VIRUS RESISTANCE: A POSSIBLE SOLUTION TO SNAP BEAN LOSSES

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Snap bean production is an important part of the procession crop landscape in Wisconsin. Normally we don't concern ourselves with virus-related problems. While the literature includes a list of virus pathogens capable of infecting snap beans, we normally don't see more than a few symptomatic plants in any given year. Usually those plants with symptoms are located near the field margins where aphids carrying viruses such as bean yellow mosaic virus are most likely to land, feed and transmit the style-borne virus. All this changed in 2000 with the arrival of the soybean aphid in such large numbers that suddenly processor field personnel were treating commercial snap bean fields for aphid control, something they rarely if ever has to previously confront. During the 2000 cropping season, Symptoms of virus infection were observed on commercial fields of snap beans in southeastern and eastern WI. This widespread outbreak affected the yield and pod quality of snap beans and ultimately led to the loss of several hundred acres of production. Two viruses, alfalfa mosaic virus (AMV) and cucumber mosaic virus (CMV), both aphid transmitted in a stylet-borne manner) were found to be the primary incitants of the observed symptoms. The timing and distribution of the soybean aphid was associated with virus outbreaks on snap beans. During 2001, these same viruses were again associated with symptomatic snap bean plants. The majority of production fields with virus-like symptoms in 2001 were planted in late June through the middle of July and the worst affected plantings were located along Lake Michigan in NE Wisconsin. Data collected in research plots at the West Madison Ag Research Station indicated differences in the severity of symptom expression among 50 plot entries representing most breeding programs in the U.S. Greenhouse inoculation studies confirmed that several lines were tolerant of AMV and CMV. Data collected during 2001 provided the basis for expanded field trials during 2002.

Field trials planted during 2002 included 120 snap bean cultivars and breeding lines provided by breeding programs across the U.S. for evaluation of virus reaction in field trials. We planted three trials – two plantings at the West Madison Ag Research Station on June 21 and July 24 and a single planting on July 9 in a commercial field near Manitowoc, WI. The planting times and locations were expected to provide a range of both aphid and virus pressure. Weather conditions during 2002 consisted of a cool and wet June followed by an unusually hot July and August. These conditions likely affected aphid pressure in the early portion of the growing season. The first planting at West Madison exhibited only sporadic symptoms of virus infection. The later planting at W. Madison, however, was exposed to soybean aphid pressure in mid August and most lines exhibited symptoms of virus infection. Symptom expression on some lines was severe while expression on many other lines was very mild thus providing a wide range of symptom development between plot entries (Table 1). Mild symptoms and low incidence of symptomatic plants characterized the Manitowoc planting. In addition to multiple readings of symptom severity at each location, leaf samples were collected and assayed for CMV and AMV

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by Tom German's program – UW Entomology. The ELISA assay confirmed the presence of CMV (threshold ELISA reading = 0.15) in most samples. Many samples had very low levels of AMV (ELISA threshold = 0.15) at both locations. Thus the predominant virus in all trials was CMV. Based on both visual and ELISA assay, there is a wide range of susceptibility among the cultivars and breeding lines included in this trial. Data from these field trials provide valuable information to breeders who will likely pursue the improvement of virus resistance in subsequent efforts. The data also assist processor personnel in making cultivar decisions, especially for those late planted fields that appear to be at the greatest risk of virus transmission from migratory aphids.

One of the key questions being asked during 2001-2 was whether seed treatment with Gaucho insecticide affected virus infection of plants and subsequent symptom development and virus multiplication. Embedded within the susceptibility trial were specific cultivars and breeding lines with (+ Gaucho) and without Gaucho treatment. While this data set (Table 2 and 3) clearly show differences in susceptibility between cultivars and breeding lines, treatment of seed with Gaucho insecticide did not appear to consistently affect symptom expression or virus multiplication. It should be noted that these data were collected from small plots. Many large commercial fields were planted with Gaucho treated seed and appropriate controls (non-Gaucho seed treatment) were included in some fields. We look forward to discussing observations from these fields with processing industry personnel during upcoming winter meetings.

Table 1. Bean virus trial, 2002 – W. Madison, July 24 planting date – Summary of foliar symptom ratings and ELISA evaluation for presence of AMV and CMV.

Means for all treatments – Visual rating and ELISA assays

Trt. No.	Line	Visual Rating – Disease Severity (%) 8/30	9/6	9/28	ELISA assay AMV 9/9	CMV 9/9	AMV 9/20	CMV 9/20
1	Igloo	3.7	5.0	8.7	0.55	0.27	0.08	0.58
2	Igloo (+ Gaucho)	7.7	10.0	15.0	0.68	0.19	0.14	0.69
3	Keeper 85	15.3	2.3	2.3	0.26	0.24	0.05	0.71
4	Keeper 85 (+ Gaucho)	6.3	8.3	10.3	0.12	0.30	0.04	0.57
5	Topps	5.7	26.7	30.0	0.05	0.22	0.14	0.92
6	Topps (+ Gaucho)	16.7	11.7	28.3	0.17	0.17	0.12	0.86
7	72	63.3	41.7	75.0	0.01	0.22	0.07	0.46
8	72 (+ Gaucho)	76.7	43.3	80.0	0.08	0.14	0.86	0.50
9	75	60.0	38.3	71.7	0.61	0.22	0.03	0.54
10	75 (+ Gaucho)	60.0	21.7	63.3	0.54	0.24	0.02	0.55
11	83	8.3	36.7	11.7	0.01	0.20	0.06	0.50
12	83 (+ Gaucho)	12.3	40.0	5.3	0.77	0.15	0.05	0.48
13	86	70.0	36.7	25.0	0.03	0.25	0.08	0.61
14	86 (+ Gaucho)	81.7	41.7	28.3	0.04	0.22	0.10	0.71
15	87	1.7	1.0	15.0	0.64	0.24	1.00	0.84
16	87 (+ Gaucho)	11.7	3.7	10.0	0.86	0.17	0.09	0.93
17	PLS 88	35.0	13.7	7.0	0.67	0.27	0.33	0.63
18	PLS 88 (+ Gaucho)	33.3	15.3	7.0	0.84	0.26	0.62	0.65
19	PLS 99	61.7	63.3	76.7	0.05	0.18	0.03	1.35
20	PLS 99 (+ Gaucho)	65.0	56.7	75.0	0.03	0.26	0.08	0.86
21	PLS 118 Romano	5.0	8.3	7.0	0.01	0.21	0.05	0.60
22	PLS 118 Romano (+ Gaucho)	7.7	11.7	21.7	0.02	0.19	0.12	0.63
23	PLS 442 Romano	5.3	26.7	28.3	0.03	0.25	0.02	0.72
24	PLS 442 Romano (+ Gaucho)	8.3	26.7	38.3	0.44	0.21	0.05	0.78
25	Agora (wax)	79.7	58.3	76.7	1.31	0.22	0.09	1.09
26	Avalon (green)	81.7	74.7	86.7	0.14	0.21	0.03	0.50
27	Green Arrow (green)	55.0	20.0	65.0	0.19	0.20	0.04	0.63
28	Jersey (green)	56.7	7.0	13.3	0.71	0.20	0.15	1.15
29	Kylian (green)	48.3	7.0	7.0	0.02	0.20	0.06	0.72
30	Minidor (wax)	68.3	41.7	86.7	0.13	0.14	0.03	0.68
31	Scuba (green)	60.0	35.0	5.3	0.13	0.15	0.10	0.63
32	Scylla (green)	73.3	28.3	51.7	0.03	0.37	0.07	0.75
33	Yukon (green)	70.0	15.0	18.3	0.02	0.20	0.12	0.64
34	RS 1394	25.0	3.7	5.0	0.01	0.34	0.15	0.87
35	08190509	15.0	1.0	8.3	0.01	0.36	0.09	1.04
36	Festina	13.3	3.7	13.3	0.02	0.29	0.96	0.77
37	RWG 1045	8.3	5.3	20.0	0.03	0.19	0.04	0.62
38	Pix Proc.	30.0	10.3	5.3	0.04	0.22	0.15	0.87
39	08790467	46.7	20.0	16.7	0.21	0.24	0.07	0.49
40	08190505	21.7	5.3	13.3	0.77	0.27	0.05	0.91
41	08780412	2.3	1.0	40.0	0.14	0.22	0.05	0.93

Trt. No.	Line	Visual Rating – Disease Severity (%) 8/30	9/6	9/28	ELISA assay AMV 9/9	CMV 9/9	AMV 9/20	CMV 9/20
42	08190504	6.7	5.3	3.7	0.01	0.37	0.07	0.67
43	Hercules	36.7	15.0	41.7	0.03	0.25	0.76	0.78
44	BBL 94	25.5	66.7	---	0.03	0.22	0.03	0.94
45	BBL 47	30.0	11.7	41.7	0.04	0.54	0.15	1.09
46	Piper	93.0	91.3	86.7	0.01	0.20	0.31	0.74
47	Alberta	3.7	5.3	2.3	0.61	0.38	0.96	0.65
48	08190506	18.3	16.7	8.7	0.67	0.13	0.03	0.41
49	Tapia	91.3	91.3	91.7	0.08	0.16	0.12	0.68
50	Opera	8.3	13.3	15.0	0.08	0.25	0.01	0.41
51	Odessa	40.0	30.0	58.3	0.21	0.30	0.10	0.52
52	Arena	56.7	46.7	40.0	0.05	0.24	0.05	0.69
53	VW 738	35.0	30.0	72.7	0.60	0.29	0.10	0.84
54	VW 535	1.3	15.0	68.3	0.06	0.24	0.05	1.05
55	Orion	87.7	73.0	85.0	0.05	0.21	0.01	0.41
56	Dorint	10.0	26.7	13.3	0.03	0.23	0.15	0.95
57	Newton	30.0	43.3	56.7	0.05	0.12	0.04	0.69
58	Nelson	26.7	30.0	66.7	0.01	0.25	0.02	0.56
59	Montano	71.7	51.7	86.7	0.02	0.15	0.06	0.54
60	Casino	78.3	41.7	18.3	0.03	0.25	0.05	0.91
61	Evergreen	85.0	73.3	48.3	0.39	0.22	0.01	0.71
62	Formost	51.7	61.7	78.3	0.02	0.19	0.06	0.66
63	Tyro	51.7	65.0	51.7	0.07	0.14	0.79	0.46
64	Saurus	78.3	73.3	16.7	0.62	0.15	0.78	0.54
65	#883	58.3	66.7	88.3	0.02	0.20	0.74	0.74
66	Honker	75.0	63.3	66.7	0.03	0.37	0.12	1.01
67	Rambo	71.7	60.0	83.3	0.52	0.16	0.04	0.47
68	Pension	20.0	23.3	58.3	0.02	0.15	0.08	0.79
69	IDVA1001	1.0	20.0	60.0	0.62	0.37	0.17	1.06
70	IDVB1002	23.3	46.7	81.7	0.32	0.33	0.04	1.11
71	IDVB1003	5.3	16.7	76.7	0.56	0.31	0.12	1.00
72	IDVD1004	1.0	18.3	38.3	0.11	0.16	0.04	0.73
73	Hystyle	13.3	13.3	41.7	0.20	0.24	0.07	0.59
74	MV-185	61.7	20.0	30.0	0.06	0.15	0.05	0.60
75	Pole bean	73.3	68.3	86.7	0.03	0.48	0.07	0.91
76	Polder	48.3	15.0	46.7	0.04	0.22	0.13	0.93
77	Castel	8.3	40.0	76.7	0.04	0.11	0.03	0.61
78	True Blue	3.0	3.0	5.3	0.02	0.25	0.42	0.56
79	Envy	30.0	40.0	75.0	0.02	0.26	0.06	0.74
80	Savannah	33.3	30.0	81.7	0.02	0.37	0.07	0.80
81	Shade	26.7	31.7	5.3	0.13	0.35	0.17	0.69
82	HMX 0103	3.7	8.3	21.7	0.02	0.31	0.04	0.49
83	HMX 0104	58.3	38.3	85.0	0.04	0.22	0.09	0.89
84	HMX 00065	7.0	5.3	50.0	0.13	0.25	0.08	1.39
85	HMX 1947	7.3	7.0	7.0	0.61	0.28	0.04	0.85
86	Evergreen	75.0	63.3	75.0	0.03	0.15	0.05	0.65
87	Evergreen (+ Gaucho)	86.7	70.0	71.7	0.03	0.21	0.07	0.70
88	Hercules	36.7	13.3	51.7	0.01	0.33	0.08	0.87

Trt. No.	Line	Visual Rating – Disease Severity (%) 8/30	9/6	9/28	ELISA assay AMV 9/9	CMV 9/9	AMV 9/20	CMV 9/20
89	Hercules (+ Gaucho)	43.3	10.0	45.0	0.01	0.46	0.11	0.73
90	BBL-156	38.3	16.7	41.7	0.03	0.22	0.03	0.70
91	HMX 0944	11.7	1.0	10.0	0.03	0.25	0.11	0.80
92	Hystyle	10.0	13.3	40.0	0.01	0.35	0.07	0.44
93	Hystyle (+ Gaucho)	8.7	13.3	46.7	0.13	0.39	0.03	0.50
94	Roma II	71.7	60.0	60.0	0.18	0.18	0.06	0.48
95	Roma II (+ Gaucho)	71.7	53.3	51.7	0.05	0.18	0.07	0.39
96	Dandy	91.7	70.0	83.3	0.08	0.19	0.04	0.47
97	Dandy (+ Gaucho)	81.7	55.0	78.3	0.05	0.18	0.03	0.47
98	Summit	5.3	2.3	4.0	0.21	0.26	0.01	0.42
99	Summit (+ Gaucho)	15.0	1.0	10.0	0.08	0.21	0.03	0.45
100	HB 1745-3-1-5-4	55.0	15.0	56.7	0.03	0.23	0.04	0.54
101	SB4243	8.3	16.7	20.0	0.01	0.29	0.22	0.64
102	Indy Gold	10.3	18.3	15.0	0.07	0.27	0.06	0.64
103	Carson	69.7	41.7	78.3	0.06	0.20	0.05	0.47
104	IDMV40	4.0	10.3	25.0	0.71	0.43	6.86	0.75
105	Castano	8.3	13.3	30.0	-0.01	0.24	0.12	0.49
106	Lexus	15.0	10.0	20.0	0.04	0.19	0.09	0.54
107	Mayon	89.7	26.7	30.0	0.03	0.15	0.05	0.57
108	WISC.MDR-214	21.7	25.0	70.0	0.01	0.20	0.05	0.73
109	Landmark	33.3	31.7	70.0	0.79	0.26	0.47	0.53
110	Sirio	81.7	56.7	68.3	0.28	0.14	0.01	0.43
111	IDMV20	63.3	50.0	10.0	0.05	0.29	0.06	0.47
112	IDMV19	66.7	60.0	83.3	0.02	0.18	0.03	0.40
113	Benton	18.3	20.0	73.3	0.85	0.29	0.70	0.53
114	Masai	31.7	21.7	23.3	0.01	0.24	0.09	0.69
115	Benchmark	55.0	41.7	30.0	0.03	0.19	0.54	0.42
116	Celtic	68.3	46.7	38.3	1.04	0.26	0.02	0.98
117	Endurance	30.0	28.3	41.7	0.10	0.23	0.04	0.65
118	Ambassador	15.0	13.3	18.3	0.01	0.35	0.05	0.54
119	Probe	70.0	45.0	70.0	0.13	0.31	0.08	0.48
120	Probe	80.0	61.7	68.3	0.01	0.28	0.06	0.72
	Pr > F	< 0.01	< 0.01	< 0.01	0.37	< 0.01	0.53	< 0.01
	LSD	19.8	20.1	12.1	NS	0.13	NS	0.30

Table 2. Effect of Gaucho treatment on disease severity and presence of virus – factorial analysis.

	Visual Rating – Disease Severity (%)			ELISA assay			
				AMV	CMV	AMV	CMV
Cultivar	8/30	9/6	9/28	9/9	9/9	9/20	9/20
Cultivar means for all cultivar pairs (+/- Gaucho)							
Dandy	86.7	62.5	80.8	0.07	0.18	0.04	0.47
Evergreen	80.8	66.7	73.3	0.03	0.18	0.06	0.67
Hercules	40.0	11.7	48.3	0.01	0.39	0.09	0.80
Hystyle	9.3	13.3	43.3	0.06	0.37	0.05	0.47
Igloo	5.7	7.5	11.8	0.62	0.23	0.11	0.63
Keeper85	10.8	5.3	6.3	0.19	0.27	0.04	0.64
PLS118	6.3	10.0	14.3	0.01	0.20	0.09	0.62
PLS442	6.8	26.7	33.3	0.24	0.23	0.04	0.75
PLS72	70.0	42.5	77.5	0.05	0.18	0.47	0.48
PLS75	60.0	30.0	67.5	0.57	0.23	0.02	0.54
PLS83	10.3	38.3	8.5	0.47	0.17	0.05	0.49
PLS86	75.8	39.2	26.7	0.03	0.23	0.09	0.66
PLS87	6.7	2.3	12.5	0.75	0.20	0.54	0.89
PLS88	34.2	14.5	7.0	0.75	0.27	0.48	0.64
PLS99	63.3	60.0	75.8	0.04	0.22	0.06	1.10
Roma II	71.7	56.7	55.8	0.11	0.18	0.07	0.43
Summit	10.2	1.7	7.0	0.14	0.23	0.02	0.44
Topps	11.2	19.2	29.2	0.11	0.19	0.13	0.89
Pr > F	< 0.01	< 0.01	< 0.01	0.17	< 0.01	0.42	< 0.01
LSD	11.8	15.5	9.2	NS	0.09	NS	0.22
Effect of Gaucho treatment							
Gaucho	38.6	27.4	38.1	0.28	0.23	0.15	0.64
No Gaucho	34.7	29.0	37.4	0.19	0.23	0.12	0.66
Pr > F	0.06	0.53	0.62	0.48	0.74	0.78	0.59
LSD	3.9*	NS	NS	NS	NS	NS	NS
Interaction	0.83	0.96	0.36	0.99	0.62	0.65	0.68

Interpretation: Cultivar susceptibility (regardless of Gaucho treatment) affected disease severity on all three rating dates and ELISA test results on both sampling dates. Treatment of seed with Gaucho insecticide did not affect disease severity on two of three rating dates or ELISA test results for either AMV or CMV.

Table 3. Selected lines with and without Gaucho (G) treatment.

Cultivar and treatment	Visual Rating – Disease Severity (%)			ELISA assay			
	8/30	9/6	9/28	AMV 9/9	CMV 9/9	AMV 9/20	CMV 9/20
Dandy G	81.7	55.0	78.3	0.053	0.179	0.033	0.472
Dandy	91.7	70.0	83.3	0.083	0.190	0.040	0.469
Evergreen G	86.7	70.0	71.7	0.034	0.214	0.069	0.696
Evergreen	85.0	73.3	48.3	0.393	0.216	0.010	0.707
Hercules G	43.3	10.0	45.0	0.008	0.456	0.114	0.728
Hercules	36.7	15.0	41.7	0.031	0.250	0.760	0.776
Hystyle G	8.7	13.3	46.7	0.135	0.387	0.026	0.498
Hystyle	10.0	13.3	40.0	0.014	0.348	0.068	0.442
Igloo G	7.7	10.0	15.0	0.683	0.188	0.144	0.686
Igloo	3.7	5.0	8.7	0.550	0.268	0.079	0.576
Keeper85 G	6.3	8.3	10.3	0.119	0.300	0.037	0.572
Keeper85	15.3	2.3	2.3	0.258	0.242	0.050	0.706
PLS75 G	60.0	21.7	63.3	0.535	0.240	0.015	0.549
PLS75	60.0	38.3	71.7	0.611	0.220	0.032	0.539
PLS87 G	11.7	3.7	10.0	0.855	0.171	0.087	0.929
PLS87	1.7	1.0	15.0	0.640	0.236	0.996	0.842
PLS88 G	33.3	15.3	7.0	0.837	0.260	0.619	0.647
PLS88	35.0	13.7	7.0	0.666	0.274	0.335	0.633
Roma II G	71.7	53.3	51.7	0.051	0.178	0.072	0.390
Roma II	71.7	60.0	60.0	0.177	0.178	0.062	0.477
Summit G	15.0	1.0	10.0	0.075	0.209	0.026	0.453
Summit	5.3	2.3	4.0	0.210	0.259	0.007	0.423
Topps G	16.7	11.7	28.3	0.169	0.170	0.124	0.862
Topps	5.7	26.7	30.0	0.048	0.215	0.137	0.915