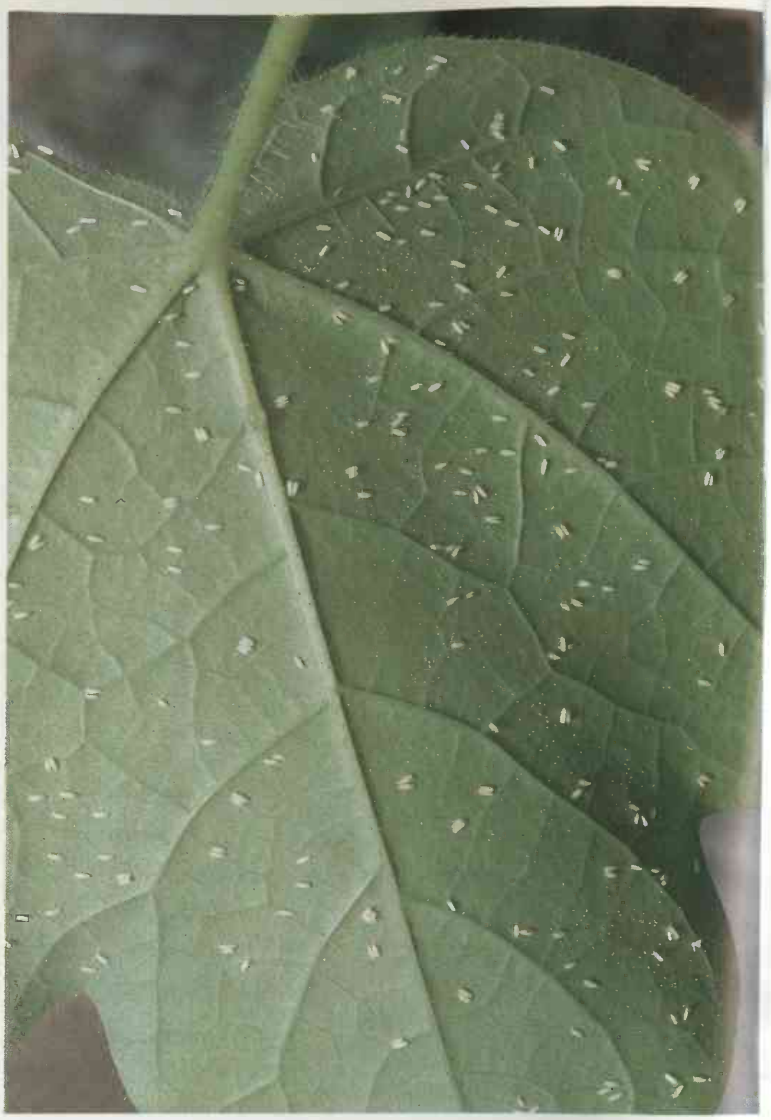

Whiteflies, so tiny they can easily go unnoticed on healthy foliage, damage plants directly by laying eggs which turn into sap-sucking nymphs.

The Bug of the Year

By Lorraine B. Kingdon

The 'B' biotype of the sweet potato whitefly poses a major economic threat to world agriculture. It has the ability to cause severe feeding damage to plants; it's resistant to pesticides and is the known vector of more than 60 geminiviruses.

WHITEFLIES CAUSE A TRULY REMARKABLE AMOUNT OF damage, particularly considering their minuscule size — about the size of the proverbial pinhead (.8 millimeter). They cause yield and quality losses to cotton, spread diseases in melons and vegetables and even panic urban gardeners when the whiteflies make their annual Phoenix summer appearance by the billions.

By this measure, 1992 was a banner year for the whiteflies. Arizona cotton farmers suffered at least $55 million in yield losses alone, says Arden Palmer, state director for the Agricultural Stabilization and Conservation Service of the U.S. Department of Agriculture. This figure did not include losses from lower prices paid for mold-damaged cotton, nor the extra expenses farmers incurred trying to control the whiteflies.

The whitefly became a media "star," appearing frequently on nightly television. Media attention, however, focused on Phoenix backyards, not on the state's farms. Billions of the tiny insect made their annual August and September appearance in the city, looking like a winter snowfall.

The pest is equally dangerous as a host for bacterial diseases and mold, such as the virus seen here attacking a pepper plant.

University of Arizona entomologist David Byrne, here collecting specimens for counting, has discovered that white-fly infestations follow a predictable pattern. *Ken Matesich photos.*

"The panic was far worse than any problems whiteflies caused," says Terry Mikel, University of Arizona Cooperative Extension agent for horticultural crops in Maricopa County. "A very few landscape plants were killed by the nymphs sucking plant juices from the underside of the leaves, and a lot of plants looked pretty raggedy, but that's about it. Of course, there were so many whiteflies around, they made great TV footage."

The 30-or-more urban gardeners who phoned Mikel's office daily wanted more than reassurance; they wanted a cure. (A dilute, less than 2 percent, solution of detergent in water sprayed on the underside of the leaves is an adequate control. Mikel has tested 5 detergents at 7 rates on 30 different plants. He says they all control whiteflies, but Dawn detergent works the best. He's also testing terpenes, such as Campho Phenique, as repellents.)

Detergent sprays may be sufficient when "raggedy leaves" are the major problem, but that's not enough when farmers' livelihoods are at stake. A UA team of plant scientists, plant pathologists, entomologists and remote sensing technologists are working together to find out how best to manage the whitefly, wherever it shows up and whatever crop it attacks.

"There is no 'silver bullet' available for the whitefly," says Jeff Silvertooth, UA Extension cotton specialist. "Difficult and complex decisions face us on an individual, community and statewide basis. The whitefly has clearly demonstrated an ability to adapt and adjust; we must be able to adapt and adjust as well."

Yuma County melon and vegetable growers proved Silvertooth's point in their 1992 battle against the whitefly, says Mark Wilcox, the county's Extension agricultural agent for vegetable crops. After devastating damage suffered in 1991, the farmers took joint action to alleviate pressures from the whitefly.

Cotton growers planted earlier maturing varieties of cotton, terminated irrigation earlier, harvested and disked under the residue about 10 days to 2 weeks earlier than usual in past years.

The whiteflies now needed another host, but, for the most

"Whitefly management, by its very nature, requires an integrated crop management approach . . ."

part, were unable to find fall melon plants, a preferred host, because none were planted this year. Also, in 1992, vegetable growers used transplants to a much greater extent, rather than seed their crops. All told, the whiteflies had to wait at least a month for major preferred host plants. Although farmers used pesticide sprays to some extent, chemical controls were incorporated into widespread changes in cultivation practices — changes in the ways farmers had traditionally grown their crops.

Many of the whiteflies died during this host-limited period, but a large number also migrated into the backyards in Yuma. "They ate my roses down to a nubbin," Wilcox said ruefully.

But he has regularly checked vegetable fields throughout the county, and he's impressed. During his career as a vegetable crop expert, Wilcox has worked across the United States, but says he has never seen weed control as well and carefully done as in Yuma County. This kind of care denies whiteflies the host plants they need while waiting for a commercial crop to infest.

"In 1991, farmers in Yuma County had a disastrous year," Wilcox says. "In 1992, I didn't notice a great deal of physical damage to vegetable plants, and I predict the whitefly won't affect the quality or quantity of our vegetable harvest."

The changes in practices that helped Yuma County farmers combat the whitefly began with research by the UA team into the basic biology of the insect. The whitefly starts as a creamy-yellow, football-shaped egg laid on the undersurface of leaves. It hatches to a crawler stage that, in turn, becomes a flattened nymph. Nymphs feed on the phloem sap of the leaves, beginning the cycle of plant damage. In large numbers, the nymphs can suck the leaves dry and even kill their hosts, certainly reducing overall crop yields.

But that's not all. Nymphs secrete large amounts of honeydew that drips onto open cotton bolls, making them sticky and interfering with ginning. When entomologists analyzed the honeydew, they found large amounts of amino acids and sugars that support the growth of microorganisms, including sooty mold. Both stickiness and sooty mold lower the grade — and the price paid — for cotton lint.

In field tests, UA plant scientists also found that intense sunlight, commonplace in Arizona, combines with honeydew to scald leaves — again reducing crop yields. General plant stress from hordes of attacking whiteflies increase the crop's need for water and can mature cotton plants earlier, leading to lower yields because a second fruiting cycle doesn't occur.

Entomologists David Byrne and Theo Watson discovered that in early summer the sweet potato whitefly displaces and dominates another species, the banded-winged whitefly, which usually causes little damage in cotton.

The sweet potato whitefly has infested Arizona cotton fields for many years, but only recently has it become a significant pest. The change in status may be the fault of a new B strain, now widespread over an amazing range of several hundred host plants that allow the whitefly to overwinter and reproduce year-around in Arizona.

The pest can move from one crop to another. Growers who actively produce a wide variety of crops, as many do in Arizona, have to consider how far whiteflies can migrate. Byrne studied migratory patterns in his laboratory and in the field, finding that these insects can fly as much as 12 miles in one morning if helped with a 5 mph wind. But they can't fly against a wind.

"Spring melons downwind of cotton may increase the risk of infestation of cotton somewhat, but not nearly as much as if the melons were planted upwind," Byrne says. Later in the season, when cotton has matured and the water is cut off, the whiteflies will head to nearby early fall vegetable fields.

That leads to the question, "How isolated does a crop have to be to avoid whitefly infestations?" Definitive answers aren't available, but Merritt Nelson, head of the UA department of plant pathology, is leading a regional analysis of whitefly-transmitted plant virus diseases in Yuma Valley. He and Robert MacArthur, an expert in geographic information systems and spatial analysis, are using the remote mapping systems to track pests and diseases as they move from field to field.

Conventional defense methods are of limited effectiveness. Farmers usually respond to large infestations of whiteflies by spraying with a broad spectrum of insecticides. Since the pest takes only 16 - 21 days to produce another generation under hot Arizona summer conditions, the spraying is apt to be almost constant. And, chemical controls don't always solve the problem. Growers spend a great deal of money on the sprays, further reducing the possibility of making a profit. And, insecticide-resistant secondary pests, such as aphids and mites, can still damage cotton under such an intense spraying regime. Finally, the repeated use of the same insecticides can rapidly lead to whiteflies that are resistant.

Those are cotton crop impacts. What about melons? And vegetables? Obviously the plants are directly affected by the huge numbers of voracious whiteflies. In addition, whiteflies are excellent vectors of plant pathogenic viruses. UA plant virologist Judith Brown says that wherever the "B" biotype, with its broader host range, takes over, epidemics of viral plant disease outbreaks follow within two or three years. This has happened around the world — and in Arizona.

The infestations seem to be getting worse every year. The reason could be Arizona weather, at least partly. Analysis of past weather trends have revealed some interesting patterns,

says Paul Brown, UA Extension biometeorologist. For example, the 1991-2 winter was one of the warmest on record. The effect?

• Fewer cold nights may have helped the whitefly overwinter;

• Whiteflies were able to reproduce later into the fall and winter and earlier in the spring;

• Host plants survived and supported whitefly populations.

As the UA whitefly team of scientists immediately realized, managing this pest will never be simple. There is no "magic bullet." Each part of the cropping season has its own dangers and precautions for growers.

"Whitefly management, by its very nature, requires an integrated crop management approach," the team concluded in its report to Arizona cotton farmers. "Though chemical control may be the tactic of choice once infestations have reached damaging levels, there are many other tactics and practices that may be employed well before the onset of infestation to maximize the likelihood of producing a successful crop. Our report points out the importance of considering crop and non-crop dynamics outside the cotton field.

"Cooperation among growers, within communities, or over large areas is encouraged and should result in maximum benefits to all concerned."

Willcox Serves Up Tomatoes Under Glass

By Lorraine B. Kingdon

THE GARDEN — A GREENHOUSE SPREAD OVER 10 ACRES — bears no resemblance to the backyard plot producing tomatoes "with real taste" back in the Midwest. But the fresh, huge, juicy, red "Beefsteak" tomatoes from Bonita Nurseries, Inc. near Willcox taste amazingly similar.

They should. Bonita is merely the newest venture for the owner, VHB — Van Heyningen Brothers Ltd. — which has worldwide experience growing tasty fresh tomatoes under glass.

Leo and Wil Van Heyningen, from Bleiswijk, Holland (where their management company is still located) started their first tomato greenhouse in the South Coast area of England in 1963. In the past 30 years, they have expanded to sites in South Africa, Saudi Arabia, the Philippines, China, Japan, East Germany, Portugal, as well as Pennsylvania in the U.S.

In this country, VHB grows primarily for the fresh tomato market on the East Coast, a booming market. "The people in Boston and New York have never seen anything like our tomatoes as far as their taste, high quality and shelf life," said Wil Van Heyningen, VHB president.

Willcox, for its part, has been struggling to solve its own economic problems and welcomed VHB wholeheartedly. "VHB is the most sophisticated agricultural system in all Arizona," says community leader Eddie Browning.

Browning calculates the greenhouse construction in 1992 impacted the local economy by about $100,000 in the first month alone. The company spent $7.2 million on the first phase — the 10-acre greenhouse — with more to come as the fresh tomato market increases. The payroll for 34 people, plus management, equals about $750,000 annually. That figure does not include about 20 part-time laborers needed during harvest — people who would otherwise be out of work when the apple season ended.

"Don't forget, the greenhouse, and our regional economic development plans, [also] have given us visibility and media attention we badly needed," Browning says.

The story behind the VHB trek to southeastern Arizona involves old friendships, new expertise and the right combination of climate, energy and labor.

"I've known Wil for years," says Merle Jensen, assistant dean for sponsored research at the College of Agriculture. Jensen has many years of experience in greenhouse vegetable production.

"The Van Heyningens are one of the largest, most respected vegetable growers in the world," he says. "Wil came to Arizona a couple of years ago. He told me they were seriously considering building a greenhouse somewhere in Arizona because of the high light conditions. They wanted to grow tomatoes 12 months year-round in the U.S., and Wil asked me to help them find the best location."

So, friendship started the ball rolling. VHB looked at possible greenhouse locations in Nogales, Parker, Safford, Sierra Vista, Yuma — and land between Bonita and Willcox. The company had several criteria:

• Clean, pure water — Bonita gets clean and plentiful water from surrounding mountain ranges;

• Good light — The belt between El Paso and Willcox has the highest light concentration in the United States;

• Ample energy at a competitive cost — A natural gas supply was available in the Willcox area;

• A climate that was not too hot, nor too cold — Willcox