

## A Revised List of Host Plants of the Melon Fly in Hawaii<sup>1</sup>

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A half-century ago the melon fly (*Dacus cucurbitae* Coq.) entered Hawaii and has since become the most important pest of cucurbits. However, it does not restrict its activity to the cucurbits alone, but infests plants in several other botanical families as well. A list of 10 host plants of melon fly in Hawaii was presented by Van Dine in 1906 and in 1908. In 1914 a list of 13 host plants was recorded by Severin *et al.* In 1917 and 1918, Back and Pemberton brought out more complete lists of 21 and 22 plants respectively. Since Back and Pemberton's work on the biology of the melon fly, no additional host list has been reported in Hawaii. The following list is presented to include several new hosts and also to revise the list presented by Back and Pemberton. The list of host plants in Hawaii is given in table 1. In table 2 is presented a list of plants which are not as yet recorded as hosts of the melon fly in Hawaii but which have been reported as such in other countries.

The extent of injury that may result from the attack of the melon fly depends upon the number of melon flies, the abundance and attractiveness of the hosts, the resistance of hosts to oviposition, and the development of larvae within the hosts. In table 1 the host plants are separated into five groups. The first three groups have been separated on the basis of the frequency of injury under general field conditions. The first group includes the highly susceptible plants, the fruits of which are frequently infested by the melon fly. The plants in the second group are infested only occasionally, and in general not all their fruits are injured. The plants in the third group are rarely infested and the fourth group includes the host plants that are not being cultivated. It is apparent that the position of some of these plants may vary depending on the availability of favorable hosts and on the population of the melon fly. For example, beans and peppers are heavily infested when the melon fly population is high and when more susceptible hosts are lacking.

Most of the plants in the first four groups have been confirmed by us, and our colleagues in the University and Bureau of Entomology and Plant Quarantine's Fruit Fly Investigations Laboratory at Honolulu, as hosts of melon fly.<sup>2</sup> The remaining plants have been reported from reliable sources. Wherever there is a

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<sup>2</sup> For additional information regarding investigations on the melon fly see University of Hawaii Agricultural Experiment Station Biennial Reports 1942-1944 and 1944-46.

doubt as to the validity of a host record, the plant has been placed in the fifth group of "doubtful hosts."

For every host record the reference from which the record has been obtained is cited. Nearly all the scientific names given in the tables have been inserted by the present authors. These names have been obtained from the "Manual of Cultivated Plants" and "The Standard Cyclopedia of Horticulture" by L. H. Bailey (1941, 1944), and from Chung and Ripperton (1929).

In Hawaii plants representative of the following botanical families serve as hosts of the melon fly: (1) Cucurbitaceae, (2) Solanaceae, (3) Leguminosae, (4) Passifloraceae, (5) Malvaceae, (6) Anacardiaceae, (7) Lauraceae, (8) Caricaceae, (9) Rosaceae, (10) Rutaceae, (11) Moraceae, and (12) Cruciferae. However, the preferred hosts are the cucurbits and tomato. All the cultivated cucurbits are severely attacked, and only one, the chayote (*Sechium edule* Swartz.), is able to resist the attack successfully. There are very few records of the successful rearing of melon fly from chayote, although the female fly frequently punctures and usually lays eggs in the fruit. The eggs may hatch but the larvae fail to complete their development.

Many types of squashes and gourds are grown in Hawaii, and the literature on the melon fly hosts refers to them only by their common names. The squashes are mostly of the two species, *Cucurbita maxima* Duchesne and *C. moschata* Duchesne. Among the gourds there are the white-flowered gourd (*Lagenaria siceraria* [Molina] Standl.), the dish-cloth gourds (*Luffa acutangula* [L.] Roxb. and *L. cylindrica* Roem.), and the snake gourd (*Trichosanthes anguina* L.). There are undoubtedly other species that have been grown in Hawaii and found susceptible to melon fly infestation.

The beans, especially string bean and cowpea, are apt to be attacked when there is an abundance of melon flies in the vicinity. The lima bean was never found infested by Back and Pemberton (1917), but in 1946 several bean pods that had been collected (by Y. T.) from the King's Daughters Home at Waialae, Honolulu, were found infested with melon fly. The infested pods were firm and slightly purplish at the site of oviposition punctures. From 12 pods about 50 adults were reared. Lucas (1941) has reported rearing the melon fly from hyacinth bean (*Dolichos Lablab* L.).

Okra has been found (by O.C.M.) to be a host of the melon fly. In 1945, 16 melon flies emerged from 1 okra pod picked from the garden of the Pineapple Research Institute at the University of Hawaii. Melon flies also oviposited in stems of okra plants that were about 3 feet tall and growing on the University Farm.

In 1930 Fleury reported that the puparia of the melon fly were found by the California Plant Quarantine Service in cucumber and dry onions from Hawaii. We question whether onion is a host of the melon fly.

Pepper, kohlrabi, and cabbage were reported by Back and Pemberton (1917, 1918) as erroneously recorded host plants. They have been reported from Hawaii previously as follows: pepper and cabbage were reported as hosts by Fullaway in 1914; however, in 1915 he thought it was an abnormal condition in the cabbage plant that resulted in attack by melon fly and considered such attack as of a secondary nature; Severin *et al.* (1914) included kohlrabi in their list of host plants. One of the present authors (Y.T.) has reared the melon fly from both pepper and kohlrabi.

The melon fly was reared in 1946 from six varieties of bell pepper (Calwonder Early, Waialua, Large Early Neapolitan, Okamura M, Fordhook, and Manatu Wonder) which were growing on the farm of the University of Hawaii Agricultural Experiment Station. The infestation was rather severe, and many infested fruits dropped prematurely. The symptoms of the infested fruits were like those on tomato—an initial discolored, water-soaked streak and later collapse of the fruit into a soft, soggy mass.

The infested kohlrabi was collected in March 1945 from a garden of the Central Union Church on Beretania St., Honolulu. The stems when collected were firm and had several deep cracks extending from the bases of the leaves part way down the sides of the enlarged portion. The condition was unlike the soft rot which is usually found in tomato and cucurbits. From 3 fully enlarged stems of kohlrabi, 31 melon flies and 6 scavenger flies, *Atherigona excisa* (Thomson), emerged.

In the fall of 1945 a cauliflower plant which was infested with melon fly was found (by O.C.M.). It was wilted and had several punctures on the stem just below the head. At the site of the punctures soft rot had begun to develop. When the stem was cut open, several larvae were found and from them two adults were reared. In 1946 a grower reported that the melon fly was infesting his cauliflower, but the report was not confirmed.

Two growers, who were farming at Koko Head, Oahu, reported that broccoli was being infested by the melon fly. In the field of one of the farmers we saw several plants which, according to the farmer, had been infested by maggots of the melon fly. The infestation was old and no maggot was present at the time. Both farmers were university graduates, and since they were familiar with the melon fly, their report of broccoli as a host of melon fly is probably authentic. Another grower who was farming at Waialua, Oahu, also reported that the melon fly was infesting his broccoli.

Hardy (1949) reared the melon fly from samples of kai choy, a leaf-mustard cabbage (*Brassica juncea* [L.] Cosson), obtained from Hilo, Hawaii. He reported that the assistant county agent found the infestation in kai choy rather general in the Hilo area, and that there was severe damage in some fields.

The fruit crops, in contrast to the vegetable crops, are rarely attacked by the melon fly. Such fruits as waterlemon (passion

fruit), orange, fig, papaya, peach, and mango have been reported as hosts by various sources (Van Dine 1906, 1908; Ehrhorn 1910; Severin *et al.* 1914; Back and Pemberton 1918; Strong 1937; Nishida 1949). The melon fly has been reared from avocado and mango (by O.C.M.). In 1946, from 19 avocado fruits that had ripened on the tree, 5 melon flies emerged. The mango varieties; Common or Manini, French, Fairchild, and Pirie, have been found infested. From 31 fruits of the Common variety 10 flies emerged; from 20 fruits of the French variety 2 flies; from 20 fruits of the Fairchild variety 10 flies; and from 22 fruits of the Pirie variety 1 fly.

Under laboratory conditions the melon fly has been bred frequently in ripe papaya (O.C.M.). In the field C. B. Keck<sup>3</sup> observed a melon fly ovipositing in a small ripe papaya at Kailua, Oahu, on August 28, 1946. The fruit was placed in a cage over sand, and 55 melon flies were reared.

There are three additional fruit crops, tangerine (*Citrus reticulata* Blanco), longan (*Euphoria Longan* [Lour.] Steud.), and Bluefield banana (*Musa paradisiaca* L. ssp. *sapientum* [L.] Ktze.), from which Miss Mabel Chong<sup>3</sup> of the Territorial Board of Agriculture and Forestry has reared the melon fly. Since she obtained only 1 or 2 melon flies from each type of fruit, these hosts have been placed in the category of doubtful hosts until they are confirmed by further records. From 10 fruits of tangerine, which were collected in Honolulu (Punahou) on April 22, 1947, there were 259 oriental fruit flies (*Dacus dorsalis* Hendel) and 1 melon fly; from 94 fruits of longan collected in Honolulu (Nuuanu) on July 14, 1947, were 10 oriental fruit flies and 2 melon flies; from 11 fruits of Bluefield banana collected in Kaneohe, Oahu, on August 25, 1947, were 1 oriental fruit fly and 1 melon fly.

Within susceptible host plants there are certain varieties that are resistant to the melon fly. Fernando and Udurawana (1941) found some strains of bittergourd, *Momordica Charantia* L., to be more resistant than others. They found that four Central Division strains were more resistant than a North-Western Division strain. The Central Division strains were not significantly different from one another. The strain green rough, however, was consistently the best in regard to resistance to the melon fly and also in crop yield. Krauss (1905) reported that, among four varieties of squash, Hubbard was more resistant than Summer Crook Neck, Scallop, and Gold o'Heart.

Some varieties of tomato show marked resistance to melon fly. In 1904 Smith noted that some varieties of tomato in Hawaii were resistant, but he did not identify these varieties. In 1919 Higgins reported that a small-fruited wild variety growing in Hawaii appeared to be immune, and that the "pear" and "plum" varieties were also resistant. He believed that resistance in tomato

<sup>3</sup> Unpublished note.

was due to a combination of slipperiness and toughness of the skin and to certain characters concerning the shape of the fruit. The offspring of crosses between resistant varieties and susceptible commercial varieties was less susceptible (Higgins 1919; Pope 1924, 1925). Sumida *et al.* (1943) reported that a wild cherry tomato, the Hawaiian Cherry, was apparently resistant. This variety is apparently the one referred to by Higgins in 1919. Back and Pemberton (1917, 1918) reported that they had never found the melon fly attacking the fruits of currant tomato (*Solanum pimpinellifolium* [also known by present-day botanists as *Lycopersicon esculentum* Mill. subsp. *Galenii* (Mill.) Luckwill (*L. esculentum* var. *cerasiforme*)], grape tomato (*S. lycopersicon* [also known as *Lycopersicon esculentum* Mill.]), popolo (*Solanum nodiflorum* Jacq.)), and a spiny yellow-fruited *Solanum*.

While working with two varieties of tomato, Marlowe (1937) found that the average infestation by the melon fly was 19.3 per cent for the Break O'Day variety, and 59.3 per cent for the Pritchard variety. The average yield of marketable fruits of Break O'Day was eight times that of Pritchard.

In 1917 Back and Pemberton reported that most varieties of bean were seldom attacked by the melon fly and only the fleshy, long-podded Chinese variety was susceptible to infestation. They also noted distinct differences in susceptibility among varieties of cowpea. In 1919 Higgins reported that J. H. Cowan tested the susceptibility of 16 varieties of bean to the melon fly. Cowan found that the varieties Early Refugee and Refugee Wax were not infested by the fly, the varieties Stringless Refugee (not wax) and the Ventura Wonder Wax had less than 1 per cent injury, and the varieties Stringless Green Pod and Black Valentine, which were most heavily attacked, had infestations of 21.1 and 16 per cent, respectively. Holdaway (1940) also noticed a difference in susceptibility among three varieties of string bean. The variety Lualualei exhibited the highest percentage of attack, McCaslan the next, and Kentucky Wonder the lowest. He stated that a bush green-podded type of bean, Tendergreen, was observed by the grower to be the most heavily attacked of all.

Table 1.—Host plants of the melon fly recorded in Hawaii

HOST PLANT	REFERENCE
Plants Frequently Injured	
Cucurbitaceae: Cantaloupe or muskmelon ( <i>Cucumis Melo</i> L.) <sup>4</sup>	Van Dine 1906, 1908; Severin <i>et al.</i> 1914; Back and Pemberton 1917, 1918.
Gourds ( <i>Lagenaria siceraria</i> [Molina] Standl. [Syn. <i>L. leucantha</i> and <i>L. vulgaris</i> ]; <i>Luffa cylindrica</i> Roem.; <i>Luffa acutangula</i> [L.] Roxb.; <i>Trichosanthes anguina</i> L.)	} Back and Pemberton 1917, 1918.
Chinese cucumber, <i>Momordica</i> sp. (Balsam-pear, <i>Momordica Charantia</i> L.)	
Chinese melon (Chinese preserving melon, <i>Benincasa hispida</i> [Thunb.] Cogn. [Syn. <i>B. cerifera</i> ]; oriental pickling melon, <i>Cucumis Melo</i> var. <i>Conomon</i> [Thunb.] Makino)	
Squash ( <i>Cucurbita maxima</i> Duchesne; <i>C. moschata</i> Duchesne)	} Van Dine 1906, 1908; Severin <i>et al.</i> 1914; Back and Pemberton 1917, 1918.
Cucumber ( <i>Cucumis sativus</i> L.)	
Pumpkin ( <i>Cucurbita Pepo</i> L.)	
Watermelon ( <i>Citrullus vulgaris</i> Schrad.)	
Solanaceae: Tomato ( <i>Lycopersicon esculentum</i> Mill.)	
Plants Occasionally Injured	
Leguminosae: String bean ( <i>Phaseolus vulgaris</i> L.) <sup>5</sup>	Van Dine 1906, 1908; Severin <i>et al.</i> 1914; Back and Pemberton 1917, 1918.
Cowpea ( <i>Vigna sinensis</i> [L.] Savi)	Back and Pemberton 1917, 1918.
Hyacinth bean, <i>Dolichos Lablab</i> L.	Lucas 1941.
Lima bean, <i>Phaseolus limensis</i> Macf.	Tanada. <sup>6</sup>
Solanaceae: Green pepper ( <i>Capsicum frutescens</i> L. var. <i>grossum</i> [L.] Bailey) <sup>5</sup>	Fullaway 1914; Maskew 1919; Tanada. <sup>6</sup>
Eggplant ( <i>Solanum Melongena</i> L.)	Fullaway 1914; Severin <i>et al.</i> 1914; Back and Pemberton 1917, 1918.

<sup>4</sup> Names in parentheses have been inserted by the authors.<sup>5</sup> Occasionally heavy infestation occurs in favorable localities.

Table 1.—Continued

HOST PLANT	REFERENCE
<b>Plants Rarely Injured</b>	
Anacardiaceae:	
Mango ( <i>Mangifera indica</i> L.)	Van Dine 1906, 1908; Severin <i>et al.</i> 1914; Back and Pemberton 1917, 1918.
Caricaceae:	
Papaya ( <i>Carica Papaya</i> L.)	Van Dine 1906, 1908; Severin <i>et al.</i> 1914; Back and Pemberton 1917, 1918; Strong 1937.
Cruciferae:	
Kohlrabi ( <i>Brassica caulorapa</i> [DC.] Pasq.)	Severin <i>et al.</i> 1914; Tanada. <sup>o</sup>
Cauliflower, <i>Brassica oleracea</i> var. <i>botrytis</i> L.	McBride. <sup>o</sup>
Leaf-mustard cabbage, <i>Brassica juncea</i> (L.) Cosson	Hardy 1949.
Cucurbitaceae:	
Chayote ( <i>Sechium edule</i> Swartz)	Back and Pemberton 1918.
Lauraceae:	
Avocado, <i>Persea americana</i> Mill. [Syn. <i>P. gratissima</i> ]	McBride. <sup>o</sup>
Leguminosae:	
Pigeon pea ( <i>Cajanus Cajan</i> [L.] Millsp.)	Foreign Plant Quarantine Interception Files 12014, 1946. <sup>o</sup>
Malvaceae:	
Okra, <i>Hibiscus esculentus</i> L.	McBride. <sup>o</sup>
Moraceae:	
Fig ( <i>Ficus Carica</i> L.)	} Back and Pemberton 1917, 1918.
Passifloraceae:	
Waterlemon, <i>Passiflora</i> sp.	} Nishida 1949
<i>Passiflora Seemanni</i> Griseb.	
Rosaceae:	
Peach ( <i>Prunus Persica</i> [L.] Batsch)	Back and Pemberton 1917, 1918.
Rutaceae:	
Orange ( <i>Citrus sinensis</i> [L.] Osbeck)	Ehrhorn 1910; Severin <i>et al.</i> 1914; Back and Pemberton 1917, 1918.
<b>Wild Hosts</b>	
Cucurbitaceae:	
<i>Momordica</i> sp. (Balsam-apple, <i>Momordica Balsamina</i> L.)	Back and Pemberton 1917, 1918.
<i>Sycos</i> sp. ( <i>Sicyos</i> ?)	Van Dine 1906, 1908; Severin <i>et al.</i> 1914; Back and Pemberton 1917, 1918.

<sup>o</sup> Unpublished.

Table 1.—Continued

HOST PLANT	REFERENCE	
<b>Doubtful Hosts</b>		
Cruciferae:		
Broccoli, <i>Brassica oleracea</i> L. var. <i>botrytis</i> L.	Report of three farmers.	
Cabbage ( <i>Brassica oleracea</i> L. var. <i>capitata</i> L.)	Fullaway 1914, 1915.	
Liliaceae:		
Dry onion ( <i>Allium Cepa</i> L.)	Fleury 1930.	
Musaceae:		
Bluefield banana, <i>Musa paradisiaca</i> L. ssp. <i>sapientum</i> (L.) Ktze.	} Chong. <sup>o</sup>	
Rutaceae:		
Tangerine, <i>Citrus reticulata</i> Blanco		
Sapindaceae:		
Longan, <i>Euphoria Longan</i> (Lour.) Steud.		



Table 2.—Plants which have not been recorded in Hawaii as hosts of the melon fly, but which have been reported as such in other localities

HOST PLANT	COUNTRY	REFERENCE
Cucurbitaceae:		
<i>Bryonopsis laciniosa</i> (L.) Naud.	Formosa	Shiraki 1933.
<i>Citrullus</i> sp.	Java	Back and Pemberton 1917, 1918.
<i>Cucumis</i> sp.	India; Burma	Fletcher 1917.
Dondakaya or kovaikkai, <i>Coccinia indica</i> Wight and Arn. ( <i>C. cordifolia</i> [L.] Cogn.) <sup>7</sup>	India	Cherian and Sundaram 1939.
<i>Luffa</i> spp.	Philippines; India	Woodworth 1922 (II); Pruthi 1937.
<i>Melothria heterophylla</i> Cogn.	Formosa	Shiraki 1933.
<i>Parya-soorten</i> , <i>Momordica</i> sp.	Java	Franssen 1937.
<i>Trichosanthes cucumerina</i> L.	India; Burma	Fletcher 1917.
<i>Trichosanthes cucumeroides</i> Maxim.	Formosa	Shiraki 1933.
<i>Trichosanthes dioica</i> Roxb.	India; Burma	Fletcher 1917.
Leguminosae:		
*Mungos or green gram, <i>Phaseolus radiatus</i> L.	Philippines	Woodworth 1921 (I).
<i>Vigna</i> spp.: cowpea, sitao, * <i>Vigna sesquipedalis</i> (Koern.) Wight, etc.		
Annonaceae:		
*Annonas or custard-apple ( <i>Annona reticulata</i> L.)	Philippines	Woodworth 1922 (III); Ponce 1937.
*Ates or sugar-apple ( <i>Annona squamosa</i> L.)		
*Guanabanos or soursop ( <i>Annona muricata</i> L.)		
Myrtaceae:		
*Guava, <i>Psidium Guajava</i> L.	Philippines; India	Woodworth 1922 (III); Chopra 1928; Ponce 1937.
Palmae:		
*Date ( <i>Phoenix dactylifera</i> L.)	India	Chopra 1928.
Passifloraceae:		
*Granadilla, <i>Passiflora quadrangularis</i> L.	Philippines	Woodworth 1921 (I).
*Passion flower, <i>Passiflora edulis</i> Sims.		
*Passion flower, <i>Passiflora foetida</i> L.		
Rosaceae:		
*Apple ( <i>Pyrus Malus</i> L.)	Japan <sup>8</sup>	Fukai 1938.
*Pear ( <i>Pyrus communis</i> L.)		
*Strawberry ( <i>Fragaria chiloensis</i> [L.] Duchesne)		
Rutaceae:		
<i>Citrus</i> ( <i>Citrus</i> spp.)	India; Japan <sup>8</sup>	Husain 1929; Fukai 1938.

\* Plants found in Hawaii also.

<sup>7</sup> Names in parentheses have been inserted by the authors.

<sup>8</sup> Probably not field infestation.

## SUMMARY

A list of host plants of the melon fly (*Dacus cucurbitae* Coq.) in Hawaii has been compiled. The list includes approximately 36 plants belonging to 12 botanical families. Four of these plants—lima bean (*Phaseolus limensis* Macf.), avocado (*Persea americana* Mill.), okra (*Hibiscus esculentus* L.), and cauliflower (*Brassica oleracea* L. var. *botrytis* L.)—are here reported for the first time as hosts of the melon fly. Pepper (*Capsicum frutescens* L. var. *grossum* [L.] Bailey) and kohlrabi (*Brassica caulorapa* [DC.] Pasq.), have been previously considered as erroneously recorded hosts, but because they have been found infested by the melon fly, they must be regarded as hosts. Six plants have been placed in the category of doubtful hosts until they are confirmed by further records.

The most susceptible hosts of the melon fly are the cucurbits and tomato. The host plants have been divided into five groups. The plants in the first three groups are separated on the basis of the frequency of injury under general field conditions. Wild and doubtful hosts make up the other two groups.

Host plants reported from other countries, but which have not yet been found infested in Hawaii, are also listed.

Certain varieties of bittergourd, squash, tomato, string bean, and cowpea have been reported to be much more resistant to infestation by the melon fly than other varieties of these species.

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