

**NPAG DATA: *CUSCUTA JAPONICA*
JAPANESE DODDER**

Draft - November 1, 2001

TAXONOMY:

Phylum: Embryophyta
Class: Dicotyledoneae
Order: Polemoniales
Family: Cuscutaceae

According to some sources (Gleason & Cronquist, 1963; Reed & Hughes, 1977), the Genus *Cuscuta* is in the Family Convolvulaceae.

Full Name: *Cuscuta japonica* Choisy
Synonyms: *Monogynella japonica* (Hadac & Chrtek, 1970)
Common Name: Japanese dodder (Clemson, 2001)

US DETECTION DATA:

Location: Houston, TX (Near but *not* in Wholesale Nursery - US Trees)
Date: Unspecified date of initial collection
Host: (Possibly weeds near fence)
Collector: Cynthia Heintze, IPM Coordinator, Field and Fleet Operations
Houston Parks and Recreation, 2999 S. Wayside
Houston, TX 77023 (713) 742-1413
Initial Identifier: Rodney Young, USDA-APHIS-PPQ
Bldg. 580, BARC-E
Beltsville, MD 20705 (301) 504-8605
Confirming Identifier: Dr. Lytton Musselman, Department of Biological Sciences
Old Dominion University
Norfolk, VA 23529-0266
Iden. Date: 2001(?)

Note: Subsequent detections (data is uncertain) are in the immediate area:

- Hobby Area Apartment ornamental beds Contact: Dea Clemons
- Hobby Area Broadway McDonald's and Walgreen's
- Hobby Area Bellfort and Glenn Valley
- SE of Hobby Area 9738 Buena Park

Three previous introductions of Japanese dodder have occurred (Clemson Univ., 2001):

- 1941 San Antonio, TX *Pueraria* inside a greenhouse
- 1943 Quincy, FL (Gadsen County) On *Pueraria*
- 1971 Clemson University, SC *Pueraria* (kudzu) in the Horticultural Gardens

Apparently, all these introductions were eradicated (Check Floridata, 2001).

QUARANTINES:

Seeds of *Cuscuta* species are commonly intercepted contaminants of commercial seed shipments entering the United States. Currently, any seed shipment found to contain seed of any dodder is denied entry and the commodity is either devitalized or returned to the country of origin. These procedures are followed despite the fact that many species of *Cuscuta* are native to the United States (Knepper *et al.*, 1990).

In 1978, the ARS (Agricultural Research Service) translated a Russian manual, *A Handbook of Pests, Diseases, and Weeds of Quarantine Significance*; this manual mentioned eleven dodders. *A Geographical Atlas of World Weeds* mentions 48 species of *Cuscuta*, including *C. japonica*. Presumably, other countries will monitor or deny the entry of our seed, especially certified seed for planting, if there is a possibility of contamination by this dodder.

This dodder is listed as an invasive weed by the following sources:

- Federal Noxious Weed List
http://www.aphis.usda.gov/ppq/permits/noxiousweed_list.html
- Uva, R. H., Neal, J. C., & DiTomaso. 1997. *Weeds of the Northeast*. Cornell Univ. Press
- Various State Noxious Weed Laws USDA Natural Resources Conservation Service
http://plants.usda.gov/earl=plant_search.cgi&Go.x=7&Go.y=11
<http://www.aphis.usda.gov/ppq/weeds/>

LIFE HISTORY:

Dodder affects the growth and yield of infected plants. Losses range from slight to complete destruction of the crop in infected areas (Agrios, 1997).

The germinating seed produces a slender, yellowish shoot. This leafless shoot rotates as if searching for a host. If contact is *not* made with a susceptible plant, death occurs. If contact is made, the shoot encircles and then sends haustoria into the susceptible host. Penetrating into the vascular tissues of the host, the haustoria absorb food materials and water (Agrios, 1997).

Soon after dodder contacts its host, the base of the dodder shrivels and dies. Without contact with the ground, the dodder continues to grow and expand; the twisting tips of the dodder reach out and attack adjacent plants. Thus, the infection spreads from plant to plant, forming patches of infected plants (Agrios, 1997).

While growing and expanding from plant to plant, dodder completes its reproductive cycle (Agrios, 1997). *C. japonica* flowers August through October (Reed & Hughes, 1977). After flowering, seeds are produced. The seeds fall to the ground where they either germinate immediately or remain dormant until next season (Agrios, 1997).

Description of Plant: Japanese dodder is a parasitic annual that is rather fleshy and glabrous (smooth). The stems are terete (circular in cross section) and much-branched. The stem color is pale yellow with red spots and striations. The scale-like, deltoid leaves are 2 mm long (Reed & Hughes, 1977).

Description of Flower: The flowers are sessile (directly on the stem) or on very short pedicels (flower stalks). The rather numerous, pale-yellow flowers are in short, dense axillary spikes (Reed & Hughes, 1977).

Calyx segments are elliptic to orbicular, erect, rounded at the apex, and 1 mm in length. The corolla is campanulate (bell-shaped), fleshy, 5-lobed, and 3.5 to 4 mm. The lobes are oblong (Reed & Hughes, 1977).

Description of Fruit: The capsules are ellipsoid-ovoid, about 4 mm in length. At first, the capsules are enveloped in a persistent corolla, but they are naked when ripe. The capsules are circumscissile, that is, they open by a transverse circular split (Reed & Hughes, 1977).

Description of Seed: The seeds are 2.5 to 3 mm in length and 2 to 3 mm in diameter. Various dented, the color of the seeds is from pale straw to blackish (Reed & Hughes, 1977).

Seed Survival: The seeds of *Cuscuta* have no specialized germination requirement to ensure that they germinate only in the presence of a host. A proportion of the seeds do, however, have a dormancy, based on an impervious hard seed coat which ensures that they germinate over a long period and so run little risk of all germinating simultaneously when there might happen to be no host available (Parker and Richie, 1993).

Seeds of *Cuscuta* are capable of long survival, up to 50 years or more in dry storage, depending on the species, and at least 10 years in the field (Parker and Richie, 1993). According to Chrték and Osbornová (1991), longevity of buried seed in the soil may reach two decades.

Overwintering: Dodder overwinters in two ways: (1) by seed which remains dormant until spring and (2) by established stems on perennials (Chrték & Osbornová, 1991; Heald, 1943).

Dodder seed overwinters in infested fields or mixed with the seed of crop plants (Agrios, 1997).

Habitat: This dodder occurs in lowlands or low mountains (Reed & Hughes, 1977).

Dispersal: Dodder seed may be spread to nearby areas by animals, water, equipment, and other means. Long-distance dispersal is by contaminated crop seed (Agrios, 1997; Musselman, 1989).

Morphology and Identification: Tererkhin and Kotov (1988) compared embryo development of *C. japonica* with that of *C. lehmanniana*, *C. convallariifolia*, *C. europea*, and *C. australis*. Their article presents diagrams to illustrate the development of the microsporangia and pollen grains, fertilization and seed formation (including endosperm development), early stages of embryogenesis, and the formation of the seed coat. Their article also illustrates structures of the ripened seed coat for all five species; these structures are important for studying the systematics of the Family Cuscutaceae.

Chapter 5 in *Parasitic Weeds of the World: Biology and Control* (Parker & Riches, 1993) contains a key and detailed descriptions of various dodder species. This key divides the Genus *Cuscuta* into three Sections:

- | | |
|--|------------------|
| 1. One style, supporting two stigmas | Section Monogyna |
| 2. Two styles, stigmas linear, without knobs | Section Cuscuta |
| 3. Two styles, capitate, with knobs | Section Grammica |

Cuscuta japonica is in Section Monogyna. Section Monogyna is distinguished by seeds over 2 mm, testa cells not collapsed and scar area rectangular. Within this section, two species are separated as follows (Knepper, Creager, & Minn, 1990; Parker & Riches, 1993);

- | | |
|--|-------------------------|
| 1. Hilum hidden, scar area narrow-rectangular and sunken | <i>Cuscuta monogyna</i> |
| 2. Hilum exposed, scar area square and flush with seed surface | <i>Cuscuta japonica</i> |

Based on seed coat morphology, a table exists that will differentiate the Sections/Subgenera *Cuscuta*, *Grammica*, and *Monogyna* (Knepper, Creager, & Musselman, 1990).

Based on morphological characteristics, Guo and Li (2000a) suggest that this dodder can be divided into two varieties.

HOSTS:

Parker and Riches (1993) note that both woody and herbaceous hosts are attacked.

In Taiwan, *C. japonica* var. *formosa* is associated with at least 36 host species, attacking a number of orchard fruits and other crops (Kuoh & Chiang, 1989).

A survey along the Okhotsk coast of NE Hokkaido revealed that Japanese dodder parasitized a total of 32 different species of wild plants belonging to 30 genera of 16 families, as well as 7 crop

species. Potato and eggplant, on which this dodder showed moderate growth, were among the crop species. This dodder showed moderate, though limited, vigor on pumpkin, *Cucurbita moschata*. On soybeans, this dodder was relatively weak (Zaroug & Ito, 1988).

According to various sources, this dodder parasitizes the following species:

<i>Cucurbita moschata</i>	Pumpkin	Zaroug & Ito,1988 (Moderate vigor)
<i>Glycine max</i>	Soybean	Zaroug & Ito,1988 (Limited vigor)
<i>Nicotiana tabacum</i>	Tobacco	Cui, Li, and Hua, 1999; Liu, 1992
<i>Pueraria lobata</i>	Kudzu	Clemson Univ., 2001
<i>Salix purpurea</i>	Purple osier	Huang <i>et al.</i> , 1991
<i>Solanum melongena</i>	Eggplant	Parker & Riches, 1993; Zaroug & Ito,1988
<i>Solanum tuberosum</i>	Potato	Parker & Riches, 1993; Zaroug & Ito,1988

According to various sources, this dodder does *not* parasitize the following species:

<i>Cucumis sativus</i>	Cucumber	Parker & Riches, 1993; Zaroug & Ito,1988
<i>Lycopersicon esculentum</i>	Tomato	Parker & Riches, 1993; Zaroug & Ito,1988
<i>Pisum sativum</i>	Pea	Parker & Riches, 1993; Zaroug & Ito,1988
<i>Trifolium pratense</i>	Clover	Parker & Riches, 1993; Zaroug & Ito,1988
<i>Zea mays</i>	Maize	Zaroug & Ito,1988 (5-7 day survival)

DISTRIBUTION:

Europe: France (Holm *et al.*, 1979) (Possibly eradicated)

Asia: China (incl. Hong Kong, Manchuria, Taiwan), Korea, Japan, Russia (Amur, E. Siberia) (Liao, Chen, & Kuoh, 2000; Reed & Hughes, 1977)

N. America: U. S. A. (Introduced: TX)

Note: After being introduced to several States, this dodder was eradicated: FL, SC, TX (Do Reed & Hughes, 1977, indicate a US infestation? Also see Floridata, 2001.)

DAMAGE WHERE ESTABLISHED:

Parker and Riches (1993) include this dodder in their listing of “The Main *Cuscuta* Species.” In their discussion on *Cuscuta japonica*, they note that this dodder is “locally important in China and Japan, but not well documented.”

Reed and Hughes (1977) mark the Japanese occurrence of *Cuscuta japonica* with an asterisk which indicates a serious weed undergoing control efforts.

METHODS OF CONTROL:

For dodder control by mechanical means, Parker and Riches (1993) discuss the following methods: hand-pulling, rotation, land preparation, time of planting, method of planting, post-planting cultivations, fertilization, mixed cropping, solarization, mowing, and fire. For dodder control by chemical means, Parker and Riches discuss the following methods: fumigants, herbicides to prevent establishment, and herbicides to control established dodder. In addition, besides discussing resistant and tolerant varieties, Parker and Riches discuss biological control by insects and by pathogens. Finally, Parker and Riches discuss integrated control of dodder.

Prevention of Infestation: Dodder is best controlled by preventing its introduction into a field: (1) by the use of dodder-free seed, (2) by cleaning all equipment before removing the equipment from dodder-infested fields, (3) by limiting the movement of domestic animals from dodder-infested to dodder-free fields (Agrios, 1997; ARS, 1978; Parker & Riches, 1993).

Burning is the best method for destroying dodder (1) growing in pastures, meadows, and nonagricultural lands, (2) growing in patches in commercial and vegetable crops, and (3) overwintering in post-harvest remnants (ARS, 1978).

Control of Scattered Infestations: If dodder is present in a field in scattered infestations, the dodder may be sprayed early in the season with contact herbicides, or cut, or burnt. Herbicide treatments and cutting and burning of patches kill both dodder and host plants; however, the dodder is prevented from spreading and from producing seed (Agrios, 1997; ARS, 1978).

Control of Widespread Infestations: If dodder is widespread in a field, the dodder may be controlled by frequent tillage, flaming, and use of herbicides that kill the dodder plant upon its germination from the seed, before the dodder becomes attached to its host (Agrios, 1997).

As control measures for dodder, crop rotation and crop rotation with clean fallow are effective (ARS, 1978),

When infestations are severe, fields should be fallowed after eradication measures are completed. Afterwards, a five-year rotation is recommended (Heald, 1943).

Eradication Strategy in South Carolina: The following strategy was used to eradicate the infestation in South Carolina (Clemson, 2001):

- I. Vegetation Control
 - A. Cultural Control Removal of all *Cuscuta* vegetative mats
 - B. Chemical Control Use of herbicides, Glyphosate and/or Dacthal, to kill all host and parasitic vegetation within the infested site, thus preventing further seed production.

II. Controlled Burn

Post-senescence After senescence of the treated vegetation, a controlled burn, done thoroughly, to clear the site of all remaining vegetation and kill all dodder seed lying on the soil surface.
Controlled Burn

III. In-Soil Seed Destruction

A. Fumigation Fumigation with methyl bromide, applied under a soil tarp, to kill dodder seed in the soil.

B. Soil Sterilization

1. Propane-torching Use of a tractor-mounted scarifier (?) with a propane torch to destroy subsurface seed
2. Use of Vapam Application of Vapam as a soil drench
3. Use of Basamid Application of granular Basamid to the soil surface

IV. Site Monitoring

Periodic surveys which are required to assess the eradication effort and to ensure eradication

PERTINENT POINTS/PREDICTED CONSEQUENCES:

Survival in North America: Gleason and Cronquist (1963) note that several European dodders are established in the United States: *C. epithymum*, chiefly parasitic on species of legumes, occurs throughout much of the United States; *C. epilinum*, parasitic on flax, commonly occurs wherever flax is grown; *C. europaea* is established in various locations in the eastern United States. Presumably, *C. japonica* will be able to establish itself as easily as these European species, because of its extensive host range and adaptation to a similar climate. Its previous establishment in several States (FL, SC, TX) supports this ease of establishment.

Factors that will affect survival in North America are (1) the similarity of climatic zones in North America to the climatic zones in the Far East and (2) the presence of a suitable host or hosts.

Climatic Zones: According to various sources (Guo & Li, 2000a; Liao, Chen, & Kuoh, 2000; Reed and Hughes, 1977; Zaroug & Ito, 1988), the range of this dodder in the Orient includes China (Taiwan, Hong Kong, Manchuria), Japan, Korea, and Russia (Amur and E. Siberia). This range indicates an ability to thrive in regions with the following Climatic Zones (Walter, 1977; Walter, Harnickell, & Mueller-Dombois, 1975):

- | | | |
|-------------|---------------------------------|----------------------|
| • Zone II | Subtropical Climatic Zone | Taiwan |
| • Zone V | Warm Temperate Climatic Zone | Kyushu, Japan |
| • Zone V-VI | An Intermediate Climatic Zone | Honshu, Japan |
| • Zone VI-V | An Intermediate Climatic Zone | Korea |
| • Zone VI | Typical Temperate Climatic Zone | Honshu, Japan; Korea |

Based on its range in the Orient, this dodder should be able to survive in all of the eastern United States, which is mostly in the Warm Temperate Climatic Zone and in the Typical Temperate Climatic Zone in the eastern United States. (See accompanying maps.)

Suitable Hosts: Host crops of this dodder are commonly grown in the United States (*see* Hosts). Many native plants are in the genera named.

Common weeds will probably serve as hosts. As one example, kudzu (*Pueraria lobata*) is a known host (Clemson Univ., 2001). As another example, because eggplant, potato, and tobacco are hosts (Liu, 1992; Parker & Richie, 1993) and all in the Family Solanaceae, there is a possibility that perennial species in the Family Solanaceae may serve as overwintering wild hosts. At least ten species of *Solanum* are native to the United States (Gleason & Cronquist, 1963):

<i>Solanum dulcamara</i>	Bittersweet	From Eurasia; naturalized in northeastern US; perennial
<i>S. nigrum</i>	Black nightshade	Cosmopolitan
<i>S. sarrachoides</i>		Native of South America; widely introduced
<i>S. triflorum</i>		Native of western United States
<i>S. jamesii</i>	Wild potato	Native of southwestern United States; perennial
<i>S. rostratum</i>	Buffalo-bur	Native of Great Plains; introduced westward
<i>S. citrullifolium</i>		Native of United States; Iowa and Kansas to Mexico
<i>S. sisymbriifolium</i>		Native of South America; weed in southern US
<i>S. carolinense</i>	Horse-nettle	Native of southeastern US, now widespread; perennial
<i>S. elaeagnifolium</i>	Wild potato	MO and KS to TX and AZ; perennial

According to Gleason and Cronquist (1963), other species in the Family Solanaceae are found in the northeastern United States: one species in *Nicandra*, ten species in *Physalis*, one species in *Lycium*, one species in *Hyoscyamus*, two species in *Datura*, one species in *Nicotiana*, two species in *Petunia*.

Host Range: Chrtek & Osbornova (1991) note that most dodder species are not strictly confined to a particular taxonomical, morphological, or ecological group of plants. Apparently, this is the case with this dodder. (*See* Hosts.)

Identification Problems: Seed characteristics are not distinct enough to permit easy determination of species within *Cuscuta* (Knepper *et al.*, 1990). The species of *Cuscuta* are cosmopolitan and difficult to distinguish through identification of seed or stem propagules; therefore, all should be prohibited entry into the United States (Ritchie, 1981). (Is this the standard operating policy at the ports?)

Use as a Herb: *Cuscuta japonica* is frequently mentioned as a medicinal herb (Floridata, 2001; Medboo, 2001). The (viable?) seeds of Japanese dodder may be sold under various name: “Semen Cuscutae,” “Dodder Seed Semen,” “Cuscutae,” or “Tu Si Zi” (Healthlink, 2001; Medboo, 2001).

According to the Medboo (2001) website, this herb is the ripe seed of *Cuscuta chinensis* Lam. or *C. japonica* Choisy, annual parasitic herbs of the Family Convolvulaceae. The seed is collected in autumn after ripening, dried in the sun, and used unprepared or boiled after the removal of impurities. Sweet in flavor, warm in nature, the herb acts on the liver, kidney, and spleen meridians. Being sweet, moist, and warm in nature, it functions in tonifying (?) both kidney yang and yin, nourishing the liver, and improving vision.

Dodder as a Vector of Pathogens: *Cuscuta japonica* has been used to transfer plant pathogens from one host to another (Zhang *et al.*, 1991). However, this transfer of pathogens may only be a minor problem in the field.

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