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Diseases of Food Legumes Caused by Pea Leaf Roll Virus in Iran

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Various food legumes (pulse crops) are grown in Iran for human consumption and provide an important source of protein in the local diet. Food legumes are cultivated on about 150 000 hectares and include bean (*Phaseolus vulgaris* L.), mungbean (*P. aureus* Roxb.), chickpea (*Cicer arietinum* L.), broad bean (*Vicia faba* L.), lentil (*Lens esculenta* Moench), pea (*Pisum sativum* L.) and cowpea [*Vigna sinensis* (L.) Savi ex Hassk.].

Numerous diseases affect pulse crops in Iran (4, 5, 6). In the drier areas of the country virus diseases are an important factor contributing to annual reductions in yield and quality of pulses (4). One of the viruses affecting most food legumes in all major pulse growing regions of Iran is pea leaf roll (PLRV). This virus has been reported to affect different leguminous crops in Europe (1, 3, 7, 8, 9, 13), Iran (4, 5, 6) and New Zealand (15). Subterranean clover stunt virus, which affects *Trifolium subterraneum* L. and bean in Australia (2, 11), appears to be closely related to PLRV, and may be the same virus.

Viral transmission

Various leguminous plants infected by PLRV were ground with a mortar and pestle in 0.01 molar phosphate buffer of pH 7.0 and rubbed on carborundum-dusted leaves of different test plants in the glasshouse. No symptoms of PLRV developed on any of the inoculated indicator plants (Table 1), although repeated attempts were made to transmit the virus using various inoculation techniques at different times of the year.

Several species of aphids which colonized pulse crops in nature were used in virus-trans-

mission studies with PLRV. Aphids were fed on virus-infected plants in cages in the glasshouse or field (Figure 1), for various periods of time, before being transferred to healthy indicator plants for a 72-hour inoculation feeding period (Table 1). Aphids at different stages of development acquired PLRV in one to three hours and transmitted the virus through moults, often for the entire life span of the vector. Only plants in the Leguminosae were infected by PLRV (Table 1). Aphid vectors of PLRV in Iran were *Aphis craccivora* Koch, *A. fabae* Scopoli, *A. gossypii* Glover, *Acyrtosiphon pisum* (Harris) and *A. sesbaniae* David. *Myzus persicae* (Sulzer) occasionally transmitted PLRV, if groups of ten or more aphids from PLRV-infected plants were fed on individual healthy test plants. PLRV was also transmitted by grafting but not by dodder (*Cuscuta* spp.) or in seed from PLRV-infected legumes.

Viral symptoms

In Iran, PLRV infected the following food legumes: bean (Figures 2, 3), broad bean (Figure 4), chickpea (Figure 5), cowpea (Figure 6), lentil (Figure 7), and pea (Figure 8). Plants infected by PLRV were usually severely stunted, especially if infection occurred in the early stages of development. Often, a proliferation of the axillary buds was noted (Figure 3) and a shortening of the internodes (Figures 2, 3). A twisting, thickening and rolling of the leaves sometimes developed after infection. Chlorosis did not always occur on plants infected by PLRV,

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TABLE 1. — TRANSMISSION OF PEA LEAF ROLL VIRUS TO VARIOUS TEST PLANTS IN GLASSHOUSE INOCULATION STUDIES

Host plant	Transmission	
	Mechanical ¹	Aphid ²
Amaranthaceae		
<i>Gomphrena globosa</i> L.	—	—
Chenopodiaceae		
<i>Chenopodium amaranticolor</i> Coste & Reyn.	—	—
Cucurbitaceae		
<i>Cucumis sativus</i> L. "National Pickling"	—	—
Leguminosae		
<i>Cicer arietinum</i> L. "Ghazvin"	—	+
<i>Lens esculenta</i> Moench "Ghazvin"	—	+
<i>Medicago sativa</i> L. "Yazdi"	—	+
<i>Melilotus alba</i> Desr.	—	—
<i>Phaseolus aureus</i> Roxb. "Berken"	—	—
<i>P. vulgaris</i> L. "Bountiful"	—	+
<i>P. vulgaris</i> "Pinto U.I. III"	—	—
<i>P. vulgaris</i> "Topcrop"	—	+
<i>Pisum sativum</i> L. "Rondo"	—	+
<i>Vicia faba</i> L. "Algerian"	—	+
<i>Vigna sinensis</i> (L.) Savi ex Hassk. "Early Ramshorn"	—	+
Solanaceae		
<i>Datura stramonium</i> L.	—	—
<i>Nicotiana glutinosa</i> L.	—	—
<i>N. tabacum</i> L. "Xanthi-nc"	—	—

¹ Sap of PLRV-infected plants was rubbed on carborundum-dusted leaves of test plants.

² Groups of 5-10 viruliferous aphids were given a 3-day inoculation feeding on individual test plants.

but was generally present in diseased broad bean, chickpea, lentil and pea. Flowering was usually sparse and pod formation negligible. Symptoms of PLRV usually appeared within 7 to 14 days after inoculation.

Distribution of PLRV

Annually, since 1966, disease surveys were made of legume plantings in various regions of



Figure 1. Nonviruliferous aphids placed in cages (one shown above) on plants suspected of being infected by pea leaf roll virus.



Figure 2. Stunted Wade bean plant (left), with dwarfed leaves which roll inward, infected by pea leaf roll virus. Healthy plants on right.

the country. Diseased plants with symptoms of PLRV were indexed mechanically on different test plants. Nonviruliferous aphids were also fed on portions of diseased plants for three days before being transferred to healthy indicator plants, usually Bountiful bean, Algerian broad bean or Rondo pea. PLRV was widely distributed in all major pulse producing areas of Iran (Figure 9) and was isolated from 14 leguminous food, forage and weed crops (Table 4).



Figure 3. Dwarfed Wadz bean plant, with proliferation of the axillary buds and shortening of the internodes, infected by pea leaf roll virus.



Figure 4. Algerian broad bean plant with dwarfed, chlorotic leaves which roll inward (centre) infected by pea leaf roll virus. Flowering and pod formation sparse or lacking in virus-infected plants.

Effect of PLRV on yield

Bean, broad bean, chickpea, lentil and pea were inoculated with PLRV in replicated field trials at two stages of plant growth, pre-bloom (3 to 5 weeks after planting) and full bloom (8 to 10 weeks after planting), by feeding viruliferous aphids on plants for three days. Cowpeas were tagged at both stages of growth



Figure 5. Chickpea plants (right) infected by pea leaf roll virus, severely stunted and chlorotic when compared to healthy plants (left) of the same age.



Figure 6. Stunted Meshed cowpea plant (lower left) infected by pea leaf roll virus. Note proliferation of axillary buds, shortening of internodes and dwarfing of leaflets.

Figure 7. Lentils infected by pea leaf roll virus (right), chlorotic and stunted with twisted and deformed leaves. Healthy lentils on left.





Figure 8. Leaflets of pea infected by pea leaf roll virus (three on right), deformed, dwarfed, rolled and chlorotic. Healthy leaf on left.

after being infected naturally. Plots were sprayed with an insecticide at periodic intervals and were rogued of all unhealthy plants before each inoculation date. At maturity, data were recorded on the number of pods and seeds and seed weight per plant. Seed yields of all food legumes were reduced at pre-bloom by 81-100 percent and by 19-94 percent at full bloom (Table 2). Largest yield reductions at both inoculation dates occurred with bean, broad bean, chickpea and cowpea. Mortality of plants infected by PLRV at pre-bloom usually exceeded 50 percent for most food legumes studied.

Effect of planting date on incidence of PLRV

Two bean varieties susceptible to PLRV, Red Kidney and Wade, were planted at 15-day intervals in replicated field trials at Karaj, Iran. The first of eight dates of planting was 17 April and the last was 31 July 1971. At periodic intervals plots were surveyed for PLRV and infected plants tagged. Very little infection occurred in the early and late plantings (Table 3); the highest incidence of PLRV occurred in the fifth date of planting (15 June 1971) when 21 percent and 16 percent of the Red Kidney and Wade bean plants were infected, respectively (Table 3).

Alternate hosts of PLRV

Surveys were made in various regions of Iran to determine the naturally occurring alternate and overwintering hosts of PLRV. Numerous leguminous and nonleguminous plants were inoculated with PLRV in glasshouse studies (Table 4). Only plants in the Leguminosae were found to be infected by PLRV in nature and in the glasshouse inoculation tests (Table 4). The most important reservoir and overwintering host of PLRV was alfalfa (*Medicago sativa* L.), which is the major forage crop grown in Iran. The virus usually produces no symptoms in alfalfa under Iranian conditions.



Figure 9. Distribution of pea leaf roll virus in Iran.

Discussion

PLRV belongs to the group of plant viruses, including potato leaf roll and barley yellow dwarf, which are transmitted in a circulative (persistent) manner by their aphid vectors and are usually not sap transmitted (10, 12, 14). Most aphids which colonize pulse crops in Iran transmit PLRV, although some are very inefficient vectors, e.g. *Myzus persicae*. In contrast to stylet-borne viruses affecting food legumes (5, 12, 14), aphid vectors of circulative viruses require longer feeding periods on an infected host to acquire PLRV, but retain the virus for

TABLE 2. — EFFECT OF PEA LEAF ROLL VIRUS ON SEED YIELDS OF SIX PULSE CROPS IN FIELD TRIALS AT KARAJ, IRAN

Pulse crop	Healthy control	Pre-bloom ¹		Full bloom ¹	
	Yield ²	Yield ²	Decrease	Yield ²	Decrease
	<i>Grams</i>	<i>Grams</i>	<i>Percentage</i>	<i>Grams</i>	<i>Percentage</i>
<i>Cicer arietinum</i> L. "Ghazvin"	2 015	1	99	117	94
<i>Lens esculenta</i> Moench "Ghazvin"	422	40	91	209	50
<i>Phaseolus vulgaris</i> L. "Bountiful"	786	0	100	32	96
<i>Pisum sativum</i> L. "Rondo"	369	70	81	259	19
<i>Vicia faba</i> L. "Algerian"	1 950	0	100	220	89
<i>Vigna sinensis</i> (L.) Savi ex Hassk. "Early Ramshorn"	2 700	0	100	25	99

¹ Pre-bloom, plants 6-12 cm tall; full bloom, plants flowering and in very early fruiting stages.

² Seed yield from 100 plants.

TABLE 3. — EFFECT OF DATE OF PLANTING OF TWO BEAN VARIETIES ON INCIDENCE OF PEA LEAF ROLL VIRUS AT KARAJ, IRAN ¹

Date of planting	Red Kidney			Wade		
	Number of plants	Number infected with PLRV	Plants infected	Number of plants	Number infected with PLRV	Plants infected
			<i>Percentage</i>			<i>Percentage</i>
17 April 1971	172	1	0.6	82	3	3.7
1 May 1971	333	0	0.0	326	1	0.3
16 May 1971	227	6	2.6	217	13	6.0
1 June 1971	262	36	13.7	230	31	13.5
15 June 1971	261	59	21.0	188	30	16.0
1 July 1971	309	17	5.5	307	17	5.5
15 July 1971	269	4	1.5	253	4	1.6
31 July 1971	284	3	1.1	274	0	0.0

¹ Plots were two rows wide and 5 m long with four replications/variety/planting date.

extended periods even through the various moults which occur in the development of an aphid.

PLRV infects many leguminous crops grown in Iran, including all food legumes, except mung bean. At times PLRV has been a limiting

factor in the cultivation of some pulse crops in different areas of the country. On a recent field trip to Turkey, the author (unpublished data) found PLRV affecting bean and broad bean, indicating that PLRV is probably widely distributed in other countries of the Near East where

TABLE 4. — ANNUAL AND PERENNIAL LEGUMINOUS HOSTS OF PEA LEAF ROLL VIRUS IN IRAN

Host	Natural infection ¹	Inoculated ²
<i>Cicer arietinum</i> L.	+ ³	+
<i>Cyamopsis tetragonoloba</i> (L.) Taub.		+
<i>Galactia</i> sp.		+
<i>Glycine max</i> (L.) Merr.		+
<i>Lathyrus odoratus</i> L.		+
<i>L. sativus</i> L.		+
<i>Lens esculenta</i> Moench.	+	+
<i>Medicago hispida</i> Gaertn.	+	+
<i>M. lupulina</i> L.	+	+
<i>M. sativa</i> L.	+	+
<i>Melilotus indica</i> (L.) All.	+	+
<i>Phaseolus lunatus</i> L.		+
<i>P. vulgaris</i> L.	+	+
<i>Pisum sativum</i> L.	+	+
<i>Trifolium alexandrinum</i> L.		+
<i>T. incarnatum</i> L.		+
<i>T. resupinatum</i> L.	+	+
<i>T. subterraneum</i> L.		+
<i>Trigonella foenum-graecum</i> L.	+	+
<i>Trigonella</i> sp.	+	
<i>Vicia faba</i> L.	+	+
<i>V. narbonensis</i> L.	+	+
<i>V. sativa</i> L.		+
<i>V. villosa</i> Roth		+
<i>Vigna sinensis</i> (L.) Savi ex Hassk.	+	+

¹ Plants infected by the virus in nature.

² Viruliferous aphids were fed on plants in the glasshouse.

³ + = positive virus transmission.

food legumes are cultivated. Symptoms of PLRV in some food legumes are very characteristic, but insect transmission and host range studies should be utilized in its identification because symptoms of other viruses affecting pulse crops, such as curly top of bean (16), could be confused with those of PLRV.

Preventing the spread of PLRV in food legume crops in Iran by application of costly insecticidal sprays to control the aphid vectors of the virus was not feasible, due to the low economic value of these crops. The only effective and economical method of controlling PLRV in Iran is by finding resistance to the virus through plant selection and breeding. In some pulse crops, such as broad bean, no resistance to PLRV was found in over 115 lines which were screened in the field and glasshouse (Kaiser, Unpublished data). However, with dry beans, several lines in 1560 types screened in field trials at Karaj, Iran, were highly resistant or immune to the virus. Additional screening of the pulse germ plasm in the glasshouse and at various field locations in Iran will be required before acceptable pulse varieties containing resistance to PLRV, and preferably other diseases, can be released to the farmer. Until resistant varieties of food legumes are available, it is recommended that pulse plantings not be located immediately adjacent to important reservoir hosts of the virus, especially alfalfa.

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