Inheritance of Resistance to Cowpea Chlorotic Mottle Virus in Southern Pea, *Vigna sinensis*[1]

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Abstract. The inheritance of resistance to cowpea chlorotic mottle virus (CCMV) in southern pea, *Vigna sinensis* (L.) Savi., Plant Introduction 255811, was determined in crosses with the susceptible cvs. Knuckle Purple Hull, Mississippi Silver, and Princess Anne. Segregation of F_2 and backcross populations indicated that resistance to CCMV in P.I. 255811 is governed by 1 major recessive gene pair.

Virus diseases are among the most important diseases of southern pea, *Vigna sinensis* (L.) Savi. Sources of resistance to several southern pea viruses have been discovered (4, 7) and the inheritance of resistance has been determined for 5 of these (1, 2, 5, 6). Sinclair and Walker (6) found that resistance to certain strains of cucumber mosaic virus (CMV) was dominant and governed by 1 gene pair. Brantley and Kuhn (2) determined that the hypersensitive response (resistance) to southern bean mosaic virus-cowpea strain (SBMV-CS) on inoculated leaves was controlled by a dominant single gene pair. Inheritance of resistance to cowpea yellow mosaic virus (CYMV) is dominant and due to a single gene segregating independently of loci determining tolerance which is controlled by 3 additive loci (1). Tolerance to cowpea mottle virus (CMeV) was dominant to susceptibility, with either 1 or 2 genes controlling the inheritance, depending on parents (1). Reeder et al. (5) found inheritance of resistance to bean yellow mosaic virus (BYMV-CS) in southern pea was controlled by a single recessive gene pair.

The objective of this study was to determine the inheritance of resistance to cowpea chlorotic mottle virus (CCMV) in southern pea.

Materials and Methods

Eight *Vigna sinensis* Plant Introductions resistant to CCMV (4, 7) and 3 susceptible cultivars of southern pea were planted in the field in 1969. Single plant selections were made from all plant introductions and susceptible cultivars to avoid differences in genetic material within a cultivar or Plant Introduction. All controlled pollinations necessary to obtain F_1, F_2, and backcross generations were made in the greenhouse during the winter.

The CCMV isolate used in this study was obtained from Harrison and Gudauskas (3). It was maintained and increased in the southern pea cvs. Clay and Princess Anne, respectively, in an insecticide-treated controlled environment chamber. CCMV-infected 'Princess Anne' plants, 14 days after infection, were used as an inoculum source. The infected trifoliate leaves of the source plants were ground in a mortar and the expressed sap used as inoculum for screening seedlings.

Screening tests were conducted in the greenhouse. Seedlings were inoculated the first day of leaf expansion by rubbing abrasive-dusted (600-mesh silicon carbide) primary leaves with a pestle dipped in freshly prepared inoculum. Plants were rated for CCMV symptom expression when the second trifoliate leaf reached mature size, usually 14 to 21 days after inoculation. The rating scale was based on severity of visual symptoms. Plants were scored from 0 for no symptoms to 5 for severe symptoms (Table 1). To verify the rating system, F_3 families of the cross 'Knuckle Purple Hull' x P.I. 255811 were grown from seed of different F_2 plants with ratings of 0 through 5.

Results and Discussion

Screening of parents. A single plant selection of P.I. 255811 was selected as the resistant parent to avoid genetic variation within this source. In addition to its resistance characteristic of permitting little multiplication of CCMV as indicated by local lesion assay, P.I. 255811 is also early and prolific. 'Knuckle Purple Hull', 'Princess Anne', and 'Mississippi Silver' were used as susceptible parents. 'Knuckle Purple Hull' and 'Princess Anne' exhibited more pronounced CCMV symptoms than 'Mississippi Silver' following inoculation. Field observations of the 3 cultivars when not mechanically inoculated indicated 'Mississippi Silver' has some tolerance to CCMV.

Table 1. Rating scale of cowpea chlorotic mottle virus infection in southern peas.

Rating	Symptoms	Class
0	No visible symptoms	Resistant
1	Chlorosis of vein and 1 to 5 chlorotic spots 1 to 3 mm in diameter[z]	Resistant
2	Chlorotic mottle, 1 to 5% of leaf chlorotic	Susceptible
3	Chlorotic mottle, 5 to 30% of leaf chlorotic	Susceptible
4	Chlorotic mottle, 30 to 70% of leaf chlorotic	Susceptible
5	Chlorotic mottle, 70 to 100% of leaf chlorotic	Susceptible

[z]Vein chlorosis faint to bright yellow, less than 2 cm in length, usually along mid-rib. Chlorotic spots faint, spherical, inconspicuous, and approximately 1 to 3 mm in diam.

Rating scale. The 0 and 1 ratings were considered resistant and the 2 through 5 ratings susceptible (Table 1).

The F_2 plants of 'Knuckle Purple Hull' x P.I. 255811 cross

Table 2. Reaction of F_3 families to cowpea chlorotic mottle virus.

F_2 parent[z]			Number of F_3 plants					
			CCMV ratings					
			Resistant		Susceptible			
CCMV rating	Class	No.	0	1	2	3	4	5
0	Resistant	5	152	13				
1	Resistant	5	204	16				
2	Susceptible	2					2	6
3	Susceptible	1			7	14	7	14
5	Susceptible	1			2	15	4	13
P.I. 255811	Resistant		21	1				
Knuckle Purple Hull	Susceptible				1	9	6	6

[z]'Knuckle Purple Hull' x P.I. 255811

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Table 3. Reaction of F_1 and F_2 populations to cowpea chlorotic mottle virus.

Cross[z] and generations	No. of families	Number of plants Virus reaction			Chi Square 3:1	P range
		Resistant	Susceptible	Total		
PA x PI						
F_1			61	61		
F_2	1	61	177	238	0.02	.90
PI x PA						
F_2	1	60	225	285	2.27	.25-.10
KPH x PI						
F_1			108	208		
F_2	1	18	64	82	0.26	.75-.50
PI x KPH						
F_2	1	79	216	295	0.45	.50
MS x PI						
F_1			114	114		
F_2	1	73	207	280	0.17	.75-.50
PI x MS						
F_2	1	97	214	311	6.12	.05-.01
Total pooled data						
F_2	6	388	1103	1491	0.73	.50-.25

[z]PI = P.I. 255811; PA = 'Princess Anne;' KPH = 'Knuckle Purple Hull;' MS = 'Mississippi Silver.'

Table 4. Reaction of backcrosses to resistant parents to cowpea chlorotic mottle virus.

Cross[z]	Number of plants Virus reaction			Chi Square 1:1	P range
	Resistant	Susceptible	Total		
F_1 (PA x PI) x PI	64	54	118	0.85	.50-.30
F_1 (KPH x PI) x PI	24	25	49	0.20	.70-.50
F_1 (MS x PI) x PI	140	93	233	9.48	.01-.001

[z]PI = P.I. 255811; PA = 'Princess Anne;' KPH = 'Knuckle Purple Hull;' MS = 'Mississippi Silver.'

which received CCMV ratings 0 and 1 produced an F_3 population with ratings of only 0 or 1, following inoculation. The F_2 plants with CCMV ratings 2, 3, or 5 produced F_3 populations with 2 through 5 ratings only (Table 2). These data provided the basis for combining the 0 and 1 ratings into the resistant class and the 2 through 5 ratings into the susceptible class.

Inheritance of resistance. Susceptibility of all F_1 plants indicated that resistance to CCMV in P.I. 255811 is recessive. Segregation of 6 F_2 populations involving 3 susceptible cultivars used as both male and female parents did not deviate significantly from an expected 3:1 ratio (Table 3). Homogeneity Chi Square tests indicate that data from these populations could be pooled, and it was concluded that resistance is controlled by a single gene. All 604 plants from the backcross to susceptible parent were susceptible to CCMV. The backcross to the resistant parent did not deviate significantly from a 1:1 ratio for crosses involving the susceptible parents 'Princess Anne' and 'Knuckle Purple Hull'. The backcross of the F_1 ('Mississippi Silver' x P.I. 255811) x P.I. 255811 was significantly different from a 1:1 ratio (Table 4).

Since the segregating F_2 populations fit a 3:1 hypothesis and segregation of the backcross to resistant parents for crosses involving 'Princess Anne' and 'Knuckle Purple Hull' fit a 1:1 ratio, one major recessive gene pair is considered to be controlling resistance to CCMV. In crosses involving 'Mississippi Silver', 1 major recessive gene pair with minor genes or other factors contributed by the susceptible parent is considered to be controlling resistance to CCMV. These minor genes or other factors are assumed to have resulted in the departure from the expected 1:1 ratio in the backcross to resistant parent and caused an excess of resistant F_2 plants which nearly deviated significantly from a 3:1 ratio.

Literature Cited

1. Bliss, F. A., and D. G. Robertson. 1971. Genetics of host reaction in cowpea to cowpea yellow mosaic virus and cowpea mottle virus. *Crop Science* 11:258-262.
2. Brantley, B. B., and C. W. Kuhn. 1970. Inheritance of resistance to southern bean mosaic virus in southern pea, *Vigna sinensis. J. Amer. Soc. Hort. Sci.* 95:155-158.
3. Harrison, Arthur N., and Robert T. Gudauskas. 1968. Identification of viruses isolated from cowpeas in Alabama. *Plant Dis. Rpt.* 52:34-36.
4. Kuhn, C. W., B. B. Brantley, and Grover Sowell, Jr. 1966. Southern pea viruses: identification, symptomatology and sources of resistance. *Ga. Agr. Expt. Sta. Bul. N.S.* 157.
5. Reeder, B. D., J. D. Norton, and O. L. Chambliss. 1971. Inheritance of bean yellow mosaic virus resistance in southern pea, *Vigna sinensis* (Torner) Savi. *J. Amer. Soc. Hort. Sci.* 97:235-237.
6. Sinclair, J. B., and J. C. Walker. 1955. Inheritance of resistance to cucumber mosaic virus in cowpea. *Phytopathology* 45:563-564.
7. Sowell, Grover, Jr., C. W. Kuhn, and B. B. Brantley. 1964. Resistance of southern pea, *Vigna sinensis,* to cowpea chlorotic mottle virus. *Proc. Amer. Soc. Hort. Sci.* 86:487-490.