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# Arthropod Resistance in Plant Introduction Accessions of *Malus* sp. to Some Arthropod Pests of Economic Importance

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## Abstract

Field evaluations for arthropod resistance were made on 573 *Malus* accessions, acquired from 40 countries and growing at Glenn Dale, Maryland. Damage to leaves caused by aphis, European red mite, leafhopper, leafminer and leafroller were recorded. When fruit was present any damage caused by codling moth, fruitworm and plum curculio was noted. To confirm our field observations a total of 297 of the 573 accessions were evaluated in the laboratory or greenhouse. Of the following accessions evaluated in the laboratory were: 168 for apple maggot; 224 for codling moth, 249 for plum curculio; and 261 for redbanded leafroller. Nineteen accessions were evaluated in the greenhouse for European red mite. Accessions were classified as resistant, to apple maggot, codling moth, plum curculio and redbanded leafroller if their resistance levels were significantly ($P < 0.05$) better than the cv. 'Jonathan' and to European red mite if their resistance levels were significatly ($P < 0.05$) better than the cv. 'Redfree.' None of the cultivars were resistant to apple maggot; 5 were resistant to codling moth; 1 to European red mite; 7 to plum curculio and 4 to redbanded leafroller. Dual resistance was found in: PI 223602 (cv. 'Mutsu') to plum curculio and redbanded leafroller; and PI 279645 (cv. 'Golden Delicious' x 'Ingrid Marie') to codling moth and plum curculio. No laboratory tests were carried out to confirm any resistance to fruitworms, leafhooper and leafminer, in accessions lacking field damage by these insects.


## Introduction

A wide spectrum of arthropods (4) and diseases (1) may damage apple. It is also likely that other pests and diseases not mentioned in the references cited above could be economically import to commercial growers. Major pests and diseases that hinder apple production are generally managed by chemical treatments often applied at regular intervals, as perceived to be required, or as monitoring indicates a need. An alternate pest management procedure could be developed through the use of pest and disease resistant cultivars integrated with other control measures to produce the desired fruit with high quality and without blemishes.

The initial step for the development of resistant cultivars is to identify sources of resistance from domesticated or wild germplasm. Our objective in this study was to screen the foreign and domestic collection of *Malus* available at the Plant Introduction Station, Glenn Dale, MD, USA, for resistance to selected arthropods.

## Materials and Methods

Apple accessions from 40 countries that were budded onto seedling rootstocks were studied in the orchards at Glenn Dale. The distance between trees varies from 0.5 to 2.0m and

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between rows from 1.5 to 6.7m. The age of the trees varied from 10 to over 30 years. Routine management procedures for the orchards required the application of the manufacturers' recommended dosage of pesticides at the following growth stage or calendar dates—early spring (dormant oil), bloom (captan & malathion), from petal fall to June 20 at 7-14 day intervals (kelthane, malathion, captan, guthion and benlate) and then on July 20 (thiodan, guthion and benlate). Three sprays of streptomycin sulfate (21.2% wettable powder) were applied at a rate of 45 g per 378 ml of water beginning with full bloom and then on two successive seven-day intervals for the control of fireblight, *Erwinia amylovora* (Burr.). The trees were fertilized annually in April with 10N-10P-10K broadcast at a rate of 181 kg per 0.4 hectare. Additionally to correct soil acidity in 1980, bulk lime was applied at 1814 kg per 0.4 hectare. Lime was applied again at half this rate in 1984.

**Orchard survey:** was conducted in two parts in 1981.

a. Pherocon® traps and lures were used to monitor: codling moth (CM), *Laspeyresia pomonella* (L.), oblique banded leafroller, *Choristoneura rosaceana* (Harris), redbanded leafroller (LR), *Argyrotaenia velutinana* (Walker); spotted tentiform leafminer (LM), *Phyllonorycter blancardella* (F.); and apple maggot (AM), *Rhagoletis pomonella* (Walsh).

b. Foliar and fruit surveys were conducted for the above insects and also for other arthropods: aphid (AP); European red mite (EM), *Panonychus ulmi* Koch; undetermined species of fruit worms (FW) and leafhoppers (LH), and plum curculio (PC), *Conotrachelus nenuphar* (Herbst). Sampling for fruit pests was done by examining fruits which had dropped from each tree and noting damage. An additional sample of 'hanging fruit' not exceeding ten fruit were chosen at random, when available, cut open and examined for internal damage. Sampling for EM was begun about 20 days after petal fall by examining ten randomly chosen leaves per tree. A similar sample was also used to record leafminer (LM) incidence. Aphids were counted on 10 terminals.

Leafrolling by LR and damage to fruit by the specific pests were first checked 14 to 20 days after petal fall and throughout the growing season.

**Laboratory evaluations:** were conducted in 1982, 1983, 1984 and 1985 to confirm some of the leads that were suggested in the 1981 orchard survey along with those accessions that had no fruit when surveyed.

Resistance at $P < 0.05$ compared to the cv 'Jonathan' was not found in any of the 168 accessions evaluated for AM. Only 2 selections were resistant to more than one pest — PI223602 ('Mutsu') to PC and LR and PI279645 ('Golden Delicious' x 'Ingird Marie') to CM and PC. These selections were not evaluated in the field for lack of fruit. Additionally, resistance to PC was also found in PI162735 cv 'Mattais,' PI-183961 cv 'Canavial-14'; PI247022 cv 'Cox's Orange Cherry'; PI371809 cv 'Carola'; and PI392298—an apple rootstock (MM106 x EMCII-Selection 86-1-22). PC damage to PI162735, 247022 and 392298 was not observed in the field because of the lack of fruit, but on PI183961 no PC damage was observed.

CM resistance was observed on four accessions, PI277013 cv 'Laxton's Leader'; PI279326 cv 'Reine des Reinette x 1700'; PI293884 cv 'Druzhba #1443'; and PI304637 cv 'Summerred' plus the accession with dual resistance mentioned above. Among these PI-127013 and 279326 were observed in the field to have no damage. PII293884 and 304637 were not evaluated for lack of fruit.

LR resistance was found in PI123967 cv 'Saltcote Pippin,' PI199420 cv 'Padley's Pippin'; and PI241999 cv 'Sub-

**Table 1. Apple accessions with resistance to five arthropods in laboratory evaluations of 297 accessions and their arthropod infestations that were observed in the field.**

| Arthropod | Number of Accessions Tested | PI numbers and cultivar names of resistant accessions | Arthropods observed on accessions in the field |
|---|---|---|---|
| Apple maggot | 168 | None | |
| Codling moth | 224 | PI127013 cv. 'Laxton's Leader' | Leafhopper, leafroller, plum curculio |
| | | PI279326 cv. 'Reine des Reinettes X 1700' | Leafhopper, leafroller, plum curculio |
| | | PI279645 cv. 'Golden Delicious' x 'Ingrid Marie' | Leafhopper, leafroller |
| | | PI293884 cv. 'Druzhba #1443' | Leafhopper, leafminer, leafroller |
| | | PI304637 cv. 'Summerred' | No field data |
| European red mite | 19 | PI122586 *Malus hupehensis* | Leafhoppers, and plum curculio |
| Plum curculio | 249 | PI162735 cv. 'Mottais' | Leafhoppers and leafrollers |
| | | PI183961 cv. 'Canavial-14' | Leafhoppers and leafrollers |
| | | PI223602 cv. 'Mutsu' | No field data |
| | | PI247022 cv. 'Cox's Orange Cherry' | No field data |
| | | PI279645 cv. 'Golden Delicious' x 'Ingrid Marie' | Leafhopper, leafroller |
| | | PI371809 cv. 'Carola' | Leafhopper, leafroller |
| | | PI392298 MM106 x EMXXVII-AR86-1-22 | No field data |
| Redbanded leafroller | 261 | PI123967 cv. 'Saltcote Pippin' | Aphis, plum curculio |
| | | PI199420 cv. 'Padley's Pippin' | Aphis, leafhopper |
| | | PI223602 cv. 'Mutsu' | No field data |
| | | PI124199 Subtropical apple | Aphis,codling moth, fruitworm, leafhopper, leafminer, leafroller, plum curculio |

tropical Apple' along with PI223602 mentioned earlier. LR infestation was not observed on PI199420 in the field. Although fruit from PI241999 was resistant in the laboratory, we observed leaf rolling only but no fruit damage in the field.

Only PI122586 was resistant to EM when compared to cv 'Redfree.'

The arthropod status of some PI accessions reported provides needed information for use by apple breeders in transferring traits for resistance as well as indicating the pest susceptibilities of others, if they are used in commercial apple production.

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# Overlapping Double and Early Single Cropping of Low-chill Peaches in Australia[1]

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## Abstract

The overlapping double cropping system occurs in low-chill feral peaches in east coastal areas of Australia. This system also occurs in recently introduced low-chill Florida bred cultivars. The overlapping double cropping system consists of partial predormancy bloom, winter fruit growth, and postdormancy harvest plus the normal postdormancy bloom and harvest with a 4 to 6 week difference between harvests. Research on enhancing this system has led to the early single cropping system which consists of total postdormancy bloom, winter fruit growth and early spring harvest. The 2 cropping systems are enhanced by timing of predormancy defoliation and bloom as regulated by water stress and nutrition.


The development of low-chill peach cultivars (1) and their production in subtropical areas has permitted testing of the biannual cropping system described in Venzuela for medium-chill Spanish-distributed peaches (14). The introduction of low-chill peach cultivars and their production in Australia (8, 10) has led to the opportunity to observe overlapping double crops and the potential for developing a unique early ripening single crop system. Times of events are presented in months rather than season so that a 6 month change is needed for northern hemisphere conversions.

The overlapping double crop system occurs naturally in the lowest chill, feral peaches in areas near Brisbane where no winter temperatures below 2°C occur. The area is at 28°S latitude with elevations up to 200 m. The coldest month averages about 14°C. Partial bloom in late April, initiated by early autumn (March to April) defoliation from leaf rust and drought stress, results in fruit set that overwinters on dormant trees where no winter frosts occur. This fruit ripens in September before pit hardening in the normal spring (November) crop. Marketing of these "off season" fruit has been practiced in the Brisbane area for more than 30 years.

The low-chill stonefruit industry is rapidly expanding in Australia and has largely replaced the locally selected

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