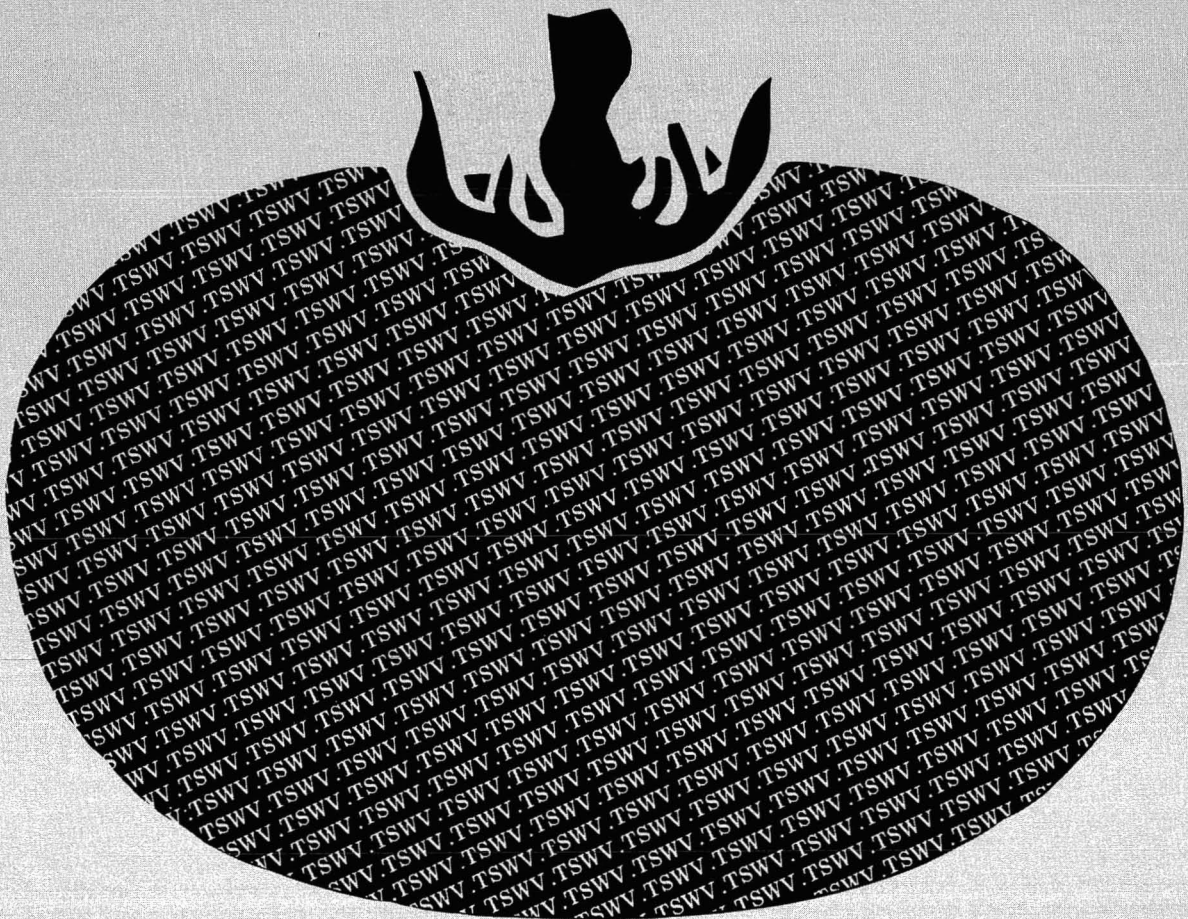


HOST LIST OF PLANTS SUSCEPTIBLE TO TOMATO SPOTTED WILT VIRUS (TSWV)

J. J. Cho, R. F. L. Mau, W. C. Mitchell, D. Gonsalves, and L. S. Yudin

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CONTENTS

	Page
Introduction.....	3
Table 1. Hosts of Tomato Spotted Wilt Virus.....	4
Literature Cited.....	9

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INTRODUCTION

Spotted wilt of tomato was first described by Brittlebank (1919) in Australia. Samuel et al. (1930) characterized the pathogenic agent as a virus and named it tomato spotted wilt virus (TSWV). Since then the disease has been reported in several tropical and temperate regions and is considered worldwide in distribution.

TSWV is unique because it is one of only two plant viruses known to be transmitted by thrips. Pittman (1927) was the first to establish that TSWV could be transmitted by the onion thrips. Six thrips species are known TSWV vectors:

- 1) the western flower thrips, *Frankliniella occidentalis* (Pergande) (Gardner et al., 1935);
- 2) the common blossom thrips, *Frankliniella schultzei* (Trybom) (Samuel et al., 1930);
- 3) the onion thrips, *Thrips tabaci* Lindeman;
- 4) the tobacco thrips, *Frankliniella fusca* (Hinds) (Sakimura, 1963);
- 5) *Scirtothrips dorsalis* Hood (Amin et al., 1981); and
- 6) *Thrips setosus* Moulton (Kobatake, 1984).

Only the first three species are known to occur in Hawaii. Of these, the western flower thrips is the most common vector (Yudin et al., 1986, 1987). TSWV can be acquired from diseased plants only by larval thrips; after a latent period of three to 12 days it can be transmitted by both larval and adult stages.

TSWV produces a variety of disease symptoms including a range of chlorotic, necrotic, stunting, and enation symptoms in all parts of the plant (Ie, 1970). TSWV symptoms on lettuce generally start as necrotic brown leaf spots on one side of the plant, becoming systemic and extending to the heart leaves. This results in a cessation of development, causing the plant to twist to one side. The outer leaves wilt and eventually the whole head collapses. On tomatoes, symptoms are characterized by initial chlorosis of leaves and terminal shoots, developing into bronzing and necrosis. Symptoms on mature fruits are blotchiness of color and rugosity of the fruit surface.

In Hawaii, TSWV has seriously affected production of lettuce, tomato, and bell pepper in the major vegetable-production areas of the state. These areas include the Lalamilo and

Pukapu areas on the island of Hawaii, the Kula area on Maui, and the Waianae area on Oahu. This disease has been quite devastating in recent years, when losses of 50 to 90 percent have been observed in lettuce and tomato production, particularly during the warm, dry summer months.

Development of feasible control procedures has been difficult because TSWV has an extensive plant host range. Best (1968) lists 157 dicotyledonous plant species in 29 families, and six monocotyledonous species in five families, as hosts. Francki and Hatta (1981) added 11 additional host species. Several of these susceptible hosts are commonly found growing along field borders and among crops of Hawaii's major vegetable-growing regions.

TSWV-infected plant hosts in vegetable-growing regions play an important role in the epidemiology of the disease. Forty-four plant species representing 16 plant families have been found to be naturally infected with TSWV. Twenty-six plant species are considered important reservoirs of TSWV (see Table 1). These plant sources perpetuate TSWV, are important habitats for thrips vectors, and serve as foci for subsequent movement and infection of susceptible crop plants. *Ipomoea congesta* (blue morning glory) and *Tropaeolum majus* (nasturtium) are present throughout the year on the islands of Hawaii and Maui. On Oahu, *Amaranthus spinosus* (spiny amaranth) is commonly found. A high percentage of those plants found on farmland harbor the virus and were associated with abundant vector thrips. Elimination of these and other important TSWV reservoirs should be helpful in reducing disease losses.

Several additional new plant hosts have been identified since 1981, and this paper presents an up-to-date listing of TSWV-susceptible plant species. Several references listed in the table cite original articles demonstrating TSWV susceptibility of plant species or host lists of TSWV-susceptible plants.

TABLE 1. HOSTS OF TOMATO SPOTTED WILT VIRUS

Scientific name	Common name	Reference
<i>Acanthospermum hispidum</i> DC.	---	Greber and McCarthy, 1977
<i>Ageratum houstonianum</i> Mill.	ageratum	Gumpf and Weathers, 1972
<i>Amaranthus caudatus</i> L.	---	Best, 1968
<i>Amaranthus graecizans</i> L.	---	Best, 1968
<i>Amaranthus hybridus</i> L.*	green amaranth	Cho et al., 1986
<i>Amaranthus retroflexus</i> L.	redroot pigweed	Milbrath, 1939
<i>Amaranthus spinosus</i> L.*	spiny amaranth	Cho et al., 1986
<i>Amaranthus viridis</i> L.*	slender amaranth	Cho et al., 1984, 1986
<i>Amaryllis</i> sp.	Barbados lily	Gardner et al., 1935
<i>Ananas comosus</i> (L.) Merr.	pineapple	Linford, 1932
<i>Anemone</i> sp.	anemone	Smith, 1957
<i>Antirrhinum</i> sp.	snapdragon	Smith, 1957
<i>Apium graveolens</i> L.*	celery, celeriac	Best, 1968
<i>Aquilegia vulgaris</i> L.	common columbine	Smith, 1957
<i>Arachis hypogaea</i> L.	peanut	Costa, 1941
<i>Arctium lappa</i> L.*	burdock	Cho et al., 1986
<i>Arum palaestinum</i> Boiss	calla	Tompkins and Severin, 1950
<i>Aster</i> sp.	aster	Smith, 1957
<i>Atropa belladonna</i> L.	deadly nightshade	Smith, 1932
<i>Begonia x hiemalis</i> Fotsch	begonia	Barnes and Halliwell, 1985
<i>Begonia semperflorens</i> Link & Otto	begonia	Gardner et al., 1935
<i>Begonia</i> sp.	begonia	Best, 1968
<i>Belamcanda chinensis</i> (L.) DC.	blackberry lily	Yamamoto and Ohata, 1977
<i>Bidens pilosa</i> L.*	Spanish needle	Greber and McCarthy, 1977
<i>Bidens pilosa</i> var. <i>minor</i> (Bl.) Sherf*	Spanish needle	Cho et al., 1984, 1986
<i>Brassica campestris</i> ssp. <i>chinensis</i> L.	white stem cabbage	Cho et al., 1986
<i>Brassica oleracea</i> var. <i>botrytis</i> L.	cauliflower	Gardner et al., 1935
<i>Browallia americana</i> L.	browallia	Gardner et al., 1935
<i>Browallia speciosa</i> Hook.	---	Smith, 1957
<i>Calceolaria</i> sp.	slipperwort	Smith, 1957
<i>Calendula officinalis</i> L.	calendula	Best, 1968
<i>Callistephus chinensis</i> (L.) Nees	China aster	Best, 1968
<i>Campanula americana</i> L.	bellflower	Gardner et al., 1935
<i>Campanula pyramidalis</i> L.	chimney bellflower	Smith, 1957
<i>Capsella bursa-pastoris</i> (L.) Medic.*	shepherd's purse	Best, 1968
<i>Capsicum annuum</i> L.	bell pepper	Sakimura, 1940
<i>Capsicum frutescens</i> L.	red pepper	Smith, 1932
<i>Capsicum</i> sp.	pepper	Best, 1968
<i>Carica papaya</i> L.	papaya	Cook, 1972
<i>Cheiranthus</i> sp.	wall flower	Smith, 1957
<i>Chenopodium album</i> L.	lamb's quarters	Paliwal, 1974
<i>Chenopodium ambrosioides</i> L.	Mexican tea	Cho et al., 1986
<i>Chenopodium murale</i> L.	nettleleaf goosefoot	Cho et al., 1986
<i>Chenopodium quinoa</i> Willd.	---	Paliwal, 1974
<i>Chondrilla</i> sp.	---	Best, 1968
<i>Chrysanthemum morifolium</i> (Ram.) Hemsl.	chrysanthemum	Gardner and Whipple, 1934
<i>Chrysanthemum</i> sp.	chrysanthemum	Smith, 1957
<i>Cichorium endivia</i> L.	endive	Sakimura, 1940

<i>Cichorium intybus</i> L.	chicory	Sakimura, 1940
<i>Cineraria cruenta</i> Mass.	---	Jones, 1944
<i>Cirsium lanceolatum</i> Hill	bullthistle	Best, 1968
<i>Convolvulus arvensis</i> L.	bindweed	Sherf, 1948
<i>Convolvulus</i> sp.	morning glory	Best, 1968
<i>Cordyline terminalis</i> (L.) Kunth.	ti, ki	Cho et al., 1986
<i>Coreopsis drummondii</i> Torr. & Gray	tick seed	Smith, 1957
<i>Coriandrum sativum</i> L.	coriander	Best, 1968
<i>Coronopus didymus</i> (L.) Smith	swinecress	Cho et al., 1986
<i>Cosmos bipinnatus</i> Cav.	cosmos	Smith, 1957
<i>Crepis capillaris</i> Wallr. Beitr.	hawksbeard	Best, 1968
<i>Crepis divaricata</i> F. Schultz	---	Best, 1968
<i>Crepis pulchra</i> L.	---	Best, 1968
<i>Crepis pumila</i>	---	Best, 1968
<i>Crepis rheadifolia</i> Bieb.	---	Best, 1968
<i>Crotalaria incana</i> L.	fuzzy rattlepod	Cho et al., 1984, 1986
<i>Crotalaria mucronata</i> Desv.	smooth rattlepod	Cho et al., 1984, 1986
<i>Cucumis sativus</i> L.	cucumber	Ie, 1970
<i>Cyanra scolymus</i> L.	artichoke	Garcia and Feldman, 1978
<i>Dahlia pinnata</i> Cav.	dahlia	Holmes, 1948
<i>Dahlia variabilis</i> (Willd.) Desf.	dahlia	Gardner and Whipple, 1934
<i>Datura ferox</i> L.	---	Greber and McCarthy, 1977
<i>Datura stramonium</i> L.*	Jimson weed	Smith, 1931
<i>Datura wrightii</i> Hort. ex Regel	---	Smith, 1957
<i>Delphinium cultorum</i> Voss	---	Gardner et al., 1935
<i>Delphinium</i> sp.	larkspur	Best, 1968
<i>Desmodium uncinatum</i> (Jacq.) DC.	Spanish clover	Cho et al., 1986
<i>Dichondra carolinensis</i> Michx.	---	Sakimura, 1961
<i>Duboisia leichhardtii</i>	---	McCarthy and Greber, 1978
<i>Emilia sagittata</i> DC.	Flora's paintbrush	Linford, 1932
<i>Emilia sonchifolia</i> (L.) DC.	red pualele	Sakimura, 1940
<i>Emilia</i> sp.	---	Best, 1968
<i>Erigeron bonariensis</i> L.	hairy horseweed	Helms et al., 1961
<i>Erigeron canadensis</i> L.	small-leaf horseweed	Cho et al., 1986
<i>Gaillardia aristata</i> Pursh.	---	Gardner et al., 1935
<i>Gaillardia</i> sp.	---	Best, 1968
<i>Galinsoga parviflora</i> Cav.*	fuji grass	Cho et al., 1986
<i>Galinsoga quadriradiata</i> (Raf.) Blake	Peruvian daisy	Cho et al., 1986
<i>Gerbera</i> sp.	African daisy	Best, 1968
<i>Gladiolus</i> sp.	gladiola	Smith, 1957
<i>Gloxinia</i> sp.	gloxinia	Best, 1968
<i>Godetia grandiflora</i> Lindl.	---	Gardner et al., 1935
<i>Gomphrena globosa</i> L.	globe amaranth	Paliwal, 1974
<i>Gypsophila paniculata</i> L.	baby's breath	Best, 1968
<i>Helipterum manglesii</i> (Lindl.) F. J. Muell. ex Benth.	Swan River everlasting	Best, 1968
<i>Helipterum roseum</i> Benth.	---	Best, 1968
<i>Hippeastrum</i> sp.	Barbados lily	Best, 1968
<i>Hydrangea macrophylla</i> 'Imaculata' Ser.	hydrangea	Allen et al., 1983
<i>Hydrocotyle asiatica</i> Bert. ex Urban	water pennywort	Paliwal, 1974
<i>Hyosoyamus niger</i> L.	henbane	Best, 1968
<i>Ipomoea congesta</i> R. Br.*	blue morning-glory	Cho et al., 1986

<i>Ipomoea hederacea</i>	---	Sakimura, 1961
'Superba' (L.) Jacq.	---	Gardner and Whipple, 1934
<i>Lactuca sativa</i> L.*	lettuce	Snyder and Thomas, 1936
<i>Lactuca sativa</i> var. <i>capitata</i> L.*	---	Tompkins and Gardner, 1934
<i>Lactuca sativa</i> var. <i>longifolia</i> Lam.*	romaine	Milbrath, 1939
<i>Lactuca scariola</i> L.	---	Snyder and Thomas, 1936
<i>Lathyrus odoratus</i> L.	sweet pea	Gardner et al., 1935
<i>Layia elegans</i> Torr. & Gray	---	Cho et al., 1986
<i>Leonotis nepetaefolia</i> R. Br.*	lion's ear	Best, 1968
<i>Lilium tigrinum</i> Ker-Gawl.	tiger lily	Cho et al., 1986
<i>Limonium latifolium</i> (Sm.) Ktze.	statice	Smith, 1957
<i>Lobelia</i> sp.	---	Gardner and Whipple, 1934
<i>Lupinus albus</i> L.	lupine	Smith, 1932
<i>Lupinus angustifolius</i> L.	---	Smith, 1957
<i>Lupinus leucophyllus</i>	---	Best, 1968
Dougl. ex Lindl.	---	Smith, 1957
<i>Lychnis coronaria</i> (L.) Desr.	dusty miller	Brittlebank, 1919
<i>Lycium ferocissimum</i> Miers	matrimony-vine	Smith, 1944
<i>Lycopersicon esculentum</i> Mill.*	tomato	Hutton and Peak, 1949
<i>Lycopersicon hirsutum</i> HBK.	---	Sakimura, 1940
<i>Lycopersicon peruvianum</i> (L.) Mill.	---	Best, 1968
<i>Lycopersicon pimpinellifolium</i>	---	Sakimura, 1961
(Jusl.) Mill.	---	Best, 1968
<i>Malcomia maritima</i> R. Br.	Virginia stock	Milbrath, 1939
<i>Malva nicaeensis</i> All.	mallow	Best, 1968
<i>Malva parviflora</i> L.*	cheeseweed	Gardner and Whipple, 1934
<i>Malva rotundifolia</i> L.	common mallow	Cho et al., 1986
<i>Marrubium vulgare</i> L.	hoarhound	Cho et al., 1986
<i>Martynia annua</i> L.	---	Best, 1968
<i>Medicago polymorpha</i> L.	bur clover	Best, 1968
<i>Melilotus officinalis</i> (L.) Lam.*	yellow sweet clover	Best, 1968
<i>Mesembryanthemum</i> sp.	tricolor ice plant	Best, 1968
<i>Montia</i> sp.	---	Best, 1968
<i>Myosotis alpestris</i> Schmidt	forget-me-not	Milbrath, 1939
<i>Nepeta cataria</i> L.	catnip	Francki and Grivell, 1970
<i>Nerium oleander</i> L.	oleander	Gardner and Whipple, 1934
<i>Nicandra physalodes</i> (L.) Gaertn.*	apple of Peru	Gardner and Whipple, 1934
<i>Nicotiana acuminata</i>	---	Gardner and Whipple, 1934
(R. C. Grah.) Hook.	---	Gardner and Whipple, 1934
<i>Nicotiana alata</i> Link & Otto	jasmine tobacco	Best, 1968
<i>Nicotiana angustifolia</i> Mill.	---	Smith, 1957
<i>Nicotiana atropurpureum</i> Hort.	---	Gonsalves and Trujillo, 1986
<i>Nicotiana benthamiana</i> Domin	---	Smith, 1957
<i>Nicotiana bigelovii</i> (Torr.) S. Wats.	---	Best, 1968
<i>Nicotiana bonariensis</i> Lehm.	---	Smith, 1957
<i>Nicotiana calyciflora</i>	---	Best, 1968
<i>Nicotiana caudigera</i> Phil.	---	Smith, 1957
<i>Nicotiana chinensis</i> Fisch.	---	Best, 1968
<i>Nicotiana debneyi</i> Domin	---	Best, 1968
<i>Nicotiana etigua</i>	---	Best, 1968
<i>Nicotiana glauca</i> Graham	tree tobacco	Smith, 1932
<i>Nicotiana glutinosa</i> L.	---	Smith, 1932
<i>Nicotiana goodspeedii</i> Wheeler	---	Best, 1968
<i>Nicotiana langsdorffii</i> Weinm.	---	Gardner and Whipple, 1934

<i>Nicotiana longiflora</i> Cav.	long-flowered tobacco	Smith, 1957
<i>Nicotiana macrophylla</i> Spreng.	---	Best, 1968
<i>Nicotiana maritima</i> Wheeler	---	Best, 1968
<i>Nicotiana nudicaulis</i> S. Wats.	---	Costa and Forster, 1942
<i>Nicotiana paniculata</i> L.	---	Smith, 1957
<i>Nicotiana plumbaginifolia</i> Viv.	---	Best, 1968
<i>Nicotiana rustica</i> L.	wild tobacco	Smith, 1932
<i>Nicotiana sanderae</i> W. Wats.	---	Gardner and Whipple, 1934
<i>Nicotiana solanifolia</i> Walp.	---	Best, 1968
<i>Nicotiana suaveolens</i> Lehm.	---	Smith, 1957
<i>Nicotiana sylvestris</i> Spegaz. & Comes	---	Smith, 1957
<i>Nicotiana tabacum</i> L.	Turkish tobacco	Smith, 1931
<i>Nicotiana tomentosiformis</i> Goodspeed	---	Best, 1968
<i>Nicotiana undulata</i> Ruiz & Pav.	---	Best, 1968
<i>Nicotiana wigandioides</i> Koch & Fint	---	Best, 1968
<i>Oenothera</i> sp.	evening primrose	Best, 1968
<i>Papaver nudicaule</i> L.	Iceland poppy	Best, 1968
<i>Papaver orientale</i> L.	oriental poppy	Gardner et al., 1935
<i>Papaver</i> sp.	poppy	Smith, 1957
<i>Penstemon hirsutus</i> (L.) Willd.	bread-tongue	Gardner et al., 1935
<i>Peonia</i> sp.	peony	Smith, 1957
<i>Petunia hybrida</i> Vilm.	petunia	Gardner and Whipple, 1934
<i>Petunia</i> sp.	petunia	Smith, 1932
<i>Phaseolus vulgaris</i> L.	snap bean	Smith, 1957
<i>Phlox drummondii</i> Hook.	phlox	Best, 1968
<i>Physalis peruviana</i> L.	cape gooseberry	Best, 1968
<i>Physalis pubescens</i> L.	husk tomato	Gardner and Whipple, 1934
<i>Pisum sativum</i> L.	garden pea	Snyder and Thomas, 1936
<i>Plantago major</i> L.	broad-leaved plantain	Smith, 1932
<i>Polygonum convolvulus</i> L.	---	Smith, 1957
<i>Polygonum</i> sp.	jointweed	Smith, 1957
<i>Portulaca oleracea</i> L.*	purslane	Allen et al., 1983
<i>Primula malacoides</i> Franch.	fairly primrose	Smith, 1957
<i>Primula obconica</i> Hance	---	Gardner et al., 1935
<i>Primula sinensis</i> Lindl.	Chinese primrose	Smith, 1957
<i>Primula</i> sp.	primrose	Best, 1968
<i>Quamoclit coccinea</i> 'Hederifolia' L.	star ipomoea	Sakimura, 1961
<i>Ranunculus</i> sp.	buttercup	Smith, 1957
<i>Salpiglossis sinuata</i> Ruiz & Pav.	painted tongue	Gardner and Whipple, 1934
<i>Salvia splendens</i> Ker-Gawl.	scarlet sage	Gardner et al., 1935
<i>Saponaria officinalis</i> L.	bouncing bet	Best, 1968
<i>Saxifraga</i> sp.	rockfoil	Best, 1968
<i>Scabiosa</i> sp.	mourning bride	Smith, 1957
<i>Schizanthus pinnatus</i> Ruiz & Pav.	pincushion flower	Gardner and Whipple, 1934
<i>Senecio cruentus</i> (Mass.) DC.	---	Gardner and Whipple, 1934
<i>Senecio jacobea</i> L.	tansy ragwort	Allen et al., 1983
<i>Sinningia speciosa</i> (Lodd.) Hiern.	gloxinia	Gardner et al., 1935
<i>Solanum aculeatissimum</i> Jacq.	cockroach berry	Smith, 1932
<i>Solanum capsicastrum</i> Link	---	Smith, 1931
<i>Solanum dulcamara</i> L.	bittersweet	Smith, 1932
<i>Solanum laciniatum</i> Ait.	---	Smith, 1931
<i>Solanum marginatum</i> L.	---	Smith, 1932

<i>Solanum melongena</i> L.	eggplant	Smith, 1932
<i>Solanum miniatum</i> Bernh. ex Willd.	---	Smith, 1957
<i>Solanum nigrum</i> L.	black nightshade	Smith, 1931
<i>Solanum nodiflorum</i> Jacq.	---	Smith, 1931
<i>Solanum sanitwongsei</i> Craib.	---	Smith, 1957
<i>Solanum seforthianum</i> Andr.	---	Smith, 1957
<i>Solanum sodomium</i> Hort. ex Dun.	apple of Sodom	Smith, 1957
<i>Solanum triflorum</i> Nutt.	---	Allen et al., 1983
<i>Solanum tuberosum</i> L.	potato	Smith, 1931
<i>Sonchus oleraceus</i> L.*	sowthistle	Best, 1968
<i>Spinacia oleracea</i> L.	spinach	Sakimura, 1940
<i>Stachys arvensis</i> L.	staggerweed	Greber and McCarthy, 1977
<i>Stellaria media</i> (L.) Cyrill.*	chickweed	Holmes, 1948
<i>Streptosolen jamesonii</i> Miers	---	Smith, 1957
<i>Tagetes minuta</i> L.	marigold	Best, 1968
<i>Trachelium caerulea</i> L.	---	Best, 1968
<i>Trachelium</i> sp.	throatwort	Best, 1968
<i>Trachymene caerulea</i> R. C. Grah.	---	Best, 1968
<i>Tribulus terrestris</i> L.	---	Allen et al., 1983
<i>Trifolium repens</i> L.	white clover	Paliwal, 1974
<i>Trifolium subterraneum</i> L.	---	Helms et al., 1961
<i>Tropaeolum majus</i> L.*	nasturtium	Best, 1968
<i>Tropaeolum</i> sp.	nasturtium	Best, 1968
<i>Troximon</i> sp.	---	Best, 1968
<i>Urtica dioica</i> L.	nettle	Gardner and Whipple, 1934
<i>Verbena hybrida</i> Voss	verbena	Gardner et al., 1935
<i>Verbena litoralis</i> HBK.	oi	Cho et al., 1984, 1986
<i>Verbena</i> sp.	---	Best, 1968
<i>Verbesina encelioides</i> (Cav.) Benth. & Hook.*	golden crown-beard	Cho et al., 1984, 1986
<i>Vicia faba</i> L.	broad bean	Best, 1968
<i>Vigna sinensis</i> Endl.	cowpea	Paliwal, 1974
<i>Vinca rosea</i> L.	Madagascar periwinkle	Paliwal, 1974
<i>Xanthium saccharatum</i> Wallr.*	cocklebur	Cho et al., 1986
<i>Zantedeschia aethiopica</i> Spreng.	common calla lily	Best, 1968
<i>Zinnia elegans</i> Jacq.	zinnia	Best, 1968

*Important TSWV reservoir hosts associated with Hawaii's vegetable-growing regions.

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