Effect of Plant-Derived Oils on Sweetpotato Whitefly on Cotton

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Abstract

Cottonseed oil applied to cotton repelled sweetpotato whitefly (SPW) adults up to 8 days in greenhouse tests. Soybean oil (5%) resulted in reduced numbers of adults and numbers of eggs laid. SPW egg hatch was reduced 84% after treatment with 10% crude cottonseed oil solutions as measured by the number of first instar larval emergence. Also, numbers of whitefly larvae were reduced 99, 91 and 83% on day 6 following treatment with 10% cottonseed oil, 5 and 1.5% soybean oil, respectively. Negligible plant leaf phytotoxicity occurred from the plant-derived oil treatments.

Introduction

The sweetpotato whitefly (SPW), *Bemisia tabaci* (Gennadius), has been a pest of increasing importance on cotton, *Gossypium* spp., and vegetables in the southwest desert agricultural areas of Arizona and California since 1981 (Butler et al. 1986). Cotton is an excellent reproductive host with SPW populations exhibiting exponential growth rates and doubling every 6 days in some instances (Butler et al. 1985). Damage to cotton resulting in significant losses may occur from feeding, infection by cotton leaf crumple virus (Brown and Nelson 1984) which is transmitted by SPW, and contamination of lint with honeydew that reduces cotton lint grade. Dispersal of high populations from cotton to lettuce, melons, cucurbits, and sugarbeets, has resulted in transmission of infectious agents that cause disease and severe losses (Brown and Nelson 1986, Cohen et al. 1983, Duffus et al. 1986).

Chemical control is difficult because the immature forms are found on the underside of plant leaves; the insects have high reproductive potential, and the SPW is resistant to most classes of insecticides currently available (Prabhaker et al. 1985).

The need for control technology to reduce SPW populations and losses to cotton and vegetables in the southwest prompted us to conduct greenhouse studies to determine the potential of plant-derived oils for SPW control.

Materials and Methods

A series of greenhouse studies were conducted to determine the effect of cottonseed oil on adult SPW visitations to 'Stoneville 825' cotton, *Gossypium hirsutum* L., seedlings in 10 cm plastic pots and in the 1 or 2-leaf stage of plant growth. Cottonseed oil, (Comate 101®, 92% cottonseed oil, 8% emulsifier; S. Helffrich and Associates, Inc., Phoenix, Arizona) was diluted with water to appropriate test percentages of cottonseed oil active ingredient, and no additional emulsifier was added. Treatments were applied with a Badger Model 150 air-brush sprayer (Badger Air-Brush Co., Franklin Park, Illinois). Adult SPW were collected from infested cotton plants in the greenhouse with an aspirator modified from a vacuum cleaner. Open collection containers with SPW were either set on greenhouse benches and insects allowed to exit the container to find host plants or SPW were shaken from the collection containers ca. 1 m over the treated plants when plants were dry after application. We estimated

that 1-2 thousand SPW were released per experiment, except as noted. In some studies, additional SPW releases were made to assure adequate numbers were available to evaluate the residual repellent effect of the oil treatment several days after application.

The effects of oil treatments on SPW eggs and larvae were determined by placing untreated, uninfested seedlings in a 105 x 68 x 105-cm screen cage. Several thousand SPW adults collected as previously described were introduced into the cage. Plants were removed in 2 to 3 days and examined to verify the presence of eggs. One series of plants was sprayed immediately to determine the effect of the oil treatments on eggs, and a second series of plants with eggs was held for 7 days until eggs hatched and the plants were then sprayed. All treatments were applied with a 1-ℓ Polyspray 2 hand-pump-operated-sprayer. The tops and bottoms of the leaves were sprayed to runoff. Oils were either a crude cottonseed oil supplied by Traders Oil Mill, Fort Worth, Texas, or a refined commercial cooking soybean oil, (Wesson Oil®, Beatrice/Hunt-Wesson, Inc., Fullerton, California). Emulsions were prepared by adding 0.5% surfactant (Tween-80) to the oil and then diluting the oil to correct percentages with water. Controls in all experiments were sprayed with water only. The effect of the oil of SPW eggs and larvae was determined by counting all larval stages on six 1-mm^2 samples per first and second true leaf. The experiment was replicated five times.

The phytotoxic effect of cottonseed oil under greenhouse conditions was determined by treating cotton plants when they were in the 2- or the 8-leaf stage of development. Treatments were 5, 10, or 15% aqueous solutions of Comate 101® or Natur'l Oil® (93% vegetable oil, Stoller Chemical Co., Inc., Houston, Tex.). Plants were sprayed with the compressed air sprayer described above. The experiment was replicated two to five times (depending on plant availability) with plants placed on greenhouse benches in a randomized complete block design. Three days after treatment, plants were rated from 1 to 5, based on visible injury to leaf tissue (1 = no damage, 3 = moderate damage, and 5 = severe damage).

Results

Fewer SPW adults were found on cottonseed oil-treated cotton for 8 days following treatment (Table 1). Large numbers of SPW adults encountering oil residues during the first 24 h after application were entrapped and died. It was observed that the SPW adults moved to new foliage that was untreated.

In a second experiment, the numbers of SPW adults settling on cotton plants was also significantly reduced for 4 days following treatment with 5% soybean oil as compared to numbers settling on water-treated plants (Table 2). Reduction of SPW numbers not only reduced the feeding damage to the plants but also the amount of honeydew secreted and possibly virus transmission because of the repellent effect. In addition, the reduction in the number of adults was reflected in a reduced number of SPW eggs on each of the sampling dates.

When SPW eggs were treated with 10% crude cottonseed oil, the number of first instar larvae 8 days after treatment was significantly reduced ($P \leq 0.05$). There was a mean of 51 larvae per treated cotton plant as compared to 321 larvae present on untreated control plants, or an 84% reduction.

When SPW larvae were treated, there was a 99, 91 and 83% reduction in the number of larvae 6 days following application of 10% cottonseed oil, and 5 on 2.5% soybean oil, respectively.

Cotton seedlings were tolerant to the phytotoxic effects of oil with only slight damage observed (Table 3). The results of these studies show a high degree of repellent activity to SPW after plant-derived oil applications to cotton. This mode of action can prevent development of infestations and may be of particular importance in the case of insect vectors of plant viruses. Repelling vectors from host plants has shown some promise in reducing spread of plant viruses (Kring 1972). Toxicity of the oils to SPW eggs and larvae also has control potential. Additional research is needed to determine the effect of plant-derived oils for SPW control under field conditions similar to the successful experiments conducted in Israel (Broza et al. 1988). More information is also needed on phytotoxicity of the oil formulations under field conditions.

Literature Cited

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Table 1. Mean[1] Number of Sweetpotato Whitefly Adults on Cotton Seedlings at Various Intervals after Treatment with Cottonseed Oil.

Treatment	Days after Application 1	2	3	4	5	6	7	8
Cottonseed oil (%)								
5%	1.9 b	0.7 b	0.3 b	0.9 b	1.4 b	0.9 b	0.6 b	0.3 b
10%	2.0 b	2.6 b	2.3 b	2.6 b	3.1 b	2.7 b	3.3 b	1.6 b
Water (control)	75.9 a	60.6 a	53.0 a	46.7 a	37.9 a	32.9 a	20.3 a	15.3 a

[1] Seven replications. Means in a column not followed by the same letter are significantly different (Duncan [1955] multiple range test, $P \leq 0.05$).

Table 2. Mean[1] Number of Sweetpotato Whitefly Adults and Eggs on Cotton Seedlings at Various Intervals After Treatment with 5% Soybean Oil.

Stage	Treatment	Days after Application 1	2	3	4
Adult	Soybean oil 5%	0.0 a	5.0 a	18.0 a	27.0 a
	Water (control)	79.0 b	123.0 b	156.0 b	210.0 b
Egg	Soybean oil 5%	0.3 a	4.4 a	13.0 a	53.0 a
	Water (control)	120.0 b	92.0 b	171.0 b	313.0 b

[1] Means of 7, 7, 7, and 9 replications on days 1, 2, 3, and 4, respectively. Means in a column not followed by the same letter are significantly different (Duncan [1955] multiple range test, $P \leq 0.05$).

Table 3. Mean[1] Phytotoxicity Ratings of Cotton Leaves on Plants after Treatment with Plant-Derived Oils.

Treatment	Rate (%)	2 leaves	6-8 leaves
Comate	5	1.0	1.2
	10	1.0	2.0
	15	1.1	1.2
Natur'l Oil	5	1.0	1.0
	10	1.5	1.5
	15	1.5	1.7
Mean	--	1.2	1.4
Untreated Control	--	1.1	--

[1] Treatments were replicated 4 and 2 times for 2-leaf, and 6 to 8-leaf cotton, respectively. Phytotoxicity rating: 1 = no damage, 3 = moderate damage, and 5 = severe damage.