had looked for information because they had used crop borders had found it harder to obtain than thought by those who had never looked for the information because they had never used crop borders. Those who had used but then quit using crop borders were more likely not to agree with the statement that they had found “the information about using crop borders to be reliable and consistent (question 37). On the other hand, both those who were using crop borders and those who had used crop borders but quit agreed with the statement that the “information about crop borders [was] very relevant for my farm” (question 38). Only those who were using crop borders agreed with the statement that “using crop borders [fit] very well with my current production system” (question 39). Those who had used crop borders but then quit disagreed with that statement. Those who had never used crop borders were neutral on that statement.

Table 8. Producers’ agreement and disagreement with statements concerning using crop borders in seed potato production compared to their use of crop borders.\*

Survey question:	Strongly disagree or Disagree	Neutral	Agree or Strongly agree	Average score	Standard deviation	Number of responses
<b>Q32. I can get all the information I need on how to use crop borders.</b>						
All responses	6	6	9	3.2	1.0	21
Never used crop borders	0	3	5	Fisher’s Exact Test (for relationship) probability = 0.13		
Used crop borders but quit	5	2	2			
Used crop borders in 2004	1	1	2			
<b>Q33. I find it very easy to obtain information on using crop borders.</b>						
All responses	7	4	10	3.2	1.0	21
Never used crop borders	0	2	6	Fisher’s Exact Test (for relationship) probability = 0.07***		
Used crop borders but quit	4	2	3			
Used crop borders in 2004	3	0	1			
<b>Q34. Would (or does) the additional management complexity imposed by use of crop borders make this tactic impractical for adoption on your farm.</b>						
All responses	9	5	6	2.8	1.0	20
Never used crop borders	3	2	3	Fisher’s Exact Test (for relationship) probability = 0.26		
Used crop borders but quit	2	3	3			
Used crop borders in 2004	4	0	0			
<b>Q35. I plan to be farming for more than 10 years.</b>						
All responses	1	5	15	4.1**	1.0	21
Never used crop borders	0	3	5	Fisher’s Exact Test (for relationship) probability = 0.68		
Used crop borders but quit	1	2	6			
Used crop borders in 2004	0	0	4			
<b>Q36. PVY control is easier if I use insecticides without crop borders.</b>						
All responses	9	8	4	2.7**	0.9	21
Never used crop borders	4	4	1	Fisher’s Exact Test (for relationship) probability = 0.68		
Used crop borders but quit	3	2	3			
Used crop borders in 2004	2	2	0			

Table 8, continued.

Survey question:	Strongly disagree or Disagree	Neutral	Agree or Strongly agree	Average score	Standard deviation	Number of responses
<b>Q37. I find information about using crop border to be reliable and consistent.</b>						
All responses	5	8	8	3.2	0.9	21
Never used crop borders	0	5	3	Fisher's Exact Test (for relationship) probability = 0.01***		
Used crop borders but quit	5	3	1			
Used crop borders in 2004	0	0	4			
<b>Q38. The information about crop borders is very relevant for my farm.</b>						
All responses	1	11	9	3.6**	0.9	21
Never used crop borders	0	7	1	Fisher's Exact Test (for relationship) probability = 0.02***		
Used crop borders but quit	1	4	4			
Used crop borders in 2004	0	0	4			
<b>Q39. Using crop borders fits very well with my current production system.</b>						
All responses	9	7	5	2.9	0.9	21
Never used crop borders	2	6	0	Fisher's Exact Test (for relationship) probability = 0.00***		
Used crop borders but quit	7	1	1			
Used crop borders in 2004	0	0	4			
<b>Q40. I do not know how to use crop borders in my seed potato production.</b>						
All responses	13	3	6	2.7**	0.9	22
Never used crop borders	4	2	3	Fisher's Exact Test (for relationship) probability = 0.62		
Used crop borders but quit	5	1	3			
Used crop borders in 2004	4	0	0			
<b>Q41. Using crop borders decreases the risk of PVY infection.</b>						
All responses	2	5	14	3.7**	0.8	21
Never used crop borders	1	3	4	Fisher's Exact Test (for relationship) probability = 0.65		
Used crop borders but quit	1	2	6			
Used crop borders in 2004	0	0	4			
*Responses of strongly disagree and disagree and also agree and strongly agree are grouped together for this table. Average score based on responses from 1-5 with 1 being strongly disagree, 2 being disagree, 3 being neutral, 4 being agree, and 5 being strongly agree. "Don't know or not applicable" responses were eliminated from the calculations reported in this table.						
**Average score is significantly different from 3 with $p \leq 0.05$ using a one-tailed Student's t-test.						
*** Fisher's Exact Test (for relationship) probability significant at 0.10, 0.05, or 0.01 probability.						

## SUMMARY

PVY has, over the past 20 years, become a very serious problem throughout most major seed potato producing states. The use of crop borders to protect seed potatoes from PVY spread has been widely adopted by Minnesota and North Dakota producers. The recent emergence of soybean aphid as a major pest throughout the Midwest and the discovery that this insect is a capable vector of PVY has caused some producers to question the advisability of continuing to use soybean as a crop border. As part of a larger study, seed potato producers in Northwestern Minnesota and Eastern North Dakota were surveyed to assess their perception of the profitability and risks associated with using crop borders to manage PVY in seed lots.

Of the 23 producers who responded (a 25% response rate), 11 grew seed potatoes only in Minnesota, 10 grew only in North Dakota, and 2 grew seed potatoes in both states. Five of these 23

producers said they had used crop borders in 2004. Nine producers said they had tried using crop borders in the past but had quit using them. Six of these had quit because crop borders didn't appear to reduce PVY, and 3 had quit because of inconvenience or cost. Four producers said they had looked into using crop borders but decided against using them. Five said they have not used crop borders because they did not have enough information to use them.

In 2004, these 23 producers entered 152 seed lots into state seed certification programs. On average, producers had less than 0.1 seed lots rejected for PVY based on summer inspection. The average number of seed lots rejected in winter trials was 1.7. Of the 152 seed lots, these producers said they had entered into state seed certification programs, they reported detailed information on 108 lots. The most common varieties were Red Norland, Russet Burbank, and Dark Red Norland. Generations 1 and 2 were the most likely generations to be protected by a crop border. Of these 108 seed lots, 104 passed summer inspection for PVY.

Seventy-four percent of the 89 lots sent in for the winter test were reported to have passed. The use of crop borders was significant in explaining whether a seed lot had passed the winter test or not. Thirty-one (97%) of the 32 seed lots that were planted within a crop border passed the winter test while 31 (54%) of the 57 seed lots that were not planted with a crop border passed the winter test.

Crop borders averaged 26.6 feet with a median width of 20 feet. The most common border crop was wheat followed by soybean and rye; wheat and alfalfa; and sudan grass. Since 28 seed lots passed the winter test of the 29 seed lots reporting the border crop used, no relationship between the choice of border crop and passing the winter test was found.

The producers' stated importance of damage caused by PVY (mosaic) infection was significantly ( $p \leq 0.10$ ) related to their use or lack of use of crop borders. However, it does not appear to be a simple relationship. While those who were using crop borders indicated that damage caused by PVY infection was "very important" relative to other problems in seed potato production. Most of the producers who had never used crop borders also said the damage was "very important." Those producers who had used crop borders but had quit were more likely to say the damage was "important" than "very important."

Producers were asked to state their agreement or disagreement with several statements regarding their knowledge and opinions on use of crop borders. In only four instances was the respondents' agreement and disagreement with these statements found to be related significantly to whether they have never tried to use crop borders, used them at one time but quit, or did use crop borders in 2004. Those who were using or had used crop borders disagreed with the statement that it was "very easy to obtain information on using crop borders" while those who had not used crop borders agreed with the statement. This counter-intuitive result is probably explained by considering that those who had looked for information because they had used crop borders had found it harder to obtain than thought by those who had never looked for the information because they had never used crop borders. Those who had used but then quit using crop borders were more likely not to agree with the statement that they had found "the information about using crop borders to be reliable and consistent. On the other hand, both those who were using crop borders and those who had used crop borders but quit agreed with the statement that the "information about crop borders [was] very relevant for my farm". Only those who were using crop borders agreed with the statement that "using crop borders [fit] very well with my current production system". Those who had used crop borders but then quit disagreed with that statement.

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## Reassessment of Crop Borders for Management of Potato virus Y in Seed Potatoes

PLEASE ANSWER THE FOLLOWING QUESTIONS  
BY FILLING IN THE BLANK OR CIRCLING YOUR ANSWER.

1. In what state does your seed potato production occur?
  - a. Minnesota
  - b. North Dakota
  - c. Both states
2. How many years have you been farming?
  - a. Less than 5 years
  - b. 5 to 10 years
  - c. more than 10 years
3. How many years have you been growing seed potatoes?
  - a. Less than 5 years
  - b. 5 to 10 years
  - c. more than 10 years
4. As a percent of total farm net income, how important are seed potatoes to your farm?
  - a. Less than 10%
  - b. 10 – 25%
  - c. More than 25%
5. Compared to other problems in seed potato production, how important has been the damage caused by PVY (mosaic) infection on your farm?
  - a. Very important
  - b. Important
  - c. Somewhat important
  - e. Not important
6. At any time in the past, have you ever used crop borders to protect seed potatoes from PVY (mosaic) infection?
  - a. no, I do not have enough information to use crop borders
  - b. no, I looked into using crop borders, but decided against it
  - c. yes, I tried using crop borders but quit because of inconvenience (or cost)
  - d. yes, I tried using crop borders but quit because it didn't appear to reduce PVY
  - e. yes, I did in 2004 and have used crop borders for \_\_\_\_\_ years (including '04)
7. Did you use the information in the 1998-2003 *Aphid Alert* newsletters to assist you in your aphid control decisions? (note because of lack of funding *Aphid Alert* was discontinued after 2003).  
\_\_\_ no \_\_\_ yes If yes, please describe how you used that information.
8. Do you use other early scouting information to assist you in your aphid control decisions?
  - a. Early season rouging                      no    yes
  - b. Preplant insecticides                      no    yes
  - c. Post plant insecticides (sprays)        no    yes
  - d. Crop oils                                      no    yes
  - e. Early vine kill                                no    yes
  - f. Other (Please describe)

9. In 2004, how many seed lots did you enter into state seed certification programs? \_\_\_\_\_lots

10. Of the seed lots you entered into certification programs in 2004,

a. How many were rejected for PVY based on summer inspection? \_\_\_\_\_lots

b. How many were rejected in winter trials for PVY? \_\_\_\_\_lots

Please complete the following table for each seed lot of seed potatoes in 2004. If you have more than 6 seed lots, please complete the information for the other seed lots on a separate page.

Seed lot:	A	B	C	D	E	F
11. What cultivar is this seed lot?						
12. What generation is this seed lot?						
13. What county is this seed lot in?						
14. Acres in this seed lot						
15. How many rows are in this seed lot?						
16. Did this seed lot pass summer inspection for PVY?	Yes No na*	Yes No na	Yes No na	Yes No na	Yes No na	Yes No na
17. Did this seed lot pass winter inspection for PVY?	Yes No na	Yes No na	Yes No na	Yes No na	Yes No na	Yes No na
	*na = not applicable					
18. If this seed lot did NOT pass inspection, what was the reason?						
19. On what date was the seed lot planted? (mo/day)						
20. On what date was the seed lot vine killed? (mo/day)						
21. What was the seed potato yield? (cwt/acre)						
22. What was the price you received or expect for this seed lot? (\$/cwt)						
23. What was the main reason for deciding when to vine kill?	M* Y NC O	M Y NC O	M Y NC O	M Y NC O	M Y NC O	M Y NC O
*M = normal plant maturity; Y=maximum yield potential; NC=potential for non certification due to virus infection; O=other, please describe						

Seed lot:	A	B	C	D	E	F
24a. Was a crop border used to control spread of viruses?	Yes No	Yes No	Yes No	Yes No	Yes No	Yes No
24b. If yes, how wide was the border? (feet)						
24c. If yes, what crop was planted in the border?						
24d. If yes, when was the crop planted? (mo/day)						
24e. If an insecticide was applied to the border, what was the product and rate?	na*	na	na	na	na	na
*na = not applicable						
25. If an insecticide was applied to this seed lot at planting, what was the product and rate?	na	na	na	na	na	na
26. If a foliar insecticide was used on this seed lot, what was the product, rate, and frequency?	na	na	na	na	na	na
27. Was a mineral or crop oil (e.g., Aphoil) used?	Yes No	Yes No	Yes No	Yes No	Yes No	Yes No
28. What, if any, other PVY control methods were used? (please list)	na	na	na	na	na	na
29. What were your fungicide expenses for this seed lot? (\$/acre)						
30. What were your fertilizer expenses for this seed lot? (\$/acre)						
31. Was the seed lot irrigated?	Yes No	Yes No	Yes No	Yes No	Yes No	Yes No

If you have other comments or notes on these seed lots, please write them below.



For the following statements, circle the answer that best describes your response to the statement in regards to seed potatoes on your farm.

SD = strongly disagree  
D = disagree  
N = neutral

A = Agree  
SA = Strongly agree  
DK = don't know or not applicable

- SD D N A SA DK 32. I can obtain all the information I need on how to use crop borders.
- SD D N A SA DK 33. I find it very easy to obtain information on using crop borders.
- SD D N A SA DK 34. Would (or does) the additional management complexity imposed by use of crop borders make this tactic impractical for adoption on your farm.
- SD D N A SA DK 35. I plan to be farming for more than 10 years.
- SD D N A SA DK 36. PVY control is easier if I use insecticides without crop borders.
- SD D N A SA DK 37. I find the information about using crop borders to be reliable and consistent.
- SD D N A SA DK 38. The information about crop borders is very relevant for my farm.
- SD D N A SA DK 39. Using crop borders fits very well with my current production system.
- SD D N A SA DK 40. I do not know how to use crop borders in my seed potato production.
- SD D N A SA DK 41. Using crop borders decreases the risk of PVY infection.

42. What is your estimate of your farm debt level compared to the total estimated market value of your farm business (that is, what is your debt to asset ratio)?

- a. Less than 5% debt                      b. 5-40% debt                      c. More than 40% debt

43. What is the highest level of education you have completed?

- a. grade school  
b. high school or equivalent  
c. some post high school education  
d. trade or technical school  
e. college (bachelor's degree)  
f. some graduate education  
g. graduate or professional school  
h. other, please specify: \_\_\_\_\_

44. What are your THREE main sources of information for making decisions on your farm?

Please circle ONLY THE TOP THREE sources of information.

- a. My own farm records                      f. Private consultants  
b. Other farmers                              g. Private companies, dealers or their representatives  
c. Personal discussion with University staff      h. Newspapers, magazines, or trade journals  
d. Extension meetings                      i. Radio or television  
e. Personal discussion with staff from      j. Other, please specify: \_\_\_\_\_  
agencies such as NRCS, SWCD, DNR      \_\_\_\_\_

45. Do you have any other comments related to this survey and topic?

Thank you for your time and wisdom.

Please return the survey to Kent Olson in the stamped envelope provided.