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FIELD TESTS FOR *MEDICAGO* RESISTANCE AGAINST THE POTATO LEAFHOPPER (HOMOPTERA: CICADELLIDAE)[1,2]

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Abstract

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A collection of 70 *Medicago* introductions were field tested for resistance against potato leafhopper, *Empoasca fabae* (Harris), damage. All *M. sativa* L. ssp. *sativa* and most ssp. mixtures were susceptible. All ssp. *falcata* (L.) Arcangeli, one ssp. mixture *sativa* and *caerulea* (Lessing ex Ledebour) Schmalhausen, ssp. × *varia* (Martyn) Arcangeli and *M. pironae* Vis were resistant receiving one-half or less damage than the standard cultivars during four seasons of testing. Resistant introductions were slower in regrowth, attained less height, had smaller leaflets, thinner, tougher stems, and more prostrate growth than standard cultivars. Results suggest most observed resistance is due to avoidance of tough stems for oviposition.

Résumé

Un groupe de 70 lignées introduites de *Medicago* ont été testées sur le terrain pour leur résistance au dommage par la cicadelle de la pomme de terre, *Empoasca fabae* (Harris). Toutes les *M. sativa* L. ssp. *sativa* et la plupart des mélanges étaient susceptibles. Toutes les ssp. *falcata* (L.) Arcangeli, un mélange ssp. *sativa* et *caerulea* (Lessing ex Ledebour) Schmalhausen, la ssp. × *varia* (Martyn) Arcangeli et *M. pironae* Vis étaient résistantes, ayant souffert la moitié ou moins du dommage causé aux cultivars standards en 4 ans d'essais. Les lignées résistantes avaient une vitesse de repousse réduite, atteignaient une hauteur moindre, avaient des folioles plus petites, des tiges plus minces et plus dures, et une stature plus affaissée que les cultivars standards. Les résultats semblent indiquer que la résistance observée est causée par l'absence de ponte dans les tiges coriaces.

The economic importance of potato leafhopper, *Empoasca fabae* (Harris), damage to alfalfa in eastern North America is well recognized (Davis and Wilson 1953; Jewett 1929; Kehr *et al*. 1975; Poos and Johnson 1936; Smith and Medler 1959) and the importance of germplasm that may contribute to development of leafhopper resistant cultivars is obvious. From United States Regional Plant Introduction Station Annual Reports we selected 70 *Medicago* introductions that were noted as having some resistance against potato leafhopper damage. Reported are the results of field tests conducted to determine the relative resistance of selected introductions.

Materials and Methods

Seeds of 51 *Medicago sativa* L. ssp. *sativa*, 7 *M. sativa* L. ssp. *falcata* (L.) Arcangeli, 10 mixtures of *M. sativa* L. ssp. *caerulea* (Lessing ex Ledebour) Schmalhausen, *falcata*, *glomerata* (Balbis) Tutin, *sativa*, and × *varia* (Martyn) Arcangeli in various combinations, 1 *M. sativa* L. ssp. × *varia* and *M. pironae*

[1]In cooperation with the New York State Agricultural Experiment Station, Geneva, New York 14456.
[2]Mention of a proprietary product does not constitute endorsement by the USDA.

Vis were obtained from the USDA North Central Regional Plant Introduction Station, Ames, Iowa. Seeds of cultivars 'Cayuga', 'Iroquois', and 'Saranac' were obtained locally and used as susceptible standards.

During May 1977 seedlings were transplanted at Geneva, New York to single-row field plots arranged in a completely random design with 2 replications/introduction and 18 plants/replication. Distance between plots was 1.8 m between rows, 1.2 m between plots within a row, and 47.7 cm between plants. On 22 July when leafhopper damage was distinctly different among plots, the percentage of leaflets damaged on one representative plant per plot was estimated. Damage criteria were characteristic wedge-shaped yellowing, subsequent total yellowing and tanning, and a limited marginal red to purple coloration which occurred on one introduction. All plants were then cut and removed from the field. Because cutting and removal greatly reduced the leafhopper population, damage was not re-estimated during 1977. On 15 August, 25 days after cutting, extended height measurements of regrowth were taken on 10 plants from each plot containing the cultivars and introductions which had less damage than the cultivars.

During 1978 it was possible to manage plots under more normal cultural practices because plants were in the second year of growth. On 5 June all plants were cut and removed from the field as the first cutting. On 18 July damage was estimated as before. To increase leafhopper pressure against less damaged introductions, after all other introductions were badly damaged, plants were not cut and damage was estimated again on 28 July and 15 August. On 28 July, extended height measurements were taken as before. Duncan's multiple range test was used to analyze the 1977 and 1978 overall damage to each cultivar and introductions with less average damage than the cultivars.

To reduce initial choice and increase initial leafhopper pressure against plants which were resistant to damage during 1977 and 1978, all plots containing susceptible plants (except plots containing cultivars) were eliminated from the test field by ploughing during the fall of 1978. This altered the proportion of plots containing susceptible and resistant plants from 126:20 plots (6:1 ratio) in 1977 and 1978 to 6:20 plants (3:1 ratio) for 1979 and 1980. Thus, the choice between susceptible and resistant plants for 1979 and 1980 was reduced by one-half and initial pressure against resistant plants was increased by a factor of 2.

In both 1979 and 1980 all plants were cut and removed from the field in early June. As indicated by damage, leafhopper infestations were later during both seasons, as was the case throughout central New York, and it was necessary to wait until 24 July 1979 and 8 August 1980 for sufficient and distinctly different damage among plots. Damage was estimated as before. Nymph populations were determined by randomly taking 20 whole stems per plot and quickly placing them in containers with a 2.5 cm^2 piece of No Pest Strip® containing 20% tech. DDVP (Vapona®). Nymphs were counted 12–16 h after cutting and the average number of nymphs per replicate was calculated for each season.

To acquire information about possible relationships between stem texture and resistance to leafhopper damage, the stem texture of susceptible (Iroquois) resistant (PI 251830) and very resistant (PI 253449) plants was measured on 27 June 1979 by recording the pressure required to puncture each of 5 randomly selected stems/replicate at a point 10 cm from the tip of each stem with a fruit and vegetable tester equipped with a plunger having a diameter of .635 mm. The same procedure was used 9 July 1980 except that the texture of each stem from 1 entire plant/replicate was measured. The average pressure required to puncture stems from each replicate was determined for each year.

Results and Discussion

All *M. sativa* spp. *sativa* and nine mixtures, 86% of all introductions, and 90% of all mixtures tested, were damaged as much as the cultivars on 22 July 1977 and 18 July 1978, and were considered susceptible to leafhopper damage. The remaining introductions which included all *M. sativa* ssp. *falcata* tested averaged 55% less damage on 22 July 1977 and 50% less damage on 18 July 1978, and were considered to have resistance against leafhopper damage. They were: *M. sativa* ssp. *falcata* Pl 235021, 251689, 251830, 258750, 258754, 262532, 263154; ssp. mixture *sativa* and *caerulea* Pl 172984; ssp. × *varia* Pl 251688; and *M. pironae* Pl 253449. On 28 July 1978 (10 days later) damage to all resistant introductions except Pl 253449 had increased from an average of 40% to 72%, but as a group they still averaged 23% less damage than the cultivars. From 28 July to 15 August 1978 damage did not increase. Overall damage to each resistant introduction was significantly less than the cultivars. Among introductions, Pl 253449 was least damaged (Table I). The significance of the data is that the level of resistance found is sustained to and beyond the normal time for the second harvest of alfalfa when leafhopper damage is most serious in central New York. Although species and subspecies are not equally represented, all *M. sativa* ssp. *sativa* were susceptible and all *M. sativa* ssp. *falcata* and *M. sativa* ssp. × *varia*, considered a hybrid of ssp. *sativa* and *falcata*, were resistant. *M. falcata* resistance against leafhoppers was noted by Sorenson (Sorenson *et al.* 1972; Webster *et al.* 1968), but data were not given. We believe the rapid increase in damage to resistant *M. sativa* ssp. between 18 and 28 July 1978 indicates that adults and nymphs migrated to these plants after damage to susceptible plants caused them to have little feeding value because time (10 days) was insufficient for substantial oviposition, hatch, and consequent nymphal feeding damage; damage rapidly increased only after susceptible plants were badly damaged. On 15 August 1977 extended heights of the resistant

Table I. Estimated percentage potato leafhopper damage to the 10 most resistant alfalfa introductions tested in 1977 and 1978

Plant introduction no. or cultivar	Source	Avg. damage on: 22/7/77	18/7/78	28/7/78	15/8/78	Mean 1977 and 1978 damage[1]
Plant introduction No.						
253449	Yugoslavia	10	40	30	40	30.0a
251830	Austria	25	30	60	60	43.7ab
258750	U.S.S.R.	20	35	60	60	50.0ab
235021	Germany	30	40	65	65	50.0bc
258754	U.S.S.R.	35	45	60	60	50.0bc
262532	Israel	40	45	65	70	55.0bcd
251689	U.S.S.R.	35	30	80	80	56.2bcd
172984	Turkey	45	45	75	75	60.0cd
251688	U.S.S.R.	25	35	90	90	60.0cd
263154	U.S.S.R.	40	50	90	99	69.7d
MEAN		30.5	39.5	67.5	69.9	
Cultivars						
'Saranac'		80	90	90	95	88.7e
'Cayuga'		75	90	100	95	90.0e
'Iroquois'		100	90	95	97	95.6e
MEAN		85.0	90.0	95.0	96.0	

[1]Means followed by the same letter are not significantly different at the 5% probability level according to Duncan's multiple range test.

M. sativa ssp. averaged 14.0 cm (9.1–18.3); *M. pironae* averaged 8.6 cm (7.9–9.1), and the cultivars averaged 24.1 cm (16.8–27.0); on 28 July 1978 their extended heights averaged 28.4 cm (17.8–50.8), 17.8 cm (12.7–22.9), and 46.2 cm (40.5–50.8). Thus, resistant *M. sativa* ssp. and *M. pironae* were 42% and 64% slower in regrowth (25 days after cutting) and attained 38% and 62% less height than the cultivars even though they were less damaged by leafhoppers. Compared to the cultivars, leaflets of all resistant introductions were smaller, stems were thinner, and growth more prostrate. Stems of *M. pironae* were redder and also unlike all other introductions. Damage was limited to marginal red to purple discoloration that did not progress to total tanning and death.

During the 1979 and 1980 seasons leafhopper damage to resistant introductions averaged 8.5% (5–12) and trace to 5%, while damage to the cultivars averaged 60% (55–65) and 9.5% (8.5–10). Initial resistance persisted and the degree of resistance varied little during four seasons of testing. Initial resistance is apparently independent of choice between the number of resistant and susceptible plants present in the field, increased pressure against resistant plants, varying periods and severity of infestation. We believe persistent resistance, especially when choice is minimal, is important because it indicates that resistance will persist in monoculture of resistant introductions and monoculture of resistant cultivars developed from resistant introductions.

During 1979 and 1980 nymphal populations averaged 2 (.5–7) and 2.3 (0–8.5) nymphs/plot in all plots containing resistant inroductions while populations in plots containing the cultivars averaged 10.6 (9–13) and 12.3 (5.5–18) nymphs/plot. Nymphal populations were therefore about 5 times greater on susceptible plants during both seasons indicating damage estimations are associated with infestation within seasons. Resistant introductions are evidently unlike some resistant alfalfa clones studied by Jarvis and Kehr (1966) who reported that resistance against leafhopper yellowing was not necessarily related to the degree of leafhopper infestation.

On 27 June 1979 average pressure required to puncture stems of 'Iroquois' (Pl 251830 and Pl 253449), was 53.3, 135, and 429 g/.32 sq. mm, respectively; on 9 July 1980 average pressure required was 103.6, 187.5, and in excess of 500 g/.32 sq. mm (maximum instrument capacity was 500 g), respectively. Stems of the resistant introduction (Pl 251830) were, therefore, tougher, requiring about 80 g more pressure to puncture than 'Iroquois' during both seasons. Differences in stem toughness between seasons are probably due to greater plant maturity at the later sampling date during 1980. Regardless of sample size or date of sampling, stems of the resistant introduction were relatively and uniformly tougher, i.e. the pressure differential between seasons was about 50 g. Stems of Pl 253449, the most resistant introduction, were toughest. We believe avoidance for oviposition or perhaps inability to oviposit in the toughest stems of resistant plants was responsible for lower nymph populations and consequently less damage. We also believe that the stems of resistant introductions were tougher because they grew slower. Ovipositional preference for tender stems has been suggested by Graber (1941), Kieckhefer and Medler (1964), and Simonet and Pienkowski (1977) as a factor responsible for greater leafhopper damage to certain alfalfa plants. Damage to Pl 253449 did not rapidly increase after susceptible plants were badly damaged (1978) and leaflet reaction to feeding suggests additional mechanism(s) of resistance.

Characteristics of the resistant plants are agronomically unacceptable as cultivars. If ovipositional avoidance were the only mechanism of resistance, results suggest that rapid, erect, but tough regrowth that attains a height equal to cultivars, an improbable combination, are the criteria for development of agronomically acceptable, resistant cultivars from the resistant introductions studied. If additional mechanisms of resistance are involved, which appears to be the case with Pl 253449, the chance of developing resistant, acceptable cultivars may be greater.

Kindler *et al*. (1973) concluded that alfalfa plants with characteristics that are detrimental to leafhoppers (e.g. nonpreference for oviposition) should be included in leafhopper resistance breeding programs and their inclusion is more desirable than phenotypic recurrent selection of clones with resistance to yellowing. The resistant, introduced plants discovered in this study appear to offer such characteristics.

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