Final Project Report to the NYS IPM Program, Agricultural IPM 2002-2003

Title: Evaluation of Phaseolus Germplasm to Identify resistance to Cucumber Mosaic Virus

Project Leader(s): Phillip D. Griffiths

Cooperator(s): Rosi Provvidenti

Type of grant: Pest-resistant crops; allelopaths

Project location(s): All of NY

Abstract:

During the 2001 growing season aphid-transmitted virus problems affected several snap bean growing areas in western NY. The main viruses identified were cucumber mosaic virus and alfalfa mosaic virus, and look to seriously threaten future snap bean harvests in NY.

Background and justification:

During the 2001 growing season virus problems affected several snap bean growing areas in western NY significantly reducing yields in later plantings. These problems are similar to those encountered by Wisconsin growers in both 2000 and 2001, and have been associated with high aphid pressure. ELISA tests of infected samples indicated that cucumber mosaic virus (CMV) was present in all samples with other viruses detected including alfalfa mosaic virus (AMV), clover yellow mosaic virus (CYMV), tobacco streak virus (TSV) and other aphid transmitted potyviruses.

CMV appears to be the most important virus in this complex, and it has been isolated from 2001 samples by Rosi Provvidenti. Resistance genes for most snap bean viruses have been documented, however, resistance to CMV has not previously been reported in *Phaseolus vulgaris*.

CMV was first reported in beans in 1941, and although entire bean fields can be infected, most have previously recovered from the infection and yielded normally. CMV was isolated from infected samples taken from western NY snap bean fields in 2001 by Rosi Provvidenti. Initial studies with this isolate indicated that it was more virulent than a previous CMV isolate that had been worked with.

While previous studies have not identified resistance in common bean, the work has been limited. Evaluation of varieties in Wisconsin in 2001 documented differences in symptom expression in the leaves between varieties, but this did not coincide with a better yield performance. It will not be possible to control these viruses (of which CMV appears to be the largest problem) effectively with chemical management of aphids, as the aphids move to snap bean plots at maturity from neighboring crops including alfalfa and soybeans. Host plant resistance has proven to be the most effective means of preventing damage by other snap bean viruses, in particular, bean common mosaic virus. This research aims to identify a source of resistance within common bean germplasm, or within closely related *Phaseolus* germplasm, and make crosses to introgress the resistance into a commercial snap bean type.

Objectives:

[1] To evaluate the core collection of *Phaseolus vulgaris* to identify resistance to cucumber mosaic virus.

[2] To evaluate closely related species of *Phaseolus vulgaris*, including *Phaseolus coccineus* for resistance to CMV.

[3] To make crosses between any sources of resistance identified and commercial snap been varieties, in order to incorporate host plant resistance.

Procedures:

[1] The core collection of common bean (*Phaseolus vulgaris*) comprises of 406 accessions representing both the Mesoamerican and Andean regions of origin. The accessions will be greenhouse tested for CMV by planting five seed of each accession and inoculating three of the five plants at the second trifoliate stage. Inoculation will be performed by grinding CMV inoculated leaf tissue in buffer with a mortar and pestle, lightly dusting leaves with carborundum powder, and followed by light abrasion of the leaf tissue with the infected mortar. The viability of using leaf blower inoculation will also be investigated as is used on tougher plants including squash. Plants will be grown at 75°C/70°C (12-hour photoperiod) until virus symptom expression. Lines exhibiting high levels of virus infection in the leaf tissue will be discarded, those showing no symptoms, or minor symptoms will be grown through maturity to determine any negative effect on the yield relative to the two uninfected plants. Resistant accessions will be re-tested in a replicated trial with infected and uninfected reps. and will be compared to infected and non-infected control varieties of snap beans.

[2] A previous study has suggested that CMV resistance is present in several *Phaseolus* species (including *P. acutifolius* and *P. coccineus*, both crossable to common bean). The core collection of *P. coccineus* will be evaluated initially, if resistance is not identified in the *P. vulgaris* core collection. Plants will be evaluated as described in [1]. A PI of *P. coccineus* (87201111) previously reported to segregate resistance will also be evaluated. Resistant accessions will be identified, and re-evaluated in replicated trials. The accession(s) showing the highest levels of resistance will be used for crossing to snap bean varieties.

[3] Evaluation of *Phaseolus* accessions as described above will be used to identify potential germplasm for use in introgressing host plant resistance. Resistant accessions will be crossed to snap bean varieties important in NY State (including 'Hystyle', 'Summit' and 'Labrador'). The crosses will be self-pollinated to generate a segregating F_2 population, which will be further evaluated for CMV resistance.

Results and discussion:

[1] Commercial varieties of snap beans and dry beans were evaluated for CMV resistance as were all accessions comprising the core collection of common bean at the USDA. Inoculations were performed using the leaf-rub technique, as the leaf-blower approach did not guarantee 100% infection of susceptible controls. Plants were rated on a 1 to 5 scale, where 1=no visible infection, and 5=completely susceptible to CMV. No commercial cultivars were resistant in these trials (Tables 1 and 2).

Variety	Source										mean
Aurora	Zwaan	2	2	2	3	2	2	3	2	1	**2.11**
Baby Bop	Seminis	3	3	3	2	2	2	2	2	2	**2.33**
Amboto	Syngenta	2	3	3	2	3	2	3	1	-	**2.38**
Eagle	Seminis	3	3	2	2	-	-	-	-	-	**2.50**
Teseo	Syngenta	2	3	2	2	3	3	2	3	-	**2.50**
Benton	Syngenta	3	3	2	2	2	3	3	3	2	**2.56**
Flevoro	Seminis	3	3	3	2	2	3	2	3	2	**2.56**
Symphony	H. Moran	3	2	3	3	2	2	3	2	3	**2.56**
Earlybird	Maffet	3	4	2	3	3	2	2	2	-	**2.63**

Table 1: Ten snap bean varieties exhibiting the highest levels of resistance to CMV (1 = higly resistant, 5 = completely susceptible).

Variety										mean
Bountiful	2	3	3	2	2	3	2	3	3	**2.56**
Redlands Greenleaf	3	3	3	3	3	3	2	3	-	**2.88**
Jaguar	2	3	2	3	3	4	3	3	3	**2.89**
Provider	3	3	3	3	3	4	2	3	3	**3.00**
Red Kanner	2	3	2	2	4	3	4	4	3	**3.00**
Spartan Arrow	3	3	2	4	3	3	3	4	2	**3.00**
T39	4	4	3	3	3	3	3	3	2	**3.11**
Atlantic	3	3	4	4	3	3	3	4	-	**3.38**
Montcalm	3	2	4	4	3	4	4	-	-	**3.43**
Contender	4	4	4	4	2	3	3	4	3	**3.44**

Table 2: Ten most resistant dry beans to CMV

Of the 93 snap bean varieties and 16 dry bean varieties evaluated, no variety scored higher than a mean of two. These results suggest that CMV resistance is not present in common bean germplasm as was suggested by Provvidenti in 1976. To further investigate common bean germplasm for resistance to CMV, the 406 accessions comprising the core collection were evaluated, and the accessions exhibiting the highest levels of resistance were documented (Table 3).

Line No.		Access.	Mean Rating	retested
Ph. V 266	PI	318703	**1.00**	
Ph. V 406	PI	535395	**1.00**	
Ph. V 291	PI	325685	**1.20**	*
Ph. V 333	PI	417641	**1.20**	*
Ph. V 246	PI	313733	**1.25**	*
Ph. V 247	PI	313749	**1.33**	
Ph. V 162	PI	311947	**1.40**	
Ph. V 292	PI	325687	**1.40**	
Ph. V 320	PI	415954	**1.40**	
Ph. V 340	PI	417679	**1.40**	
Ph. V 359	PI	430200	**1.40**	*
Ph. V 222	PI	313592	**1.50**	
Ph. V 017	PI	195402	**1.60**	*
Ph. V 237	PI	313665	**1.60**	
Ph. V 241	PI	313685	**1.60**	
Ph. V 379	PI	533277	**1.60**	
Ph. V 150	PI	310883	**1.75**	*
Ph. V 264	PI	318694	**1.75**	*
Ph. V 336	PI	417653	**1.75**	

Table 3: Common bean accessions exhibiting high levels of resistance to CMV from the USDA core collection. * Several of these accessions became infected following the evaluation, and those plants starred were selected for re-evaluation.

PI 318703 and PI 535395 were initially scored with a mean rating of 1.0, but subsequently showed symptoms of the virus later in development. Several accessions exhibited lower visual symptoms to CMV infection than any of the varieties tested. Many of these accessions developed symptoms at a later stage and were eliminated from the re-evaluation list. Of 25 accessions with a mean lower than two, seven were chosen for re-evaluation, together with a further 10 accessions that either segregated visual symptoms of CMV or had a mean disease severity higher than two (PI 319573, PI 311907, PI 313357, PI 309700, PI 313444, PI 307790, PI 309881, PI 310842, PI 313237, PI 313412). All 17 of these accessions will be re-evaluated for CMV resistance.

[2] *Phaseolus cocccineus* has previously been associated with resistance to CMV, to confirm this resistance the 260 accessions comprising the collection at Pullman, Wa. were evaluated for visual symptoms of CMV. All susceptible controls in this experiment were completely susceptible, however only 12 accessions showed viral symptoms, and only 5 in all plants tested (PI 257221, PI 313310, PI 313313, PI 319449, PI 358087). Of the 260 lines tested 15 accessions were selected for crossing based on

variable characteristics of lines that may increase the liklihood of successful interspecific crosses.

[3] The 15 *P. coccineus* lines chosen for crossing (PI 175860, PI 183412, PI 189023, PI 201300, PI 202129, PI 205360, PI 311833, PI 317596, PI 325589, PI 325603, PI 361357, PI 368709, PI 433236, PI 451872, PI 494068) will be crossed both to commercial snap bean types, and the susceptible *P. coccineus* types to generate populations for studying genetic control of the resistance. The 20 resistant and susceptible *P. coccineus* accessions will also be re-evaluated for CMV resistance with the 17 *P. vulgaris* accessions identified in [1], and susceptible commercial snap bean varieties. These crosses will be used to create interspecific hybrids, from which backcross populations can be developed for further analysis. Resistant breeding lines developed from these populations will be used to introgress CMV resistance into commercial snap bean types.

References:

Provvidenti, R. (1976). Reaction of *Phaseolus* and *Macroptilium* species to a strain of cucumber mosaic virus. Plant Dis. Rep. 60:289-293.