Crop Losses from Pea Seedborne Mosaic Virus in Six Processing Pea Cultivars

J. M. KRAFT, Research Plant Pathologist, AR, SEA, USDA, Washington State University, Prosser 99350, and R. O. HAMPTON, Research Plant Pathologist, AR, SEA, USDA, Oregon State University, Corvallis 97331

ABSTRACT

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Field responses of six processing pea cultivars to pea seedborne mosaic virus were tested in an isolated location near Prosser, WA, in 1977 and 1978. Test plots were mechanically inoculated either 2 or 3 wk after emergence. Disease incidence, determined visually on a per plant basis, was higher in all plots in 1977 than in 1978 and generally corresponded with rate of seed transmission and loss in green pea and seed yields. The later maturing, more determinate cultivars (Mars, Conway, and Corfu) were more severely affected than earlier maturing, indeterminate cultivars (Small Sieve Alaska and A-45) in both years. Losses in green pea and seed yields in 1977 were greater in plots of all cultivars inoculated 2 wk after emergence than in those inoculated 3 wk after emergence.

Pea seedborne mosaic virus (PSbMV) is a continuing threat to the pea (*Pisum sativum* L.) seed and processing industry in the United States (12,17,20,22). This virus, first reported in Czechoslovakia in 1966 (19), has also been found in Japan (14), the Netherlands (4), and Canada (5,9) and may be present in every country where peas are grown.

Considerable information has been published on detection (8–11,18,21,23), purification (15,24), chemical and physical properties (4,10,13,15), and seed and aphid transmission (1,6,12,17, 18,20,21,23). Economical control measures include eradication and isolation (12) and genetic resistance (2,3,7,16).

Field studies on the responses of commercial pea cultivars are few and are limited to single plant rows of several cultivars (22) or bulk plantings of two cultivars for seed without virus-free controls (5). We tested the effect of PSbMV on green pea and dry seed yields and on resultant seed transmission in six processing cultivars.

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MATERIALS AND METHODS

The following commercial pea cultivars were mechanically inoculated with PSbMV and grown in an isolated field near Prosser, WA, in 1977 and 1978: Small Sieve Alaska (SmSvAl) and A-45 (Crites-Moscow Growers, Inc., Moscow, ID), Dark Skin Perfection 5147 (DSP 5147) (Canners Seed Corp., Lewisville, ID), Mars (Asgrow Seed Co., Twin Falls, ID), and Conway and Corfu (Brotherton Seed Co., Moses Lake, WA). Inoculum was prepared by triturating 100 g of infected fresh leaves, stems, and roots of the cultivar 447 in 90 ml of 0.01 M phosphate buffer, pH 7, in a Waring Blendor for 1 min. The triturate was filtered through four layers of cheesecloth and diluted with buffer to a final volume of 4 L. Freshly prepared inoculum, 300 ml plus 10 g of 600-mesh Carborundum, was applied to each plot with a paint spray gun using a portable, gas-driven air compressor set at 5.6–7.0 kg/cm^2.

Seed of all cultivars was commercially treated with captan and planted 10 seeds per 31 cm of row. Each plot was 610 cm long and consisted of six rows on 28-cm centers. Three treatments were replicated twice for each cultivar in both years: 1) uninoculated control, 2) inoculation 2 wk after emergence, and 3) inoculation 3 wk after emergence.

To minimize or eliminate secondary spread of PSbMV by aphids, disulfoton (Di-Syston) (1.8 kg/0.4 ha) was plowed in as a preplant treatment, dimethoate (113 g/0.4 ha) was aerially applied every 6–8

days, beginning 6 wk after emergence and continuing until pod development, and plots were randomized and grouped by inoculation date, with control plots always upwind of inoculated plots. Distance between plots within inoculation dates was 152 cm; distance between plots with different inoculation dates was 305 cm. The cultivar Almota (Crites-Moscow Growers; resistant to pea enation mosaic virus, pea streak virus, and powdery mildew, and susceptible to PSbMV) was seeded in a 168-cm band between plots within an inoculation date and around the entire field to monitor secondary spread.

Host response to PSbMV was measured by disease incidence (based on visible symptoms), green and dry seed yields, and prevalence of seed transmission in relation to plant age at inoculation. Disease prevalence was determined by counting the number of plants with typical PSbMV symptoms just before bloom among 100 randomly chosen plants per plot. Green peas were harvested when tenderometer readings approached 100. Half of each plot (168 × 305 cm) was hand-pulled and vined through a commercial stationary viner. Green pea yield data consisted of total vine weight (pods and vines), total berry weight, sieved berry weight (2–6 sieve), and yield (adjusted to 100 tenderometer) of 2–6 sieve berries. Dry seed yields were taken when vines and pods had dried enough to be thrashed through a portable Vogel plot combine. All seed lots were air-cleaned to remove straw and debris and weighed to the nearest 0.1 g.

To detect seedborne virus, all seed lots were mechanically sieved through a seed cleaner using screens with 4.4, 5.2, 5.6, 6.4, and <6.4-mm openings. Representative samples of each sieve size and plot were then planted in flats in the greenhouse to observe virus presence. Suspect plants were indexed either on pea seedlings of the susceptible cultivar 447 or on the indicator host *Chenopodium amaranticolor* Coste & Reyn. (17,20).

RESULTS

In 1977, disease prevalence varied from 14% in A-45 to 87% in Conway in plots inoculated 2 wk after emergence (Table 1). No symptoms were visible in uninoculated control plots, plots inoculated 3 wk after emergence, or border plots of Almota. Green pea yields were significantly reduced in plots of DSP 5147, Mars, Conway, and Corfu (but not A-45) inoculated 2 wk after emergence compared with control plots. In plots inoculated 3 wk after emergence, green pea yields were significantly reduced only in Corfu. Visible virus symptoms were much lower in 1978 than in 1977, and yield reductions were correspondingly smaller in all inoculated plots.

Dry seed yields were significantly reduced in plots of Small Sieve Alaska, DSP 5147, Mars, Conway, and Corfu inoculated 2 wk after emergence compared with plots inoculated 3 wk after emergence in 1977 (Table 2). Seed yields were not reduced in any cultivar, regardless of inoculation date, in 1978, which corresponds to the lower disease incidence that year.

Percentage seed transmission of PSbMV varied from 7% (A-45) to 34% (Corfu) and from 11% (Conway) to 29% (A-45) in seed harvested from plots inoculated 2 and 3 wk after emergence, respectively, in 1977 (Table 3). Percentage seed transmission was lower in seed harvested from 1978 plots than from 1977 plots, regardless of inoculation date.

DISCUSSION

This study illustrates the potential of PSbMV disease to reduce both green product and seed yields in susceptible pea cultivars. In 1977 when visible symptoms were severe, yields of both green peas and seed were reduced more when plants were inoculated 2 wk than 3 wk after emergence, in contrast with results reported for late-maturing field peas in Canada (5).

Table 1. Effect of inoculation date of pea seedborne mosaic virus on green pea yields of five cultivars in 1977 and 1978

Cultivar	Inoculation date[w] (wk)	1977 Yield[x] (kg/plot)	1977 Virus incidence[y]	1978 Yield (kg/plot)	1978 Virus incidence
A-45	2	3.41 defg	14	2.32 bc	1
	3	4.02 ghi	0	2.58 c	0
	Control	4.06 ghi	0	2.78 cde	0
DSP 5147[z]	2	3.71 efg	50	3.31 defg	2
	3	7.31 n	0	4.00 ghi	0
	Control	7.47 n	0	3.74 fgh	0
Mars	2	1.61 ab	74	4.98 jkl	4
	3	5.91 lm	0	5.04 jkl	0
	Control	5.86 lm	0	5.65 kl	0
Conway	2	2.12 abc	87	2.93 cdef	2
	3	6.72 mn	0	4.43 hij	2
	Control	7.25 n	0	3.86 fgh	0
Corfu	2	1.31 a	75	2.60 cd	2
	3	3.71 efgh	0	4.19 ghi	2
	Control	4.82 ijk	0	3.78 fgh	0

[w] Each plot was mechanically inoculated either 2 or 3 wk after emergence. Control plots were sprayed with water plus Carborundum alone.
[x] Yield data are based on a 2–6 sieve screening at 100 tenderometer. Plot size was 168 × 305 cm. Means followed by the same letter are not significantly different ($P = 0.05$).
[y] Number of plants, among 100 sampled, with visible PSbMV symptoms.
[z] DSP = Dark Skin Perfection.

Table 2. Effect of inoculation date of pea seedborne mosaic virus on seed yields of six pea cultivars in 1977 and 1978

Cultivar	Inoculation date[x] (wk)	1977 yield[y] (kg/plot)	1978 yield (kg/plot)
SmSvAl[z]	2	1.24 bc	3.03 j
	3	4.16 l	2.48 i
	Control	3.03 j	3.38 k
A-45	2	2.51 i	1.52 cdefgh
	3	2.49 i	1.44 bcdef
	Control	1.49 cdefg	2.37 i
DSP 5147[z]	2	2.37 i	1.52 cdefgh
	3	2.81 j	1.76 fgh
	Control	3.61 k	1.64 defgh
Mars	2	0.78 a	1.82 h
	3	2.93 j	1.71 efg
	Control	3.47 k	1.16 b
Conway	2	1.49 cdefg	1.45 bcdef
	3	2.21 i	1.57 defgh
	Control	2.31 i	1.78 gh
Corfu	2	1.53 cdefgh	1.39 bcd
	3	2.44 i	1.46 cdef
	Control	3.08 j	1.50 cdefg

[x] Each plot was mechanically inoculated either 2 or 3 wk after emergence. Control plots were sprayed with water plus Carborundum alone.
[y] Plot size was 168 × 305 cm. Means followed by the same letter are not significantly different ($P = 0.05$).
[z] SmSvAl = Small Sieve Alaska; DSP = Dark Skin Perfection.

Table 3. Percentage transmission of pea seedborne mosaic virus in seed of six cultivars harvested from 1977 and 1978 test plots

Cultivar	Inoculation date[w] (wk)	Seed transmission (%) 1977[x]	1978[y]
SmSvAl[z]	2	19	0
	3	21	0
	Control	0	0
A-45	2	7	1.5
	3	29	0
	Control	0	0
DSP 5147[z]	2	32	1.2
	3	13	0
	Control	0	0
Mars	2	25	0
	3	12	0
	Control	0	0
Conway	2	12	1.2
	3	11	3.2
	Control	0	0
Corfu	2	34	3.2
	3	26	0.8
	Control	0	0

[w] Each plot was mechanically inoculated either 2 or 3 wk after emergence. Control plots were sprayed with water plus Carborundum alone.
[x] Number of seeds infected with PSbMV among 100 seeds examined per treatment.
[y] Percentage of seed infected with PSbMV among 100–280 seeds examined per treatment.
[z] SmSvAl = Small Sieve Alaska; DSP = Dark Skin Perfection.

Fewer plants had visible symptoms and green pea and seed yields were reduced less by PSbMV inoculation in 1978 than in 1977. We did not determine whether the inoculum was equally infectious in both years. Also, the growing season was cooler in 1978 than in 1977. Mink et al (17) found that PSbMV symptoms appeared sooner and were more severe at higher temperatures (30–35 C) than at lower temperatures (15–20 C). However, even with only 2% prevalence of visible symptoms in 1978, green pea yields were significantly reduced in plots of Conway and Corfu inoculated 2 wk after emergence compared with uninoculated controls. Seed transmission was demonstrated in seed harvested from all plots inoculated in 1977 and from A-45, DSP 5147, Conway, and Corfu in 1978. These data indicate the potential of this virus to seriously reduce yields and transmit through seed even when symptoms are not apparent.

In 1977 when PSbMV symptoms were more apparent, green pea and seed yields were not reduced when A-45 was inoculated either 2 or 3 wk after emergence compared with the other cultivars. This finding corresponds to the results of Stevenson and Hagedorn (22), who also reported that PSbMV symptoms were mild in A-45 under field conditions.

Like Stevenson and Hagedorn (21,23), we found no obvious correlation between seed size or shape and seed transmission of PSbMV. Seed infected with PSbMV was found in all sieve sizes from 4.4 to 6.4 mm, in shrunken and normal seed, and in cracked and noncracked seed of all six cultivars.

Because plants grown from PSbMV-infected seed are commonly stunted and overgrown by healthy plants, PSbMV is difficult to detect by field inspection alone, especially when the prevalence of the virus is low; ie, 1–2%. Furthermore, PSbMV is difficult to detect visually in earlier maturing cultivars (Small Sieve Alaska and A-45), even though green pea and dry seed yields may be substantially reduced.

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