CHAPTER 2.5

Malawi

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Introduction

Geographical context

Malawi lies between latitude 9° 22' and 17° 7' South, and between longitudes 32° 40' and 35° 55' East. The climate is characterized by three main seasons: cool and dry from May to August, warm and dry from September to November, and warm and wet from December to April. The 5-month rainy season (November to March) begins earlier in southern and central regions of the country. Annual rainfall ranges from 600 mm in the lower Shire Valley and the Karonga Lake Shore Plains to over 3000 mm in high-elevation areas. Temperatures range between 20 °C and 35 °C but may approach and surpass 40 °C in the Rift Valley areas during October and November (Mkanda et al., 1995).

Surveys were carried out in the main areas of the country growing tomato (*Lycopersicon esculentum* Mill.) during the period 1997 to 1999. Areas surveyed were Mzuzu, Mzimba, Nkhata Bay, Salima, Lilongwe, Dedza, Ntcheu and Thyolo (Figure 1).

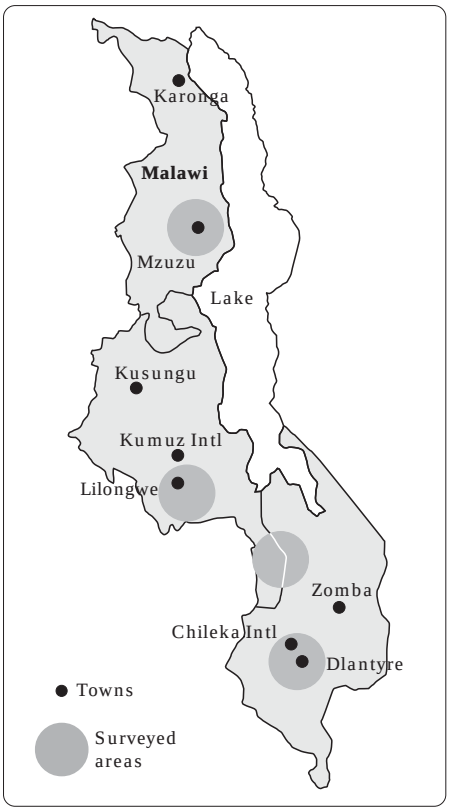

Figure 1. Tomato-growing areas surveyed for whitefly incidence in Malawi.

The emergence of Bemisia tabaci *as a pest and virus vector*

In Malawi, the whitefly species *Bemisia tabaci* (Gennadius) has been reported as the vector of cassava mosaic disease (Swanson and Harrison, 1994). Varying

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levels of infestation by the citrus woolly whitefly *Aleurothrixus floccosus* (Maskell) also have been recorded in regions of the country growing citrus (*Citrus* spp. L.) (Löhr, 1996).

Although whiteflies were suspected of transmitting viral diseases in vegetable crops, especially tomato, no reliable information on this subject was available from Malawi prior to the survey conducted under the Tropical Whitefly Integrated Pest Management (TWF-IPM) Project. The occurrence of whitefly species, their geographical distribution and their natural enemies in the vegetable cropping system also were unknown.

Increased Biological Understanding

Characterization of begomoviruses and whitefly biotypes

Selection of survey sites and other methodologies followed the standards agreed with other project partners. Questionnaires were used to gather information from vegetable producers. The incidence of plants affected by tomato yellow leaf curl was estimated on their farms, whiteflies were sampled for species identification and parasitoids and suspected natural enemies were collected.

During the surveys, 130 collections of adults and nymphs of whiteflies were made. Of these, 159 specimens were processed and mounted on 67 slides. Preliminary identification carried out at the International Center of Insect Physiology and Ecology (ICIPE) revealed that *Bemisia afer* (Priesner and Hosney) is the most prevalent species in the country, accounting for 67% of samples identified. Of the remaining specimens, *B. tabaci* comprised 30%, and *Trialeurodes vaporariorum* (Westwood), *T. ricini* (Misra) and *Aleyrodes proletella* (Linnaeus) 1% each. The species composition of samples from the various areas surveyed is reported in Table 1.

Table 1. Species composition (%) of whitefly samples collected in tomato-producing regions of Malawi.

Province	Species composition[a]				
	B.a.	B.t.	T.v.	T.r.	A.p.
Dedza	56	34	5	0	5
Lilongwe	86	14	0	0	0
Mzimba	86	14	0	0	0
Mzuzu	100	0	0	0	0
Nkhata Bay	53	47	0	0	0
Ntcheu	55	15	10	20	0
Salima	33	67	0	0	0
Thyolo	54	42	0	0	4

a. B.a., *Bemisia afer*; B.t., *B. tabaci*; T.v., *Trialeurodes vaporariorum*; T.r., *T. ricini*; A.p., *Aleyrodes proletella*.

The reproductive host plants from which whitefly nymphs were collected belong to the families Solanaceae, Euphorbiaceae, Leguminosae and Verbenaceae (Table 2). *B. tabaci* was found breeding on tomato in only a few areas.

Symptoms of tomato yellow leaf curl were observed in most of the surveyed sites. Samples of about 10 plants per field were collected from all the affected farms, squashed on nylon membranes and sent to the John Innes Centre (JIC) for hybridization. The results confirmed the presence of *Tomato yellow leaf curl virus* (TYLCV).

Disease incidence and symptom severity

Areas identified as “hot spots” (high incidence of TYLCV) include Dedza, Mzimba, Thyolo and Ntcheu (Figure 1). The highest incidences of TYLCV were observed at altitudes ranging from 1085 to 1485 m (Table 3).

Table 2. Reproductive host plants of whitefly species recorded in Malawi.

Whitefly species	Crops		Non-cultivated hosts	
	Family	Species	Family	Species
Bemisia afer (Priesner and Hosney)	Euphorbiaceae Leguminosae	*Manihot esculenta* Crantz *Phaseolus vulgaris* L.		
Bemisia tabaci (Gennadius)	Euphorbiaceae Leguminosae Solanaceae	*Manihot esculenta* Crantz *Mucuna deeringiana* (Bort.) Merr. *Phaseolus vulgaris* L. *Lycopersicon esculentum* Mill.	Euphorbiaceae Verbenaceae	*Euphorbia heterophylla* L. *Lantana camara* L.
Trialeurodes vaporariorum (Westwood)	Leguminosae	*Phaseolus vulgaris* L.		
Trialeurodes ricini (Misra)	Leguminosae	*Phaseolus vulgaris* L.		
Aleyrodes proletella (Linnaeus)	Leguminosae	*Mucuna deeringiana* (Bort.) Merr.		

Table 3. Maximum incidence (%) of *Tomato yellow leaf curl virus* (TYLCV) and species composition (%) of whitefly samples encountered at increasing altitudes in Malawi.

Altitude (m)	TYLCV incidence[a]	Whitefly species composition[b]				
		B.a.	B.t.	T.v.	T.r.	A.p.
485-685	14	31	56	0	0	13
685-885	14	38	63	0	0	0
885-1085	7	64	27	0	0	9
1085-1285	52	79	21	0	0	0
1285-1485	49	59	24	5	12	0
1485-1685	5	66	23	6	0	5

a. A TYLCV incidence of 94% was observed in one farm in the highest altitude range (1485-1684 m), while other farms in this altitude range had incidences of 0%-5%.
b. B.a., *Bemisia afer*; B.t., *B. tabaci*; T.v., *Trialeurodes vaporariorum*; T.r., *T. ricini*; A.p., *Aleyrodes proletella*.

The survey revealed that *B. afer* is the predominant whitefly species in most parts of Malawi (Table 1). This species was found on cassava (*Manihot esculenta* Crantz), common bean (*Phaseolus vulgaris* L.) and unidentified weeds but not on other vegetable crops. *B. tabaci* was also common in most parts of the country (Table 1). *pT. vaporariorum* was collected from Dedza and Ntcheu, while *T. ricini* was collected from Ntcheu only and *A. proletella* from Dedza and Thyolo. High numbers of nymphs were collected from Nkhata Bay, Dedza and Ntcheu, the latter two being the only regions from which more than three whitefly species were identified. On farms in Salima, very few whitefly nymphs could be found for identification and the region had relatively low TYLCV incidences (0%-11%). *B. tabaci* was the predominant whitefly species up to an altitude of about 900 m, while *B. afer* became more abundant at higher altitudes (Table 3).

Natural enemy species

Nine collections of whitefly parasitoids and 10 of predators were made during the survey. Among these were *Encarsia sophia* (Girault and Dodd), coccinellids (Coleoptera: Coccinellidae) and predatory bugs (Heteroptera: Anthocoridae).

Increased Socio-economic Understanding

Farmers' assessment of whitefly-related problems

Most of the producers interviewed (86%) grow tomato on their own land, while 12% rent the land. The majority of producers (88%) were men. Tomato was regarded as the most profitable vegetable crop by 98% of the producers. Only 27% of them have been growing tomato for more than 5 years. Tomato varieties commonly grown in Malawi include Moneymaker, Red Khakhi, Vercles and Heinz. The tomato seed was bought from the local market by 35% of the producers, 33% used their own seed (from the previous season), 21% obtained seed from the Agriculture Trading Company (ATC) and 11% used imported seeds. Tomato is grown both under rain-fed and irrigated conditions.

Other common vegetable crops in the country include common bean, cabbage (*Brassica oleracea* var. *capitata* L.), Irish potato (*Solanum tuberosum* L.), mustard (*Sinapis alba* L. subsp. *alba*), onion (*Allium cepa* L.), pumpkin (*Cucurbita* spp.), rape (*Brassica napus* L. var. *napus*), sweetpotato (*Ipomoea batatas* [L.] Lam.), turnip (*Brassica rapa* L. subsp. *rapa*), okra

(*Abelmoschus esculentus* [L.] Moench), pepper (*Capsicum annuum* L.), eggplant (*Solanum melongena* L.), and carrot (*Daucus carota* L. subsp. *sativus* [Hoffm.] Arcang. var. *sativus* Hoffm.). Cassava is also a major staple crop. Most producers (94%) practice crop rotation.

The main pests and diseases recorded on tomato, ranked according to importance, were late blight (*Phytophthora infestans* [Mont.] de Bary), red spider mites (*Tetranychus* spp.) TYLCV, whiteflies, bacterial wilt (*Ralstonia solanacearum*) and cutworms (*Spodoptera litura* [Fabricius]).

Eighty-three percent of producers could recognize whiteflies and 82% could recognize TYLCV. None of the producers seemed to know the interrelationship between TYLCV and whiteflies and confused TYLCV symptoms with red spider mite damage, aphid damage, heavy rain damage, fungal diseases, nitrogen deficiency and soil-borne diseases. Most of those interviewed (83%) thought that whiteflies and TYLCV caused problems on their farms. Almost half of the producers (46%) complained about the whitefly only, 17% of the disease only and 37% complained about both the disease and the whitefly.

Local names given to whiteflies include *msambe*, aphids, flies, pests, vegetable lice, white aphids, cobweb, *chinoni*, white lice, white ants, mites, small flies, lice and white butterflies. Local names given to TYLCV included blight, leprosy, *chisaka* (bushy top), *kaligwiti* (bushy top), crinkled leaves, *katungana*, *ciguduli*, bunchy top, *cicsaka*, *kafumbata* and malformation.

Estimation of disease incidence and yield losses

Among the surveyed farms, 75% had TYLCV symptoms in their tomato crop. However, only 6% of the farms had incidences of TYLCV symptoms above 25%, while 16% of the farms had incidences ranging from 10% to 25%, and 53% of the producers had incidences ranging from 0.5% to 9%. The highest incidence (94%) was reported on a farm in Dedza.

On average, the producers' estimate of yield loss in tomato due to the whitefly/TYLCV complex was 49%. According to the survey, 14% reported total yield loss, 14% reported three-quarter yield loss, 35% reported half yield loss, 29% reported one-quarter yield loss and 9% did not report any losses due to the whitefly/TYLCV complex. Those who reported incurring total loss were from the Dedza and Ntcheu Provinces, and a single producer from Mzimba. Producers who reported abandoning tomato growing, at least once, due to the problem made up 21% of those interviewed; 38% of them abandoned their farms in 1997.

Most producers (68%) believed that they had whitefly/TYLCV problems every year. The most severe attack was in 1997 according to 43% of the respondents. These producers were from Ntcheu (Kasamba), Dedza (Kalilombe, Chimlambe, Jere), Nkhata Bay (Kashonga, Chipayika), Salima (Matumba), Mzimba (Chizuminja) and Mzuzu (Kaboko). Nearly all producers (96%) believe there is a direct relationship between the climate and whitefly/disease incidence. There was no obvious consensus among the producers as to what weather conditions trigger whitefly and TYLCV outbreaks. The whitefly/TYLCV problems were reported to be worst from January to June and again from September to October. Some producers

(40%) believe that the whitefly/TYLCV incidence is higher when it is dry and hot, while others (30%) said they experience most problems when it is wet and cold. The opinions of the remaining producers were scattered between the remaining combinations of dry, moderate, wet and hot, moderate, and cold weather.

Producers gave estimation of the costs involved in crop protection measures (see below).

Costs estimated by producers in control of whitefly/TYLCV complex per season of tomato production

US$	% producers
0-49	26
50-99	16
100-199	19
200-299	14
300-400	9
>400	16

Many producers (42%) had not received recommendations on management practices for whiteflies. Those who had received advice obtained it from various sources: 34% received recommendations from technical advisors, 15% from other vegetable producers, 6% from family members or neighbours and 3% from sales agents. Most producers (90%) managed the whitefly/virus problem by means of synthetic pesticides, 4% by cultural means and 6% practiced no control at all. Other control methods such as legislative measures, natural insecticides (e.g., botanicals and bio-pesticides), biological control and the use of resistant varieties, were not reported.

Pesticide use

The decision on what insecticide to apply and when was made by the producer himself in 58% of the cases, by technical advisors (29%), sales people (3%) or a family member (2%), while 7% did not use insecticides on their farms. Half the producers (52%) applied insecticides as a preventive measure, while 33% applied them when damage was observed and 5% applied insecticides according to the calendar. Few producers (5%) reported making more than 10 insecticide applications per season, while 4% made 9-10 applications, 37% of the producers made 5-8 applications, 40% made 1-4, and 14% applied no insecticides to manage the whitefly/disease problem.

The insecticides most widely used in the management of the whitefly/TYLCV problem in Malawi include: fenitrothion, malathion and dimethoate (organophosphates); cypermethrin and lambda-cyhalothrin (pyrethroids); carbaryl and sevin (carbamates). Farmers were ignorant of the fact that chemicals with the same active ingredient often are sold under various trade names and they therefore risk using the same active ingredient throughout, rather than alternating with others. The use of fungicides was common because producers confused TYLCV symptoms with blight. Miticides such as dicofol were used also in an attempt to control whiteflies but EXTOXNET (1998) reports that this chemical has little effect on insects.

Strengthened Research Capacity

Scientists from ICIPE trained and accompanied the national scientists during the beginning of the survey. The project has equipped national scientists with a better understanding of the severity of whitefly-related problems in the country's vegetable production. New information on the status of whiteflies and the whitefly-transmitted viruses in tomato now is

available. Understanding our producers' perceptions and practices in relation to whitefly problems has been a significant achievement of this project.

Conclusions

Whitefly/TYLCV "hot spots" in Malawi include Dedza, Mzimba, Thyolo and Ntcheu. In both Dedza and Ntcheu, several farmers reported having abandoned their tomato crops at least once due to whiteflies/TYLCV. For this reason, these two areas should be targeted for further research in the second phase of the project. *B. afer*, followed by *B. tabaci*, is the prevalent whitefly species in most parts of the country and the most widespread parasitoid was *E. sophia*.

Although many producers recognized whiteflies and TYLCV, they often confused TYLCV symptoms with those of other pest and disease or nutrient deficiencies. Producers also were confused about the climatic conditions that trigger outbreaks of whiteflies and TYLCV.

Incidences of TYLCV in Malawi were not as high as in neighbouring Tanzania. Only 6% of the surveyed farms had TYLCV incidence above 25%. Although TYLCV incidences were generally low, the disease was encountered in all surveyed areas, indicating that the whitefly/TYLCV complex is a potential threat to Malawi's vegetable production.

References

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