MEETINGS

ABSTRACTS OF PAPERS PRESENTED AT THE 5TH MEETING ON WHITEFLIES IN FIELD CROPS AND VEGETABLES

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Shenkar College of Textile Technology and Fashion
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A: BIOLOGY, PHENOLOGY AND ECOLOGY OF WHITEFLIES

INFESTATION OF COTTON BY THE WHITEFLY *BEMISIA TABACI* IN THE 1985 SEASON

G. FORER
Cotton Production and Marketing Board, Tel Aviv, Israel

During the latter part of the 1970's there was an outbreak of the whitefly *Bemisia tabaci* in cotton, but at the beginning of the 1980's the population was relatively low. The problem of sugar and stickiness of the fibers was found only in smaller sized cotton fields. In 1981-82 stickiness in cv. 'Pima' which had been grown in the Bet She'an Valley became a problem. Difficulties were experienced in marketing this cotton, which in turn damaged our reputation for producing only top-grade cotton. The cotton was finally marketed and the buyers were assured that this problem was a thoroughly irregular occurrence which would not recur. At the beginning of the 1985 season, the pest appeared at the usual time. In the last week of May first reports of sighting whitefly adults were received. During June there was a slight increase in whitefly numbers in most of the country and concurrently larvae of the pest were found in the regions of the Carmel coast, Lake Kinneret coast, and east of Rehovot. Towards the end of June there was a substantial increase in the infestation by larvae and adults and special treatments were initiated in the western Galilee and Carmel coast regions. There was a further increase in the population of the pest, during July, especially in the Carmel coast, Lake Kinneret coast and Yizre'el Valley regions. During the latter half of July, there was an unusually heavy whitefly outbreak which was extremely difficult to contain, even by intensive treatment with all known pesticides, including new pyrethroids. By the end of July, the effect of aldicarb (Temik), the granules of which had been placed in drip-irrigated fields prior to placement of the irrigation pipes, had worn off. The pest outbreak continued until the end of the cotton season, with the whitefly population developing mainly in the Carmel coast, western Galilee and Bet She'an Valley (Gilboa) regions. At the beginning of August the effect of aldicarb in fields irrigated by sprinklers also ceased, and these fields, too, required intensive spraying.

During August the population continued to increase even in locations with previously low population levels – the Hefer Valley, Menashe, Hula Valley, and the Golan Heights – despite repeated regular spraying every 5-10 days. From mid-August until the end of the season, even these regular sprays failed to produce satisfactory results, especially in the Carmel coast, western Galilee, Yizre'el Valley and Gilboa regions. At the end of the season the cotton from these regions, and especially var. Pima, was sticky and had high sugar contents (2nd and 3rd degrees).

INFESTATION LEVELS AND DAMAGE OF *BEMISIA TABACI* TO VEGETABLE CROPS IN ISRAEL – 1980-1985

C. SHOHAM
Div. of Plant Protection, Extension Service, Ministry of Agriculture, Tel Aviv, Israel

Contrary to the situation with cotton, no routine pest scouting or monitoring is done in vegetable crops, and precise data on infestation levels in these crops are lacking. The information detailed herein has been extracted from weekly reports submitted during the years 1980-1985 by regional plant protection advisors for the plant protection bulletin issued weekly by this Division. These data are based on routine field observations regarding first appearance of *Bemisia tabaci*, and subsequent levels of infestation and crop damage in the respective regions.

1980: Presence of the pest was first noted on April 21. Populations increased constantly throughout the summer and by July fairly high infestation levels were found in most areas. Severe outbreaks occurred as from mid-August.

1981: First activity was noted on April 20, but the population level remained static throughout May. A marked population increase was seen only on August 17 and high infestation levels only in September.

1982: Activity was first reported on April 19. Populations increased gradually until May 10, then remained static for 2 to 3 weeks. Levels of infestation remained low to moderate until the fourth week of August and increased markedly only in September.

1983: Onset of activity was noted on April 26. A moderate population increase in May was followed by a slow growth rate in June and July. Populations remained low to moderate until mid-August, reaching higher densities only toward the end of August.

1984: First activity was noted on April 29. Populations increased very slowly during the summer. Significant population densities occurred only during the last week of August.

1985: First infestations were found earlier than in previous years: on March 4 in the Arava region and on April 8 in the Ayalon Valley. In spite of the early appearance of the pest, population increase was fairly moderate until mid-July (similar to 1981, 1982 and 1983, but lower than in 1980), but increased sharply during the last week of July, reaching extremely high levels in the course of 2 weeks. From mid-September dense swarms of adults were seen migrating from older to younger fields, completely destroying cucurbit crops and causing severe damage to peppers, covering them with honeydew on which sooty mold developed.

According to the above findings, infestation severity in the reviewed years could be graded on a scale of 1 to 5 (1=low infestation) as follows: 1980=3, 1981=2, 1982=1, 1983=1, 1984=2 and 1985=5. Due to insufficient data, no attempt was made in this review to relate development patterns of the pest to prevailing climatic conditions.

Population density and control efficacy in cotton, the main summer crop, seem to be closely related to pest severity and damage in autumn vegetables.

TRENDS IN THE ADULT POPULATION OF *BEMISIA TABACI* DURING RECENT YEARS

D. GERLING and R. OR
George S. Wise Faculty of Life Sciences, Dept. of Zoology, Tel-Aviv University, Ramat Aviv, Israel

The reliability of yellow sticky traps as sampling tools for whitefly *(Bemisia tabaci)* populations was tested using three parameters: (i) a horizontally placed trap on the ground *vs* a D-vac sampler, (ii) the variance among five traps used contemporaneously, and (iii) the variance among catches on subsequent days. According to all three parameters, the traps were reliable.

Traps hung vertically at 1, 2, 5 and 10 m height were used to estimate aerial movements of the whiteflies. At each height, five yellow and five transparent traps were used. As expected, traps closer to the ground caught much more than higher ones. Yellow traps caught more than transparent ones except at 10 m, where the catches were similar. Differences between catches at different morning hours were marked at 1 and 2 m and minor at 5 or 10 m height.

Trap catches in untreated cotton in the Bet She'an Valley were usually low to moderate until July, with a rise occurring throughout August followed by subsequent decline in September and October. During 1985, that region was characterized by moderate-size populations until mid-August, when there was an unprecedented, abrupt rise in the populations, reaching, within 1-2 weeks, levels that were 6- to 9-fold those of previous years. The outbreak could, possibly, be partly ascribed to the summer temperatures, which were normal, except during the month of August, when they averaged 2°C higher than in any other year since 1980.

INCREASE OF *BEMISIA TABACI* POPULATIONS ON WATER-STRESSED *VS* IRRIGATED COTTON PLANTS AND THEIR SPATIAL DISTRIBUTION ON ENTIRE PLANTS

U. MOR

Dept. of Field and Vegetable Crops, The Hebrew University of Jerusalem, Faculty of Agriculture, Rehovot, Israel

The whitefly *Bemisia tabaci* (Gennadius) is a well known pest in much of the tropical and subtropical world. It has been found to reduce plant dry weight and yield of seed cotton.

The net increase in whitefly populations on water-stressed *vs* irrigated plants was examined by making total immature population counts, coupled with leaf area measurements and mapping of all the leaves of whole plants (vertically and horizontally) in irrigated and non-irrigated cotton plots. In addition to a greater density of immatures that was due to smaller leaf area in stressed plants, the total whitefly population count was significantly higher on stressed plants (853 *vs* 345 larvae/plant), especially if the water stress had been caused by a sudden termination of drip irrigation. Such high populations were often followed by plant defoliation and a reduction in yield.

There was no difference in the horizontal distribution of the larvae between the stressed and irrigated plants. In both treatments, 75% of the larval population was found on the first three secondary branches, which were closest to the main stem. By measuring the correlation between the whole plant larval population and that on each leaf in the plant, we found that the best leaves for larval sampling are those on the 15th-16th main stem node and secondary branches 1 and 2.

Further research was conducted in order to determine the physiological conditions which increase the whitefly population. It was found that avoidance of stress conditions in August (in Israel) can serve as an agrotechnical means of controlling the pest. Unnecessary expenses for insecticides can thus be avoided. Furthermore, *B. tabaci* populations in August are influenced indirectly by the irrigation in June. Large amounts of water supplied in June caused rapid growth of the plant, which must then be compensated for in August by applying stress irrigation. This in turn decreases the plant's water potential and creates problems with *B. tabaci*.

THE ABILITY OF *BEMISIA TABACI*, THE VECTOR OF TOMATO YELLOW LEAF CURL VIRUS, TO SURVIVE CLIMATIC CONDITIONS

M.J. BERLINGER and NINA LEHMANN-SIGURA
Entomology Laboratory, ARO, Gilat Regional Experiment Station, M.P. Negev, Israel

The tobacco whitefly, *Bemisia tabaci,* is the vector of tomato yellow leaf curl virus. There is a high and significant correlation between the number of whiteflies trapped and the number of virus-infected plants. Since it is very complicated to find out directly whether whiteflies migrate over long distances, an attempt was made to study the ability of adult whiteflies to survive various combinations of temperatures (25, 30, 35 and 41°C) with relative air humidities (20, 50, 80 and close to 100%), without food, during short time intervals (2, 4 and 6 h). The ranges of these parameters represent, generally, the potentials of climatic conditions which prevail during the time of the day (the first 6 h from sunrise) and the season (July-October) when whitefly catches are at their maximum. The test temperatures were obtained in an illuminated incubator, and the RH's were fixed by aqueous NaOH solutions of various concentrations.

The survival of the whiteflies in the experiments was reduced by increasing temperature, decreasing RH, and increasing exposure time, at temperatures between 30 and 35°C. At lower (25°) or higher (41°) temperatures, RH and exposure time had little influence; at 25° survival was relatively high at all combinations of RH and exposure time, whereas at 41° survival was extremely low (2-7%) already after 2 h of exposure, at all RH's tested. The survival rate did not change significantly when the whiteflies were transferred to 25°, 50-60% RH and were allowed to feed for 20 h after they had been exposed to the experimental conditions. It was concluded that the whiteflies possess the ability to survive migratory conditions within the limits of temperatures, RH's and exposure times mentioned above, which may allow them a daily migration distance of several dozen kilometers.

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PRELIMINARY STUDIES OF THE DISTRIBUTION OF WHITEFLIES *(BEMISIA TABACI)*, USING FLUORESCENT DUST TO MARK THE INSECTS

S. COHEN and RACHEL BEN-JOSEPH
Dept. of Virology, ARO, The Volcani Center, Bet Dagan, Israel

Tests were conducted aimed at developing a method of marking whiteflies (*Bemisia tabaci* Gennadius). In laboratory experiments carried out in cooperation with J. Duffus and M. Jones (U.S.D.A., A.R.S., Salinas, CA), the fluorescent dust "Fire Orange" (Day Glo®) was found to be the most suitable of five different colored dusts tested. The dust persisted on the whiteflies for at least 9 days and had no deleterious effect on the life span of the insects. In preliminary field studies conducted in Israel at the Gilat Regional Experiment Station by M.J. Berlinger and Nina Lehmann-Sigura, and in the Jordan Valley by J. Kern and I. Harpaz (Ministry of Agriculture and the Hebrew University of Jerusalem, Faculty of Agriculture, Rehovot, respectively), cotton plants heavily infested with *B. tabaci* were dusted with "Fire Orange" using hand or knapsack dusters.

Sticky yellow traps were placed in circles at different distances from the dusted plot and the number of adhered glowing insects was counted under a magnifying glass using ultraviolet illumination. At Gilat, a few adults were caught at a distance of 100 m from the dusted plot when the initial dusted whitefly population reached approximately 100,000 insects. In the Jordan Valley, several marked whiteflies were caught 7 km from the dusted plot. These results show that the marking method may serve as a worthwhile tool in the study of the behavior of whiteflies under field conditions.

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B: CHEMICAL CONTROL OF WHITEFLIES

FENPROPATHRIN AND MINERAL OIL MIXTURES FOR CONTROLLING ADULTS OF THE WHITEFLY *BEMISIA TABACI*

I. ISHAAYA*, MIRIAM AUSTERWEIL** and H. FRANKEL**
**Dept. of Entomology and **Dept. of Pesticide Application Research, ARO, The Volcani Center, Bet Dagan, Israel*

Mineral oils have long been used as effective insecticides for controlling citrus pests, especially mites and scales and several other agricultural pests. In some cases mineral oils increase toxicity and persistence of contact insecticides and serve as useful adjuvants to various insect control agents. The mechanism of this phenomenon has not yet been established. Mineral oil may increase the pickup of the toxicant by the insect or reduce toxicant evaporation and/or dissipation. In some insect species mineral oils inhibit respiration and this, in turn, may synergize the toxicity of insecticides acting on the nervous system.

The present study considered the effect of a light-medium range mineral oil, Virol, on the chemical residue levels and on the toxicity of fenpropathrin applied against adults of the whitefly *Bemisia tabaci* under high- and low-volume spray conditions. Addition of 1% a.i. Virol to 0.005% a.i. fenpropathrin applied under high-volume spray conditions, resulted in a higher mortality of *B. tabaci* adults than that obtained by either of the materials applied separately. The LD-50 value of fenpropathrin when applied with 1% Virol (0.013 $\mu g\ cm^{-2}$) was approximately fivefold lower than when applied alone (0.062 $\mu g\ cm^{-2}$). On the other hand, addition of Virol to fenpropathrin under low-volume spray conditions had no effect on either the toxicity or the residual level of fenpropathrin. Thus, addition of mineral oil to fenpropathrin may have important practical implications in controlling the whitefly *B. tabaci* only under high-volume-spray conditions.

FURTHER STUDIES OF THE TOXICITY OF CHITIN SYNTHESIS INHIBITORS AND A JH-MIMIC AGAINST PREIMAGINAL STAGES OF *BEMISIA TABACI*

K.R.S. ASCHER and MIRIAM ELIYAHU
Dept. of Toxicology, ARO, The Volcani Center, Bet Dagan, Israel

Research on the toxic effects of teflubenzuron (CME 134; Celamerck GmbH); XRD-473 (N-[3,5-dichloro-4-(1,1,2,2-tetrafluorethoxy)-phenylamino-carbonyl]-2,6-difluorobenzamide; Dow Chemical Co.); chlorfluazuron (IKI 7899; Ishihara Sangyo Kaisha Ltd.); and of the JH-mimic S-31183 (formerly SK 591, 2-[1-methyl-2-(4-phenoxyphenoxy)-ethoxy]-pyridine; Sumitomo Chemical Co.) against preimaginal stages of *Bemisia tabaci*, was continued in preinfestation and postinfestation treatments. The results of the preinfestation treatments have been summarized previously (Ascher and Eliyahu (1985) *Phytoparasitica* **13**:76). For the postinfestation treatments, cotton seedlings, to the leaves of which female adults of *B. tabaci* had been confined in leafcages and allowed to oviposit, were sprayed with different concentrations of the compounds immediatly after the 2-day oviposition period or at approximately 5-day intervals thereafter. In this way eggs, N_1, N_2 or N_3 nymphal plus pupal stages were treated. Teflubenzuron caused 100% kill when sprayed on eggs and N_1 at 0.0005% a.i.; activity decreased at 0.0001% and ceased at 0.00005%. Treatment of N_2 caused some mortality between 0.1 and 0.005%, but not at 0.001%. XRD-473 caused 100% mortality when sprayed on eggs, N_1 and N_2 at 0.005%, still high mortality when sprayed on eggs and N_1 (but not N_2) at 0.001%, and started to weaken at 0.0005%. Chlorfluazuron caused 100% mortality when sprayed on eggs and N_1 at 0.001%, still high mortality at 0.0005%, and waned at 0.0001%. None of the three compounds was toxic when sprayed on N_3 plus pupae, even at 0.1%. S-31183 gave 100% mortality when sprayed on eggs at 0.001%, was still highly active at 0.0005%, and waned at 0.0001 and 0.00005%. Nymphal stages were not affected by the compound, which proved to be also a *Spodoptera littoralis* ovicide.

C: CONSEQUENCES OF COTTON INFESTATION BY THE TOBACCO WHITEFLY

SOME CONSEQUENCES OF THE INFESTATION OF COTTON FIELDS BY *BEMISIA TABACI*

O. ELSNER
Shenkar College of Fashion and Textile Technology, Ramat Gan, Israel

With the worldwide progress in agricultural productivity and with the increase in area of cotton cultivation, particularly in China, there are now large surpluses of cotton on the world market. This alone causes more stringent requirements in terms of cotton quality. However, the main pressure on cotton quality is exerted by the tremendous modernization of the textile industry. New, highly automated lines operating at speeds several times higher than those in practice a few years ago, advance requirements for better quality of the raw materials used. Further impact on the quality of raw cotton comes from new technologies developed in recent years, based on absolutely new principles. For the time being, no limit is seen to these innovations but their impact on the quality requirements of raw materials is already severe. It will thus be more and more difficult to sell honeydew-contaminated cotton even at a low price.

There is a general opinion that honeydew results from insects, in our case *Bemisia tabaci*. Some investigators claim that there must be another source of the honeydew, since honeydew-contaminated cotton is obtained despite physical exclusion of the insects from the plant. Notwithstanding many years of research, we have no practical method at present to determine the origin of honeydew. It is possible that exaggerated use of insecticides not only increases the cost of cotton growing but causes some other problems. For instance, it was found that in some cotton bolls ovules of completely undeveloped seeds are present; these ovules are covered by very fine and long fibers, some of which are green. The 'Pima' variety of *Gossypium barbadense* has the ability to synthesize an anthocyanin pigment. In the fibers that cover the ovule closely, this pigment is distributed within the fibers. Since it is chemically very stable and not easily accessible, it is difficult to bleach under normal bleaching conditions, thus producing spots on fabrics. We postulate that excessive use of insecticides, together with the recent spread of *Varoa*, has reduced the population of insect pollinators (bees, etc.), probably below the minimum required for efficient pollination of cotton. The inefficient self-pollination leaves some ovules unpollinated. The fibers that grow on such ovules are of normal length and maturity, but thin, and some contain the green pigment.