REACTION OF SNAP BEAN CULTIVARS AND ADVANCED BREEDING LINES TO APHID TRANSMITTED VIRUSES

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There are currently at least three aphid transmitted virus diseases that adversely affect processing beans in the Midwest. Beginning in 2000, when virus related symptoms began to appear in Wisconsin at epidemic proportions, we've seen varying levels of mosaic, plant stunting, distorted and discolored pods, blossom abortion and reduced yields depending on environmental conditions and aphid pressure present in each subsequent year. In Wisconsin, the majority of virus damage has been concentrated in southern and eastern areas along Lake Michigan, although there have also been localized pockets in other areas of the state where symptoms were severe in some years. In addition to the Wisconsin and Minnesota production areas, there have also been periodic reports of damage to processing beans in Michigan, New York and Ontario. The arrival of the soybean aphid in the upper Midwest in 2000 and subsequent fluctuations in aphid numbers from year to year appear to be correlated with virus damage on processing beans. All of the viruses currently identified from symptomatic processing bean plants (cucumber mosaic virus (CMV), alfalfa mosaic virus (AMV) and clover yellow vein virus (CYVV)) are all transmitted by aphids in a non-persistent manner. Thus in years when outbreaks of the soybean aphid are predicted, additional precautions are taken that include control of the aphid on soybeans, adjustments in planting schedules and changes in areas designated for early and late season production. While these efforts have undoubtedly helped to reduce losses, there is still a strong sense that we need better management tools for reducing the risk of virus infection in processing bean production.

One of the areas of research supported by the Midwest Food Processors Association is the search for resistance to aphid transmitted viruses in processing bean varieties and breeding materials. Having varieties with high levels of resistance to one or more of the viruses currently found in the Midwest would be an important tool in crop management. Thus, we've conducted field trials every year since 2001, evaluating symptom severity and incidence on a wide range of planting materials. This past year, we continued our field studies with a site at the West Madison Ag Research Station and grower sites near Markesan and Oostburg. These trials were strategically located in areas where aphid and virus pressure were high in previous years. Included in these trials were the most promising entries from the 2004 trial and additional cultivars and breeding lines bringing the total entries to 47 at Markesan and 43 at the W. Madison and Oostburg sites. In spite of early season predictions for the early arrival of the soybean aphid and concerns about

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high numbers of aphids at critical periods of the growing season, these concerns never materialized. Aphid numbers were low through most of the growing season and conse-quently, there was minimal virus incidence at Oostburg and low virus levels at West Madison. At the Markesan site, however, that is located in an area with abundant plantings of alfalfa and soybean, virus pressure was sufficiently high to obtain excellent data on the field susceptibility of the plot entries. We rated each entry for the presence of foliar symptoms, focusing mostly on mosaic and plant stunting. In addition, we also collected leaf samples from each entry at each location for virus assay back in Madison. Tom German's group used an ELISA procedure to check for the presence of CMV and AMV in samples collected on both dates and potyviruses (CYVV belongs to this virus group) in samples collected on the first sampling date. Table 1 outlines the plot details of the three planting sites.

Table 1. Details of the 2005 snap bean variety evaluation trials.

Snap bean variety trial – virus evaluation 2005

Three locations:
- **West Madison Agricultural Research Station**
- **Two commercial fields**

Arrangement:
- **2-row plots (UW breeding lines 1-row), 20' long**
- **3 replicates**

Data collected for each trial:
- **Leaf samples for ELISA virus assay - composite sample of 10 leaves/replicate from each trial, analyzed for AMV, CMV PotY.**
- **Two ratings for foliar symptom severity**

	Markesan	West Madison	Oostburg
Planted	7/16/05	7/11/05	7/8/05
Leaf sample 1 collected	8/23	8/24	8/23
Leaf sample 2 collected	9/6	9/7	9/6
Visual rating #1	8/23	8/24	8/23
#2	9/6	9/7	9/6
Number of lines planted	47	43	43

The incidence of foliar symptoms in 2005 was mild in comparison with previous years, especially at the West Madison and Oostburg sites. Thus rankings of plant susceptibility is based primarily on the field reaction of the plot entries at the Markesan site where we consistently observed severe mosaic symptoms on some of the plot entries and in some cases, a mild pod distortion (Fig. 1). We did not observe blossom drop on any of the plot site replications. The incidence of infection increased slightly in the two weeks between assessments (Table 2). None of the plot entries was completely free of symptoms at all locations, but several entries consistently exhibited a very low incidence of virus related symptoms. Cultivars such as Laguna, Redon, Sirio-LP, MV185 Arras, Alicante, Igloo, Fortune exhibited the lowest virus incidence at Markesan (<0.1 symptomatic plants per row ft), while other breeding lines exhibited as high as 2.2 symptomatic plants per row ft. Some of the lines exhibiting a low incidence of virus symptoms performed well in previous trials (Fortune, Laguna, MV185 Arras, Igloo, Sirio-LP and Redon). The incidence of symptomatic plants was highest at Markesan (Table 3), but when averaged out across all replications at all three sites, a similar pattern of susceptibility emerged (Table 4). ELISA testing revealed that viruses were present in a relatively high proportion of the samples assayed, in spite of the low incidence of symptomatic plants at the Oostburg and W. Madison sites (Table 5). Assay of leaf samples collected randomly from each plot entry and location revealed that both AMV and CMV were commonly detected in most entries, although there were a few entries where we failed to detect AMV (Table 6). CMV was the most

commonly detected virus in 2005, as has been the case in our field trials since 2001. CMV was detected in every plot entry (Tables 2 and 7). The potyvirus assay indicated the presence of this group of viruses in only four entries (Alicante, ID802, PI 309881 and PI 599021) (Table 8).

The 2005 field trials focusing on host susceptibility is the fifth year where we've been able to evaluate a broad range of germplasm for the processing bean industry. Data from the 2005 trials indicate that the primary virus is CMV. While AMV is present in many of the samples and a potyvirus is rarely detected, it appears that CMV is the primary virus of interest. It is effectively transmitted by several aphid species including the soybean aphid and has a broad host range that apparently allows the virus to survive from season to season. It is still possible that other viruses are present in this virus complex, but to date, CMV, AMV and CYVV are the only viruses identified here in the Midwest.

Several breeding lines and cultivars have emerged as less susceptible than some of the standard cultivars such as Hystyle, Hercules and others. For some plot entries, we have observed consistently low incidences of symptomatic plants in field trials, even though ELISA diagnostic procedures have indicated the presence of either CMV, AMV or both viruses. This information should be helpful to breeders as they attempt to develop improved levels of resistance in future cultivars. The information should also be valuable to processors wishing to plant cultivars that exhibit reduced susceptibility to the virus complex.

These research trials have focused attention on short and long term solutions to the virus complex issues that have confronted the processing industry over the past few years. Processors have also altered their planting schedules and locations for late season production in addition to keeping a close eye on aphid and virus pressures. Production losses have been minimized by these changes in management and it is hoped that host resistance will become an active part of their crop and pest management plans.

Figure 1. Left – Severe mosaic and leaf crinkle symptoms on bean foliage. Right – Mild distortion of a snap bean pod on a plant with mosaic symptoms on the foliage.

Table 2. Incidence of symptoms and % of positive virus assays for lines tested in 2005 trials.

UW Trt No.	Entry Name	Source	In previous trials?	Incidence of virus symptoms (# of plants/foot)						% of samples over all 3 locations with positive reactions for virus					% of samples with positive reactions for virus
				Markesan		West Madison		Oostburg		24 Aug			8 Sep		
				23-Aug	5-Sep	23-Aug	7-Sep	23-Aug	5-Sep	amv	cmv	poty	amv	cmv	
1	Hystyle	Harris-Moran	2001 2002 2003 2004	0.1	0.2	0.04	0.00	0.01	0.07	33	33	0	33	44	29
2	Ulysses (EX 081020670)	Seminis	2003 2004	0.2	0.6	0.05	0.04	0.07	0.08	11	33	0	11	33	18
3	Alicante	Seminis		0.1	0.1	0.04	0.03	0.00	0.06	22	33	11	44	33	29
4	Sea Biscuit (EX 15330724)	Seminis		0.3	0.2	0.00	0.03	0.00	0.01	22	33	0	22	33	22
5	Valentino	Seminis		0.1	0.3	0.02	0.03	0.00	0.02	0	56	0	33	67	31
6	Yellowstone	Crites-Moscow	2004	0.1	0.4	0.03	0.05	0.00	0.06	22	33	0	22	44	24
7	Fortune	Crites-Moscow		0.0	0.1	0.02	0.02	0.00	0.10	11	33	0	11	56	22
8	Laguna	Crites-Moscow	2004	0.0	0.0	0.00	0.01	0.00	0.03	11	44	0	33	56	29
9	Shakira	Crites-Moscow		0.0	0.5	0.10	0.03	0.04	0.22	11	33	0	11	44	20
10	HMX 4953	Harris-Moran		0.0	0.1	0.03	0.02	0.00	0.05	0	33	0	11	44	18
11	HMX 5100	Harris-Moran		0.24	2.24	0.03	0.10	0.02	0.06	22	33	0	33	33	24
12	HMX 4954	Harris-Moran		0.24	1.46	0.05	0.15	0.02	0.00	33	44	0	11	44	27
13	MV185 Arras	Vilmorin	2001 2002 2003 2004	0.00	0.07	0.09	0.01	0.18	0.00	0	33	0	11	22	13
14	ORION	Brotherton Seed Co.	2002, 2003, 2004	0.01	0.14	0.02	0.03	0.00	0.04	11	33	0	0	33	16
15	BSC835	Brotherton	2004	0.07	0.37	0.01	0.00	0.02	0.00	11	33	0	33	44	24
16	HS906	Brotherton	2004	0.37	0.23	0.01	0.02	0.00	0.08	33	33	0	0	56	24
17	BSC864	Brotherton	no	0.04	0.14	0.07	0.09	0.04	0.07	11	33	0	33	33	22
18	PLS 87	Pure Line Seeds	2002 2003 2004	0.08	0.12	0.05	0.03	0.00	0.01	22	33	0	11	33	20
19	PLS 75	Pure Line	2002	0.04	0.22	0.16	0.12	0.00	0.12	33	33	0	22	33	24
20	PLS 99	Pure Line	2002 2003	0.22	0.21	0.06	0.01	0.01	0.05	11	33	0	33	67	29
21	Igloo	Pure Line	2002 2003	0.12	0.10	0.01	0.01	0.00	0.03	11	33	0	33	67	29
22	PI 309881	M Sass/Hort	2004	0.00	0.01	0.02	0.04	0.00	0.00	0	11	11	0	11	7
23	2313.9.1000	M Sass/Hort	2004	0.01	0.17	0.00	0.00	0.00	0.00	0	33	0	0	33	13
24	ID8011X	Del Monte	no	0.17	0.79	0.08	0.04	0.00	0.05	0	33	0	0	56	18

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				23-Aug	5-Sep	23-Aug	7-Sep	23-Aug	5-Sep	amv	cmv	poty	amv	cmv	
25	IDC IX	Del Monte	2004	0.06	0.05	0.00	0.00	0.01	0.04	22	33	0	22	67	29
26	ID552	Del Monte	no	0.06	0.22	0.00	0.05	0.01	0.02	11	44	0	11	33	20
27	ID802	Del Monte	no	0.17	1.09	0.09	0.08	0.00	0.02	11	33	11	0	67	24
28	Sirio-LP	Syngenta	2002 2003 2004	0.02	0.07	0.02	0.00	0.00	0.02	11	33	0	0	56	20
29	Redon	Syngenta	2004	0.02	0.03	0.09	0.01	0.01	0.04	11	33	0	11	33	18
30	Stayton	Syngenta	no	0.07	0.14	0.00	0.02	0.00	0.02	11	33	0	11	33	18
31	PI 417782	UW Hort, M. Sass, J. Nienhuis	no	0.30	0.31	0.00	0.01	0.02	0.00	22	44	0	11	33	22
32	PI 288016	UW Hort	no	0.15	0.83	0.00	0.00	0.00	0.00	0	33	0	0	33	13
33	PI182000 (selection S)	UW Hort	no	0.10	0.07	0.01	0.02	0.01	0.02	22	33	0	22	56	27
34	PI 345581	UW Hort	no	0.08	0.18	0.02	0.00	0.00	0.00	0	33	0	0	44	16
35	PI 449412	UW Hort	no	0.08	0.43	0.00	0.00	0.00	0.00	0	33	0	0	56	18
36	PI 313458	UW Hort	no	0.00	0.18	0.00	0.00	0.00	0.00	0	33	0	22	33	18
37	PI 268110	UW Hort	no	0.12	0.61	0.02	0.00	0.00	0.00	0	22	0	0	33	11
38	PI 313833	UW Hort	no	0.00	0.25	0.00	0.00	0.00	0.02	11	33	0	0	33	16
39	PI 174997	UW Hort	no	0.06	0.06	0.00	0.00	0.00	0.00	22	33	0	0	33	18
40	PI 549853	UW Hort	no	0.00	0.25	0.02	0.02	0.00	0.02	0	33	0	0	44	16
41	PI 599021	UW Hort	no	0.12	0.57	0.02	0.00	0.02	0.02	0	33	11	0	44	18
42	PI 599014	UW Hort	no	0.08	0.08	0.00	0.02	0.00	0.00	0	33	0	11	33	16
44	PI 207180 **	UW Hort	no	0.10	0.33					0	67	0	0	100	33
45	PI 599026 **	UW Hort	no	0.02	0.04					0	100	0	0	100	40
46	PI 416468 **	UW Hort	no	0.37	0.55					0	100	0	0	100	40
47	PI 182000 (selection L) **	UW Hort	no	0.04	0.16					0	100	0	0	100	40
Pr>F				< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01						
LSD				0.12	0.46	0.07	0.06	0.03	0.06						

* includes both sampling dates, all three locations, all assays

** only at Markesan (percentages are adjusted for number of plots)

Table 3. Incidence of symptomatic plants among all entries at the Markesan site.

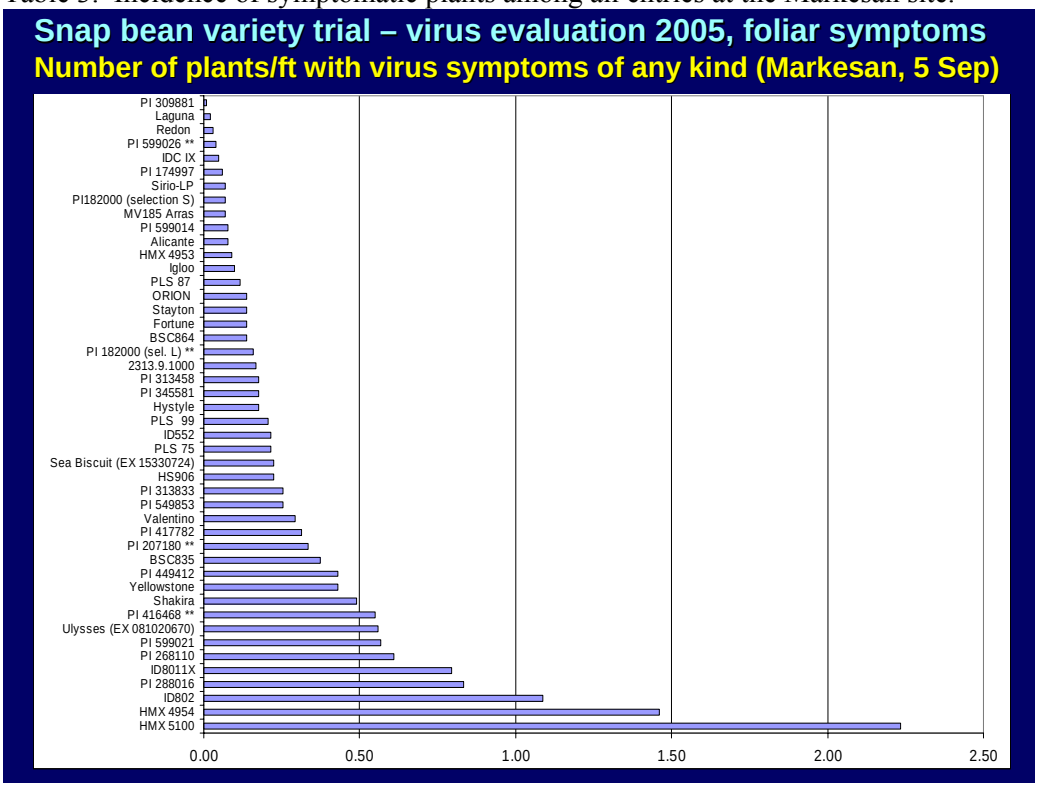

Table 4. The incidence of symptomatic plants among entries across all replications and Wisconsin locations.

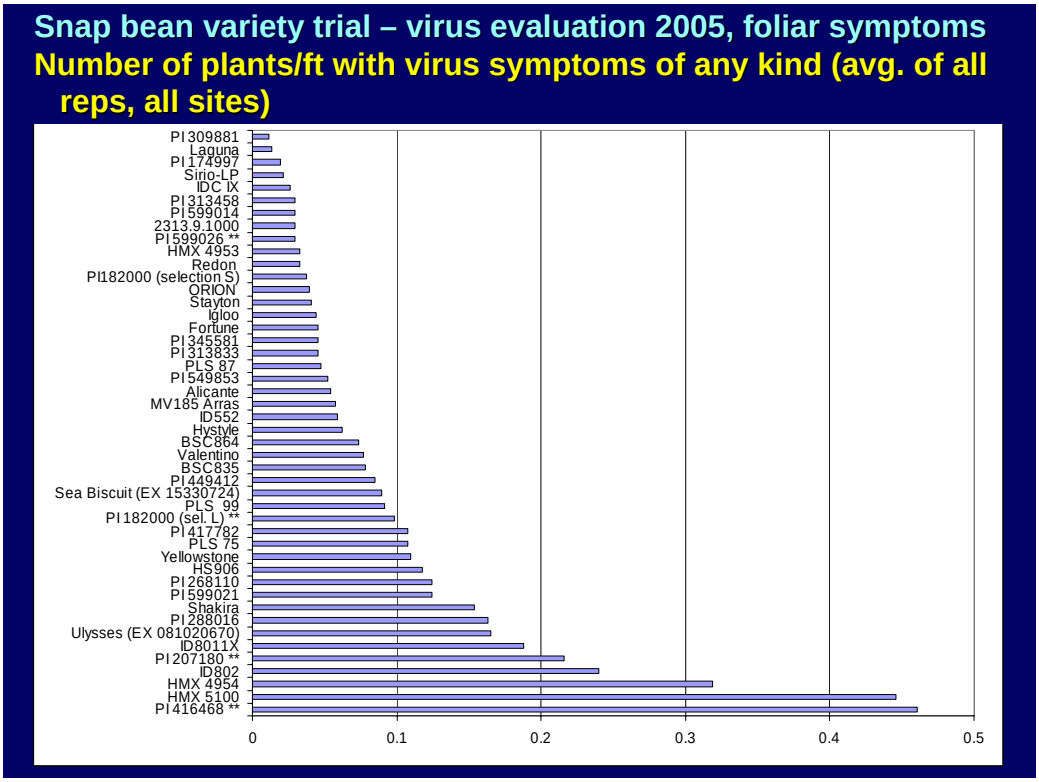

Table 5. Detection of virus in the 2005 field trials in Wisconsin.

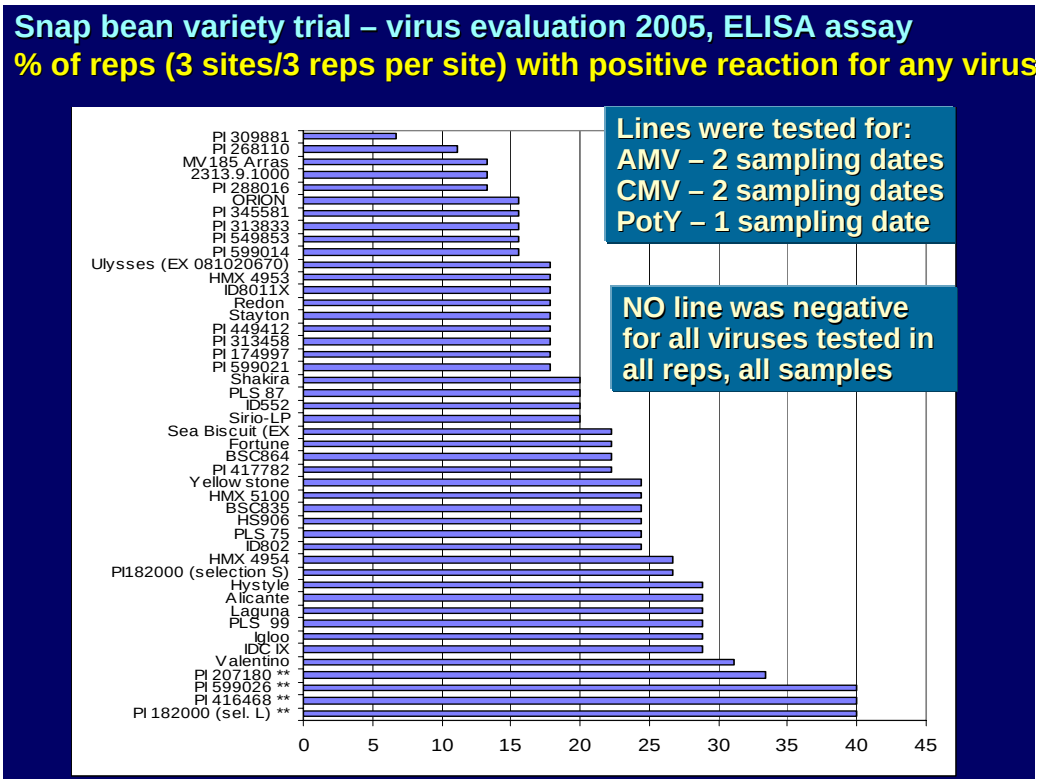

Table 6. Lines with the lowest levels of alfalfa mosaic virus on both sampling dates.

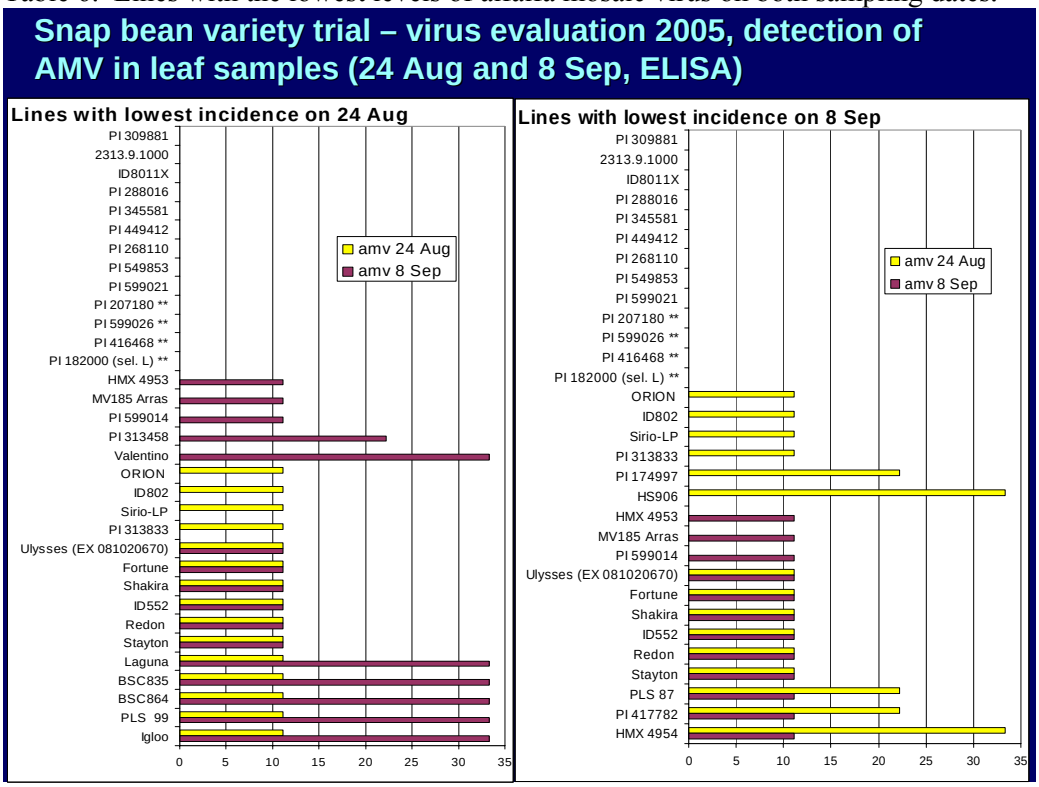

Table 7. with the lowest levels of cucumber mosaic virus on both sampling dates.

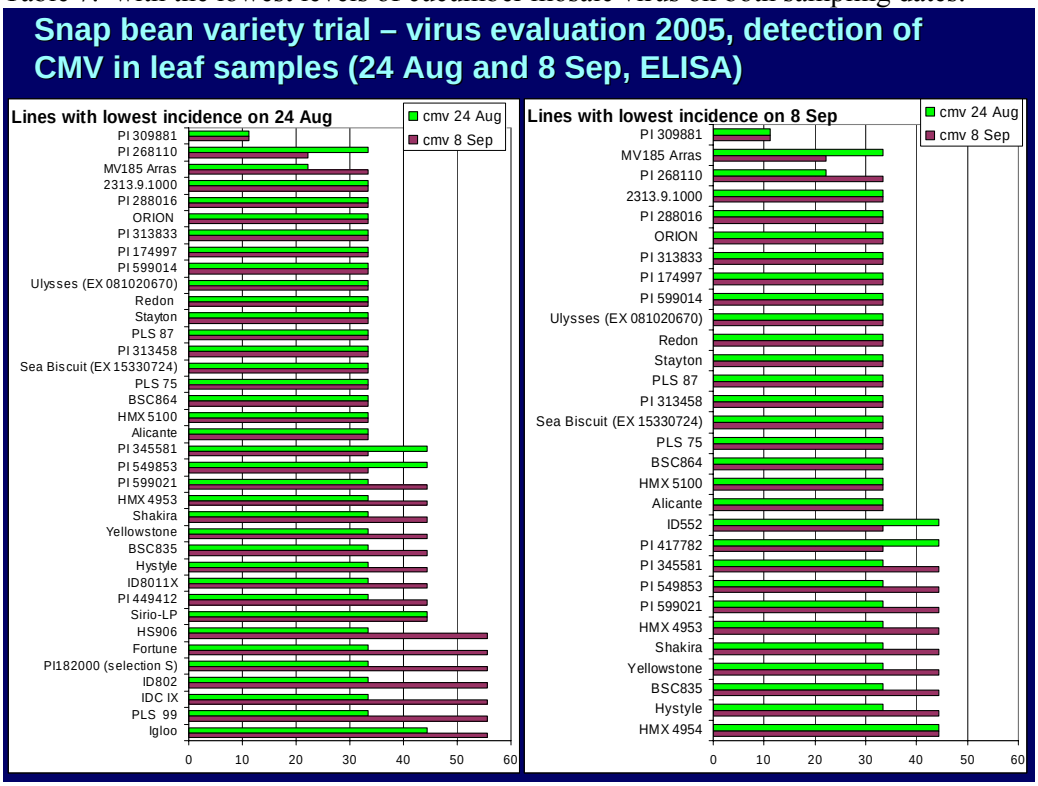

Table 8. A potyvirus was detected in only four plot entries at a single location.