On the basis of tests with zucchini squash (left), in which spun-bonded polyester protected squash plants from lettuce virus disease, authors Alfonso Durazo (above left) and Eric Natwick have extended their research to crops such as bell peppers.

Polyester covers protect vegetables from whiteflies and virus disease

Eric T. Natwick □ Alfonso Durazo, III

Profitable for high-cash-value crops

Whitefly-transmitted virus diseases have become a problem for vegetable producers in the southern California desert valleys. Unusually high populations of the sweetpotato whitefly, *Bemisia tabaci* (Genn.), caused severe crop losses in 1981 and 1984. These infestations were followed by virus disease epidemics in vegetable crops.

The adult sweetpotato whitefly is reported to be responsible for the transmission of more than 30 diseases, although so far, only five virus organisms have been identified from crops in southern California: two strains of squash leaf curl, cotton leaf crumple, lettuce infectious yellows, and tomato necrotic dwarf. Vegetable crops damaged by these viruses include lettuce, melons, squash, beans, and tomatoes. Squash and melons can become infected with either the squash leaf curl viruses or lettuce infectious yellows virus.

Squash production in the desert southwest has become increasingly difficult since squash leaf curl became a problem in 1977. Production during the fall has often resulted in total crop failure. Sweetpotato whitefly populations build up each summer in cotton and migrate to vegetable crops during late summer and fall. Use of insecticides in both cotton and vegetable crops to control whitefly adults and prevent or suppress virus diseases has been unsuccessful.

Complete exclusion of the whitefly from squash plants at seedling emergence until initial fruiting, however, has proved effective in preventing virus disease infection for a critical period during production. This has been possible through the use of spun-bonded polyester (SBP) material as a floating row cover. Floating row covers are sealed at the sides and ends of the beds with soil, but are not suspended by wire hoops as are tunnel-type row covers.

Row covers

Plastics and polyethylene are well known to the vegetable industry, but polyester has only recently come into use as row covers. Spun-bonded polyester is a cloth-like material used in the rug and clothing industry (and known in the latter as interfacing). Produced in rolls of varying weights and lengths, the white, nonwoven material is lightweight, porous to water, and transmits 75 to 80 percent of available sunlight.

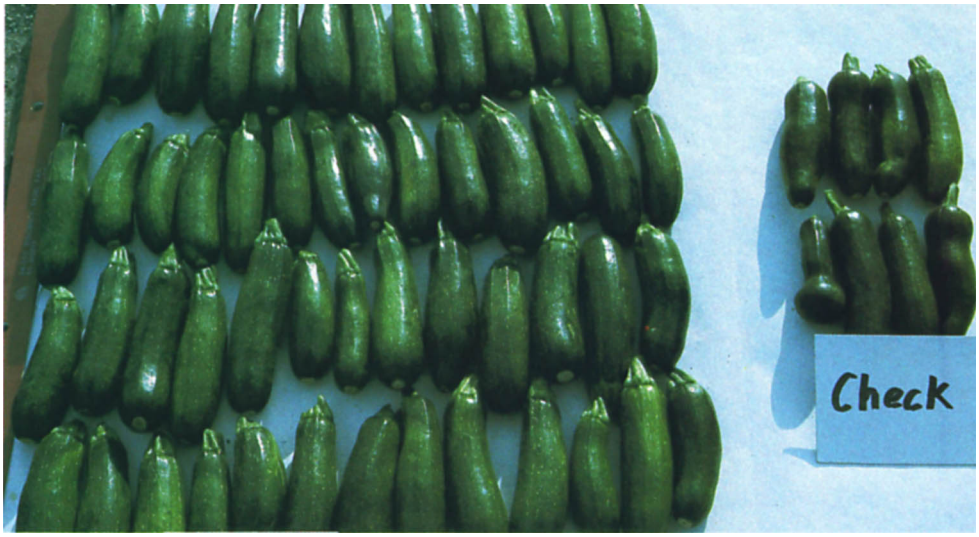
Because spun-bonded polyester is light, it can be placed without hoops directly over plants whether they are started as transplants or are direct-seeded. It was first used as a crop row cover for insulation, because it captures and holds enough heat to hasten emergence and plant growth, yet is sufficiently porous for ventilation. It has also been studied for use in frost protection.

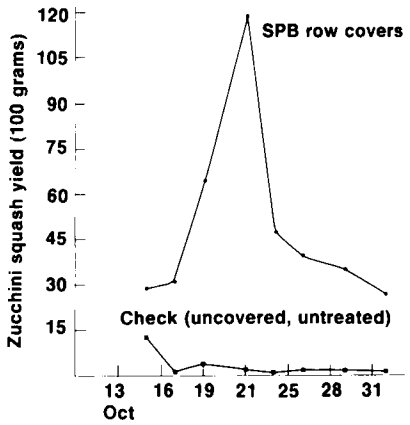
Crop protection

We conducted a study comparing the effectiveness of insecticides and SBP row covers in controlling whiteflies and thus in suppressing virus disease. One-half acre of zucchini was planted and irrigated September 4, 1984, at the Imperial Valley Agricultural Center. All treatments were arranged in a randomized complete block design with four replicates.

Spun-bonded polyester floating row covers were placed over four beds after planting and before irrigation. Several insecticides were applied to zucchini seedlings on non-SBP-covered beds on September 12, when the plants were at the first and second true leaf stage, and again on September 17, at the fourth to sixth true leaf stage. The purpose of the insecticide treatments was control of whitefly adults migrating into the squash planting. The row-cover and untreated check plots were not sprayed with insecticide.

Whitefly adults were counted on the leaves of squash seedlings in both the insecticide-treated and check (no insecti-





Protection from whitefly-spread virus diseases by spun-bonded polyester increased yield of zucchini squash 20-fold over unprotected plots. Lack of protection also led to sheepnose and cracking in diseased fruit.

cide, no cover) plots on September 14 and 20. Whitefly counts were very high, ranging from 94 to 911 and from 556 to 3,820 per plant on September 14 and September 20, respectively, including insecticide and check plots. Endosulfan or combinations of other insecticides with endosulfan provided the best control. Floating row covers excluded whitefly from the zucchini plants.

Virus disease ratings were made on September 17 and 21, five and four days after insecticide treatments, respectively. The virus ratings were based on the number of zucchini plants with lettuce infectious yellows or squash leaf curl virus disease symptoms per 10 plants examined in each of four replicates. The virus ratings ranged from 3.0 to 5.0: 30 to 50 percent of the plants were showing virus disease symptoms five days after the first insecticide treatments or about eight days after emergence. Virus disease symptoms were apparent in 75 to 100 percent of the zucchini plants four days after the second insecticide application, only 12 days after the seedlings emerged. Under floating row covers, virus disease symptoms did not appear until the plants were large (18 inches tall) and were flowering.

When the floating row covers were removed, very slight virus symptoms could be seen in new growth of a few plants. Whitefly counts were made on five leaves of each of 10 plants in four replicates on October 10 as the row covers were removed. Very few whitefly adults were found on plants that had been covered: the average was 10 adults, significantly fewer than the 6,425 on untreated check plants.

TABLE 1. Projected production costs for summer squash grown under spun-bonded polyester row covers with furrow irrigation

Cost	Sample costs per acre
	$
Application of covers	700
Removal	100
Total	800
Other preharvest costs	675
Total preharvest	1,475
Harvest (pick, haul, grade, pack, and sell 500 cartons @ $2.75)	1,375
TOTAL COSTS	2,850
Cost per carton @ 500 cartons per acre	4.19
Cost per carton @ 600 cartons per acre	3.49

NOTE: Actual costs may vary with availability of spun-bonded polyester and cultural practices. We estimate costs could be up to 5 percent higher.

Yield and economics

Zucchini fruit were harvested from the insecticide-treated, row-covered, and untreated check plots from October 15 to November 1 for a total of eight harvest dates. Rows that had been covered produced a much greater yield than any of the insecticide-treated rows or the untreated, uncovered check rows. Covered rows yielded the equivalent of 369 cartons of zucchini per acre compared with the check, which produced as little as 18 cartons per acre, based on 18-pound cartons. Yields from insecticide-treated plots ranged from 25 to 153 cartons per acre; endosulfan and combinations of endosulfan with other insecticides produced yields from 128 to 153 cartons per acre. Rows covered with the polyester produced statistically greater yield than any other treatment, as determined using multifactor analysis of variance and Duncan's new multiple range test for separation of the means at the 1 percent level of significance.

Before the squash leaf curl virus disease problem, low-desert-area growers could produce more than 800 cartons of squash per acre, averaging over 500 cartons in fall production. Since this disease and, later, lettuce infectious yellows became problems, average yields have dropped to less than 300 cartons per acre.

An economic analysis indicates that, for a profit to be realized through use of spun-bonded polyester as row covers, market prices must be higher than $5 per carton (tables 1 and 2). During the fall of 1984, squash prices reached levels as high as $14 per carton. With the cost of SBP and labor costs to cover beds exceeding $800 per acre, it appears that spun-bonded polyester floating row covers will only be profitable for protection of high cash value crops.

TABLE 2. Income above cost per acre

Boxes per acre	Income at following prices per box: $3	$5	$7	$9	$11	$13	$15
200	−1,425	−1,025	− 625	− 225	175	275	975
400	−1,375	− 575	225	1,025	1,825	2,625	3,425
600	−1,325	− 125	1,075	2,275	3,475	4,675	5,875
800	−1,275	325	1,925	3,525	5,125	6,725	8,325
1,000	−1,225	775	2,775	4,775	6,775	8,775	10,775
1,200	−1,175	1,225	3,625	6,025	8,425	10,825	13,225

Conclusions

Currently only small acreages are under cultivation with spun-bonded polyester row covers in the Imperial and Coachella valleys, but their use could become common in southern California. Technology for economical application, removal, and disposal of the material is being developed, and other materials from which tunnels or floating row covers could be constructed may provide similar insect exclusion and disease suppression.

Eric T. Natwick is Entomology Farm Advisor, Imperial County and Alfonso Durazo, III, is Limited-Scale-Agriculture Farm Advisor, Imperial and Riverside counties.