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Weed Hosts of the Cotton Whitefly (*Bemisia tabaci* (Genn.)) Homoptera Aleyrodidae

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WEED HOSTS OF THE COTTON WHITEFLY (BEMISIA TABACI (GENN.)) HOMOPTERA ALEYRODIDAE

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Introduction

Weeds delimit production of food and feed crops by direct competition for the essentials of growth such as light, water, and mineral nutrients. They also reduce land use efficiency because crop production costs are increased through cultivation, mowing, and spraying. Poisonous weeds in pasture or forage crops reduce animal production through death or ill health. Aquatic weeds reduce efficiency in irrigation systems through evapotranspiration as well as from reduction of the flow of water.

Weeds also exert their adverse effects on food and feed crops by harboring pests and disease organisms which attack crop plants. These pests and disease organisms may survive unfavorable conditions, reproduce, and build up to high populations on weed species which provide them food, shelter, and reproductive sites in the absence of host crop plants. The recognition and control of weeds--such as those that harbor pests and disease organisms--may prevent an outbreak of a pest or a disease in addition to eliminating competition of the weeds with the crop. One of the most serious of these pests in the Sudan is the cotton whitefly.

Damage and Economic Importance

The cotton whitefly has a limiting effect on cotton yields in several ways. Large numbers of whitefly larvae and adults, in feeding on the cotton plants, remove nutrients and reduce plant moisture content. This results in a reduction of plant growth rate leading to less lint yield and poorer lint quality.

While feeding, the cotton whitefly secretes "honeydew" which is a sticky liquid rich in carbohydrates. In severe infestations, honeydew covers the upper and lower leaf surfaces and drops on the cotton bolls, causing lint contamination. Molds (Cladosporium sp.) sometimes grow on honeydew, giving the plant a blackened appearance.

Although there is not a definite estimate of cotton yield and quality losses due to whitefly infestations in the Sudan's cotton growing schemes, Joyce (16), Proctor (28), and Mound (25) agreed that the loss in cotton yields and lint quality can be a serious threat to cotton production and the Sudanese economy, since cotton is the major export crop. According to them, heavy whitefly infestations decrease plant height, increase leaf drop, reduce number of bolls picked, and reduce weight per boll, thus reducing total yield, seed weight, and lint quality.

Elsewhere, Hummer (15) reported that in the cotton growing areas of Cukurova, Turkey, heavy whitefly infestations in 1974 and 1975 caused an 80% yield loss. In Pakistan, Wajeh (35) reported that the loss in cotton yields due to whitefly infestations amounted to 8 to 15%.

The cotton whitefly, in addition to its direct effect on reducing cotton yields and lint quality, transmits the virus that causes cotton leaf curl disease. This disease has a debilitating effect on cotton plants, causing a reduction in the leaf area and numbers of fruit buds and shedding of the leaves and buds. Thus, a lower number of bolls per plant is produced, plus a

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lower weight of seed and lint, a reduction in the length of the lint, and a general deletericus effect on the quality and grade of the lint produced (30). The virus was transmitted from infected cotton plants, and other malvaceous crop plants or weeds after whiteflies fed for only 3 hours. Carrier whiteflies remained capable of transmitting infection throughout their life cycle.

Rao et al. (29) reported that the cotton whitefly was the vector of the virus which caused yellow mosaic and leaf distortion of peanuts. Mariappan and Narayanasamy (21) found that tobacco leaf curl virus, which was hosted by the weeds Acanthospermum hispidium, Blainvillae rhomboridae, and Flaveria australasica, was transmitted from these hosts by the cotton whitefly. They indicated that these weeds could serve as sources of infection in the field.

The cotton whitefly is also a vector of the cotton leaf crumple virus (19). Mali (20) also described a new virus disease of cotton, on the basis of symptoms and transmission, as being the same disease as that caused by Abutilon infectious variegation virus transmitted by the whitefly.

Lana and Taylor (17) identified the cotton whitefly as one of the most important insect vectors of the okra mosaic virus in Nigeria. Granillo et al. (12) isolated a virus from kenaf (Hibiscus cannabinus) which was transmissible by the cotton whitefly to cotton and the weed Datura stramonium.

Costa et al. (6) reported that the development of large populations of whitefly on cotton, beans, and soybeans greatly increased the incidence of the virus diseases transmissible by this insect. These diseases included golden and dwarf mosaic diseases of beans and dwarf mosaic disease of soybeans.

It was reported from Sudan and Chad that cotton mosaic disease is another virus disease transmissible by whiteflies (3). Lourens (18) indicated that this virus disease originated from crop plants and weeds growing in village gardens or on fallow land.

Life Cycle, Distribution, and Occurrence

The life cycle of the cotton whitefly in the Sudan cotton fields varies from 2 to 6 weeks depending on temperatures. Schultz and Muddathir (31) reported that the average duration of the egg stage in the field in October was from 6 to 9 days and in November from 8 to 12 days. The egg to adult period in October was from 20 to 26 days and in November from 24 to 27 days. The rate of egg laying was higher when the temperatures were above 30 C and much lower when temperatures were below 25 C (30).

Eggs hatch in 4 to 10 days into active six-legged crawlers. The crawlers have beaks which they insert into the cotton leaf and begin sucking the sap. The adult whiteflies are small, moth-like, four-winged insects, about 2 mm long, which feed by sucking sap. They live for about 2 to 3 weeks and are active in warm or hot, still air but take shelter from cold, dry air and wind (16).

Actively growing leaves are preferred as feeding places, but in serious infestations some adults, nymphs, and eggs are found in the lower branches of the plant. Feeding of all stages occurs mostly on the under side of the leaf as the upper cuticle is difficult to penetrate. Feeding is by means of stylets, which are inserted through the stomates and intercellular spaces into the phloem. While feeding, whiteflies produce honeydew which causes damage and discoloration of the cotton lint. Whitefly feeding also accelerates loss of chlorophyll and development of anthocyanin pigment in cotton leaves (27).

The cotton whitefly thrives best under tropical and subtropical weather conditions. It has been reported as a pest of cotton, tobacco, soybeans, beans, and vegetable crops in many of the countries that grow these crops. Some of these countries are India, Iraq, Iran, Taiwan, Nigeria, Egypt, Uganda, and Pakistan.

In Sudan, the cotton whitefly is found in all cotton growing areas and is always abundant on cotton in Gezira and Khashm Elgirba schemes. This is mainly because of the numerous alternative host plants--both crop plants and weeds--that are available in these schemes throughout the year. These schemes, being irrigated and under intensive cropping systems of cotton, peanuts, sorghum, and vegetables--all of which are preferred host crop plants--offer favorable environments for the continued breeding of the insect. The presence of irrigation water in the fields and in irrigation canals also encourages development of high levels of weed populations which serve as alternative hosts and breeding sites for the insect.

Control Measures

Cotton whiteflies are generally difficult to control because all developmental stages are present in an infestation, the immature stages are very small, the life cycle is short, and, probably most importantly, there is a large number of weed host plants. Since whiteflies can feed and breed on a large number of crop and weed hosts, most of the control measures reported in the literature are of an integrated nature, combining cultural, chemical, and biological approaches.

In the cotton growing areas of Sudan, an integrated control system has recently been recommended (8) because reliance on insecticides as the main control measure failed to give adequate control. The chemicals in use were mainly organochlorines (endosulfan, DDT, and toxaphene) or organophosphates (azodrin, dimethoate, and methylparathion). The failure of the chemicals used in giving adequate control has been attributed to the neglect of other supporting control measures, such as adequate control of weed hosts, adoption of crop rotations that exclude planting of other host crop plants in the vicinity of cotton fields, and suspected insecticide resistance in the cotton whitefly. The suggested control program includes appropriate crop rotation schedules, efficient weed control practices, and the development of cotton varieties which are resistant to whitefly infestations and to the viruses for which the whitefly is a vector.

Monsef and Kashkoole (23) in Iran reported that an integrated control program that involved weed control, avoidance of growing watermelons and tomatoes in the vicinity of cotton crops, and chemical treatment with endosulfan or dimethoate gave the best results to control whiteflies.

Habibi (13) showed that the control of weeds such as Convolvulus and Althea sp. should form an important part of whitefly control programs. This is because these weed species offer a feeding and breeding site for the whitefly nymphs and larvae from which they migrate to cotton. In years of heavy infestations, he recommended early sowing of cotton to provide a harvest while the whitefly was still on other host plants; cultural measures such as fertilizing, irrigating, and controlling weeds to promote vigorous and early growth; the destruction of infested melon leaves after harvest; and chemical sprays with endosulfan or dimethoate.

Costa et al. (6) in Brazil attributed the spread of the virus diseases, for which the whitefly is a vector, to the large increase in whitefly populations. The whitefly populations increased because of the numerous weed and crop hosts, the long soybean planting season (November-January), and the long hot summer. To control these diseases, they thought the soybean planting season should be restricted, that work on the control of the whitefly should be intensified, and the breeding of virus resistant varieties of beans, soybeans, and cotton should be increased.

Falcon (10) in Nicaragua recommended an integrated control system consisting of the release of Trichogramma egg parasites, a reduction in the number of chemical treatments, improvements in soil management, and changes in sowing dates. Butani (4) recommended a similar whitefly control system with the addition of clean weeding and destruction of old cotton plants and debris because both of these form storage sites for viruses and feeding and breeding sites for the whiteflies.

Conclusions

The purpose of this research was to illustrate the important indirect effect of weeds in delimiting cotton production by serving as hosts of the whitefly. The whitefly has been reported to be harbored by weed species belonging to more than 30 plant families which included more than 80 common weed species. The control of these weeds has been shown to be an important part of most of the successful whitefly control programs. The recognition of such weeds can thus be helpful in formulating comprehensive integrated crop protection procedures which would be more economical and effective.

The following table lists, by plant family, the weed species which have been found to serve as alternative hosts for the cotton whitefly. The weed species belonging to the plant families Convolvulaceae, Leguminosae, Malvaceae, and Solanaceae require more attention in formulating whitefly control programs because most of these species serve as hosts for virus diseases as well as providing favorable feeding and breeding sites for the whiteflies. In addition, these plant families contain a large number of whitefly host crop species that should be excluded from crop rotations in which cotton is a major crop in order to attain effective whitefly control.

Weed Hosts of the Cotton Whitefly

Plant Family	Weed Species	Reference
Acanthaceae	*Ruellia patula*	El Khidir 1965
	Ruellia prostrata	Gameel 1972
Aceraceae	*Acer macrophyllum*	Penny 1922
Amaranthaceae	*Amaranthus gangeticus*	Gameel 1972
	Amaranthus graecizans	Gameel 1972
	Amaranthus spinosus	Gameel 1972
	Amaranthus viridis	Gameel 1972
	Digera alternifolia	El Khidir 1965
Aristolichiaceae	*Aristolochia bracteolata*	El Khidir 1965
Asclepiadaceae	*Heptadenia heterophylla*	El Khidir 1965
Bignoniaceae	*Spathodea nilotica*	El Khidir 1965
Boraginaceae	*Heliotropum ovalifolium*	Gameel 1972
	Heliotropum sudanicum	Gameel 1972
Cannabaceae	*Cannabis sativa*	Azab et al. 1970
Capparidaceae	*Gynondropsis gynandra*	Gameel 1972
Caprifoliaceae	*Lanicera japonica*	Takahashi 1957
Chenopodiaceae	*Chenopodium album*	Azab et al. 1970
Commelinaceae	*Commelina benghalensis*	Azab et al. 1970
Compositae	*Ageratum conyzoides*	Takahashi 1940b
	Calendula officinalis	Gameel 1972
	Eclipta prostrata	Gameel 1972
	Sonchus arvensis	Azab et al. 1970
	Sonchus cornutus	Azab et al. 1970
	Sonchus oleraceus	Gameel 1972
	Eclipta alba	El Khidir 1965

Plant Family	Weed Species	Reference
Compositae cont.	*Emilia sonchifolia*	Corbett 1926
Convolvulaceae	*Convolvulus arvensis*	Gameel 1972
	Ipomoea aquatica	Gameel 1972
	Ipomoea blepharasepala	Gameel 1972
	Ipomoea cairica	David & Subramaniam 1976
	Ipomoea cardiosepala	Azab et al. 1970
	Ipomoea cordofana	Gameel 1972
	Ipomoea hederacea	Azab et al. 1970
Cruciferae	*Brassica juncea*	Gameel 1972
	Brassica campestris	Misra & Lamba 1929
Cucurbitaceae	*Laginaria vulgaris*	Gameel 1972
	Memordica charantia	Azab et al. 1970
Ericaceae	*Arbutus menziesii*	Bemis 1904
Euphorbiaceae	*Euphorbia aegyptiaca*	Gameel 1972
	Euphorbia heterophylla	Gameel 1972
	Euphorbia hirta	Azab et al. 1970
	Phylanthus maderaspatensis	Gameel 1972
	Phylanthus niruri	Gameel 1972
Fagaceae	*Quercus agrifolia*	Bemis 1904
Gramineae	*Cynodon dactylon*	Azab et al. 1970
Labiatae	*Nepeta runderatis*	Gameel 1970
	Ocemum basilicum	Gameel 1970
	Ocemum gracilis	Gameel 1970
	Umbellularia californica	Bemis 1904
Leguminosae	*Bauhinia variegata*	El Khidir 1965 Gameel 1972
	Cassia senna	Gameel 1972

Plant Family	Weed Species	Reference
Leguminosae cont.	*Centrosema pubescense*	Mound 1963
	Clitoria juncea	Gameel 1972
	Clitoria pycnostachya	Gameel 1972
	Clitoria ternata	Gameel 1972
	Crotalaria saltiana	El Khidir 1965
	Indigofera sp.	Mound 1963
	Parkinsonia aculaeta	Azab et al. 1970
	Rhynchosia memnonia	Azab et al. 1970
	Tephrosia appollinae	El Khidir 1965
Malvaceae	*Abutilon pannosum*	Gameel 1972
	Sida alba	Gameel 1972
	Sida cordifolia	Gameel 1972
	Sida rhombifolia	Gameel 1972
	Sida veronicifilia	Gameel 1972
	Urena lobata	Gameel 1972
Nyctaginaceae	*Boerhaavia diffusa*	Azab et al. 1970
	Boerhaavia repens	El Khidir 1965
Oxalidaceae	*Oxalis corniculata*	Gemeel 1972
Ranunculaceae	*Clematis liquisticifolia*	Bemis 1904
Rhamnaceae	*Rhamnus californica*	Bemis 1904
	Rhamnus crocea	Bemis 1904
Solanaceae	*Datura metel*	Gameel 1972
	Datura stramonium	Gameel 1972
	Nicandra physalodes	Azab et al. 1970
	Physalis puriviana	Misra & Lamba 1929
	Solanum dubium	Gameel 1972

Plant Family	Weed Species	Reference
Solanaceae cont.	*Solanum nigrum*	Gameel 1972
Verbenaceae	*Callicarpa sp.*	Takahashi 1955c
	Lantana camara	El Khidir 1965
Zygophyllaceae	*Tribulus terrestris*	El Khidir 1965

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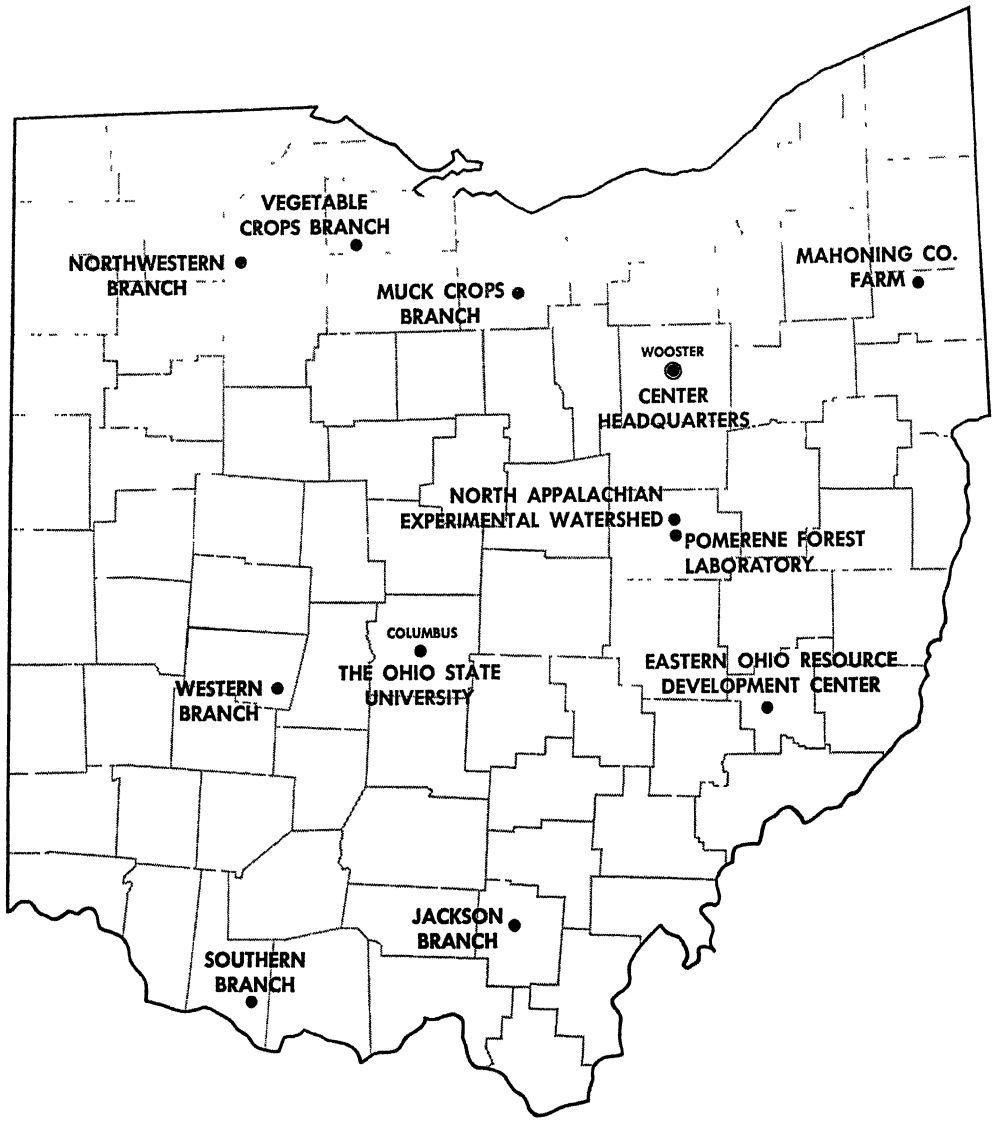

Ohio's major soil types and climatic conditions are represented at the Research Center's 12 locations.

Research is conducted by 15 departments on more than 7000 acres at Center headquarters in Wooster, eight branches, Pomerene Forest Laboratory, North Appalachian Experimental Watershed, and The Ohio State University.

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Vegetable Crops Branch, Fremont, Sandusky County: 105 acres

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