

# Resistance In Cultivated And Wild Lettuce To Lettuce Infectious Yellows Virus

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## ABSTRACT

*In 1988, Arizona's early-season lettuce crop was plagued by disease and insect problems, both intensified by unseasonably high temperatures. In the western Arizona production area, an epidemic of lettuce infectious yellows (LIY) resulted in serious economic losses to growers. The yellows disease is incited by the LIY virus (LIYV), a plant virus transmitted by the sweet potato whitefly [*Bemisia tabaci* (Genn.)]. Disease symptoms in lettuce include stunted growth, rolling, yellowing, and/or reddening of infected leaves; necrotic lesions appear at or near the leaf margins at latter stages of the disease.*

*LIYV has a wide host range which increases the difficulty of isolating lettuce fields from LIYV infected or whitefly-infested fields; also, whiteflies are resistant to insecticides. Therefore, host-plant resistance appears to be the most promising means of reducing losses due to this disease. To initiate a breeding program, commercial lettuce cultivars and breeding lines (*Lactuca sativa* L.), and related, cross-breeding wild lettuce species (*L. serriola* L. and *L. saligna* L.) were screened for resistance to LIYV in the western Arizona production area using natural inoculation by residence whiteflies.*

## PROCEDURES

The field test was planted 1 Sept. 1988, at the University of Arizona Yuma Valley Agricultural Experiment Station. Eighty-six accessions of *L. serriola*, 14 accessions of *L. saligna*, and 14 cultivars or breeding-lines of *L. sativa* were hand-planted on standard, double-row lettuce beds. Normal irrigation and fertilization operations were performed throughout the growing season. The plots were single-beds, 25 feet long, planted in two replications.

Plots were evaluated for symptom severity, bolting, and presence or absence of anthocyanin and infectious yellows symptoms. Field evaluations were made on 17 and 18 Nov. and 7 Dec. Leaf samples were collected on 8 Dec. and tested for presence using an indirect enzyme-linked immunosorbent assay (ELISA) (Brown et al, described in this volume).

## RESULTS AND DISCUSSION

Whiteflies were present throughout the growing season and LIY symptoms began to appear approximately three weeks after seedling emergence. The symptom severity scores for the two evaluation dates were significantly correlated (correlation coefficient = 0.75), and for simplicity, only the 7 Dec. date will be discussed. One *L. sativa*, 3 *L. serriola* and 12 *L. saligna* accessions were considered to be resistant under field conditions (Table 1). *L. saligna* appears to be the best source of LIYV resistance; 12 of the 14 accessions were essentially symptomless. The bulk of the *L. serriola* accessions (63 of the 86) were moderately resistant; 20 accessions expressed severe LIY symptoms (usually increased anthocyanin in leaves). *L. sativa* cultivars and breeding-lines

showed predominantly (11 of 14 accessions) severe LIY symptoms (usually both yellowing and necrosis of the leaves). Only 'Prizehead' was scored as resistant, although increased anthocyanin production could have masked the LIY symptoms.

The results of the ELISA indicated the presence of the virus in all accessions sampled (Table 1). Thus, accessions which were evaluated as resistant under field conditions were tolerant, not resistant, to LIYV. Infection had occurred in the symptomless accessions, but the symptom-severity readings were low. Correlations of the symptom severities from both field evaluations and the ELISA absorbance (optical density) values were 0.11 for 17 - 18 Nov. and 0.04 for 7 Dec. Statistically and practically, these correlations are not significant. If LIY symptoms are not expressed, or are only marginally expressed, then the quality of the head is not lowered. In addition, since the older leaves express the most severe discoloration, these leaves could be removed during harvest.

Many of the accessions in this study have been previously evaluated by McCreight and co-workers in greenhouse and field tests in the fall - winter production areas of California (1, 2). As in this study, 'Prizehead' and 'Climax' expressed the mildest symptoms among the commercial cultivars (1). Prizehead was heavily infected (as indicated by the ELISA values, Table 1), but virus symptoms were either not expressed or were masked by the cultivars normal red (anthocyanin) color. Previously screened wild lettuce types responded as expected (1), except L. saligna PI401001. It was reported as susceptible, but under the conditions of this test (Table 1), L. saligna PI401001 was tolerant.

Wild lettuce species have previously been used successfully as sources of horticultural characters and insect and disease resistances. The results of this study indicate that potential sources of LIYV resistance are available, especially within L. saligna. Prizehead and Climax are potentially good parents to cross with the resistant L. saligna accessions in an interspecific breeding program, since they are already horticulturally desirable cultivars and exhibit relatively mild symptoms, when infected with the infectious yellows virus.

## REFERENCES

1. McCreight, J. D., A. N. Kishaba, and K. S. Mayberry. 1986. Lettuce infectious yellows tolerance in lettuce. J. Amer. Soc. Hort Sci. 111:788-792.
2. McCreight, J. D. 1987. Resistance in wild lettuce to lettuce infectious yellows virus. HortScience 22:640-642.

Table 1.

Lettuce infections yellows virus tolerance, symptom severity, enzyme-linked immunosorbent assay, anthocyanin production, and necrosis in cultivated lettuce and wild lettuce accessions.

Entry	Species	Symptom Severity <sup>2</sup>		Enzyme-linked immunosorbant assay <sup>y</sup>	Field tolerance <sup>x</sup>	Anthocyanin <sup>w</sup>	Necrosis <sup>w</sup>
		November 17 & 18	December 7				
271939	<i>L. serriola</i>	2.0	3.5	6	S	+	-
273579	<i>L. serriola</i>	5.0	7.0	4	S	-	+
273596	<i>L. serriola</i>	4.0	3.5	NS	S	-	+
273597	<i>L. serriola</i>	1.5	0.75	7	T	-	-
274380A	<i>L. serriola</i>	4.0	3.5	3	S	+	-
491094	<i>L. serriola</i>	3.0	3.75	8	S	+	-
491096	<i>L. serriola</i>	3.5	3.5	4	S	+	-
491097	<i>L. serriola</i>	4.0	2.75	4	MT	+	-
491098	<i>L. serriola</i>	4.0	4.0	7	S	+	-
491099	<i>L. serriola</i>	3.5	3.5	4	MT	+	-
491100	<i>L. serriola</i>	3.5	3.5	3	S	+	-
491101	<i>L. serriola</i>	2.5	1.5	8	MT	+	-
491102	<i>L. serriola</i>	2.5	2.5	4	MT	+	-
491103	<i>L. serriola</i>	3.0	3.5	5	S	+	-
491104	<i>L. serriola</i>	3.5	4.0	4	S	+	-
491105	<i>L. serriola</i>	2.5	2.5	6	MT	+	-
491106	<i>L. serriola</i>	3.5	3.0	8	MT	+	-
491110	<i>L. serriola</i>	3.0	2.0	3	MT	+	-
491111	<i>L. serriola</i>	3.0	2.0	5	MT	+	-
491112	<i>L. serriola</i>	3.5	2.0	10	MT	+	-
491113	<i>L. serriola</i>	2.5	1.0	5	R	+	-
491114	<i>L. serriola</i>	3.5	2.5	8	MT	+	-
491115	<i>L. serriola</i>	2.5	1.25	5	MT	+	-
491116	<i>L. serriola</i>	3.0	2.0	9	MT	+	-
491117	<i>L. serriola</i>	3.0	1.75	7	MT	+	-
491118	<i>L. serriola</i>	2.0	1.0	6	T	+	-
491119	<i>L. serriola</i>	2.5	1.5	0	MT	+	-
491120	<i>L. serriola</i>	3.0	1.75	6	MT	+	-
491121	<i>L. serriola</i>	2.5	2.0	2	MT	+	-
491122	<i>L. serriola</i>	2.0	2.0	4	MT	+	-
491123	<i>L. serriola</i>	1.5	2.0	3	MT	+	-
491125	<i>L. serriola</i>	3.5	1.5	8	MT	+	-
491127	<i>L. serriola</i>	3.0	2.5	NS	MT	+	-
491128	<i>L. serriola</i>	2.5	1.75	7	MT	+	-
491129	<i>L. serriola</i>	2.5	2.5	NS	MT	+	-
491131	<i>L. serriola</i>	4.0	2.5	3	MT	+	-
491132	<i>L. serriola</i>	2.0	2.5	4	MT	+	-
491133	<i>L. serriola</i>	2.0	1.0	5	T	+	-
491134	<i>L. serriola</i>	3.0	2.0	7	MT	+	-
491135	<i>L. serriola</i>	3.0	2.5	3	MT	+	-
491136	<i>L. serriola</i>	2.5	2.5	8	MT	+	-
491137	<i>L. serriola</i>	3.0	2.0	NS	MT	+	-
491138	<i>L. serriola</i>	4.0	4.0	NS	S	+	-
491139	<i>L. serriola</i>	3.5	2.5	5	MT	+	-
491140	<i>L. serriola</i>	3.0	2.75	6	MT	+	-
491141	<i>L. serriola</i>	3.0	3.0	2	MT	+	-

Entry	Species	Symptom Severity <sup>z</sup>		Enzyme-linked immunosorbant assay <sup>y</sup>	Field tolerance <sup>x</sup>	Anthocyanin <sup>w</sup>	Necrosis <sup>w</sup>
		November 17 & 18	December 7				
491143	L. serriola	3.0	3.0	NS	MT	+	-
491144	L. serriola	2.0	3.0	5	MT	+	-
491145	L. serriola	2.5	3.5	NS	S	+	-
491146	L. serriola	2.5	3.0	NS	MT	+	-
491147	L. serriola	4.5	3.0	2	MT	+	-
491148	L. serriola	3.5	1.5	NS	MT	+	-
491150	L. serriola	3.0	3.25	NS	S	+	-
491151	L. serriola	2.0	2.0	7	MT	+	-
491152	L. serriola	2.5	1.75	1	MT	+	-
491154	L. serriola	4.0	2.0	NS	MT	-	+
491155	L. serriola	1.5	3.25	9	S	-	-
491156	L. serriola	4.5	2.25	3	MT	+	-
491159	L. serriola	2.5	1.5	7	MT	+	-
491160	L. serriola	3.5	3.5	3	S	+	-
491162	L. serriola	4.0	3.5	4	S	+	-
491163	L. serriola	3.0	2.5	1	MT	+	-
491164	L. serriola	3.0	2.0	3	MT	+	+
491165	L. serriola	3.0	3.0	4	MT	+	-
491166	L. serriola	1.5	1.5	7	MT	+	-
491167	L. serriola	3.0	2.5	NS	MT	+	-
491169	L. serriola	3.5	2.0	0	MT	+	-
491170	L. serriola	4.0	1.5	5	MT	+	-
491171	L. serriola	2.75	1.25	5	MT	+	-
491172	L. serriola	2.5	2.0	NS	MT	+	-
491173	L. serriola	1.5	1.5	2	MT	+	-
491174	L. serriola	3.0	2.0	5	MT	+	-
491175	L. serriola	3.0	2.75	8	MT	+	-
491176	L. serriola	2.5	2.0	9	MT	+	-
491177	L. serriola	3.0	2.0	5	MT	+	-
491178	L. serriola	3.0	1.75	5	MT	+	-
491180	L. serriola	2.5	1.75	10	MT	+	-
491181	L. serriola	3.5	3.0	5	MT	+	-
491230	L. serriola	3.0	3.0	10	MT	+	-
491244	L. serriola	2.5	3.0	4	MT	+	-
491250	L. serriola	1.5	1.75	4	MT	+	-
202349C	L. serriola	5.0	6.0	5	S	-	+
273596A	L. serriola	3.5	3.5	2	S	+	-
273596B	L. serriola	4.5	4.0	5	S	-	+
273597B	L. serriola	6.0	8.0	2	S	+	+
274355B	L. serriola	2.5	3.5	NS	S	+	-
251798A	L. saligna	7.5	9.0	6	S	+	-
261653	L. saligna	0.4	0.8	3	T	+	-
490999	L. saligna	0.75	0.8	1	T	+	-
491000	L. saligna	2.25	2.0	3	MT	-	-
491001	L. saligna	0.8	0.8	0	T	+	-
491206	L. saligna	0.8	0.8	4	T	+	-

Entry	Species	Symptom Severity <sup>z</sup>		Enzyme-linked immunosorbant assay <sup>y</sup>	Field tolerance <sup>x</sup>	Anthocyanin <sup>w</sup>	Necrosis <sup>w</sup>
		November 17 & 18	December 7				
491208	L. saligna	0.75	0.5	0	T	-	-
WP233	L. saligna	0.8	0.8	6	T	+	-
WP238	L. saligna	0.8	0.6	5	T	+	-
WP239	L. saligna	0.75	0.4	0	T	-	-
WP242	L. saligna	0.8	1.0	5	T	-	-
WP246	L. saligna	0.8	0.75	2	T	+	-
WP246A	L. saligna	0.75	0.75	1	T	-	-
WP247	L. saligna	0.4	0.0	1	T	-	-
Empire	L. sativa	3.2	5.5	4	S	-	+
GL659	L. sativa	2.5	3.0	NS	MT	-	+
Merit	L. sativa	4.25	4.5	NS	S	-	+
El Toro	L. sativa	4.5	5.25	2	S	-	+
Summer Bibb	L. sativa	3.5	5.25	NS	S	-	+
Paris Island	L. sativa	3.5	5.2	NS	S	-	+
Vanguard 75	L. sativa	3.0	3.5	NS	S	-	+
Climax	L. sativa	1.5	3.5	NS	S	-	+
Calmar	L. sativa	3.5	3.5	NS	S	-	+
88-926	L. sativa	2.0	3.5	3	S	-	+
Da-K Green Boston	L. sativa	2.0	4.5	NS	S	-	+
Prize Head	L. sativa	0.5	0.0	8	T	+	-
Waldman's Green	L. sativa	2.5	3.0	NS	MT	-	+
Autumn Gold	L. sativa	3.0	4.0	NS	S	-	+

<sup>z</sup> Evaluated on a scale 0-9 (0 = 0% leaves infected, 1 = 10% leaves infected, etc.)

<sup>y</sup> Evaluated on a scale 0-10 (0 = 0.100 - 0.149,

1 = 0.150 - 0.199 optical density,

2 = 0.200 - 0.249 optical density,

3 = 0.250 - 0.299 optical density,

4 = 0.300 - 0.349 optical density,

5 = 0.350 - 0.399 optical density,

6 = 0.400 - 0.449 optical density,

7 = 0.450 - 0.499 optical density,

8 = 0.500 - 0.549 optical density,

9 = 0.550 - 0.599 optical density,

10 = 0.600 - 0.629 optical density,

NS = not sampled.)

<sup>x</sup> T = tolerant to LIYV

MT = moderately tolerant to LIYV

S = sensitive to LIYV

<sup>w</sup> Evaluated as presence = + or absence = -.