

PLANT-DERIVED OILS AND SOAP SOLUTIONS AS CONTROL AGENTS FOR THE WHITEFLY ON COTTON

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ABSTRACT: Plant-derived oils and a washing powder were evaluated as sprays against sweetpotato whitefly, *Bemisia tabaci* Genn., in field studies in India. Two cottonseed oil formulations, (Flyteck-1[®]) and a local formulation, castorbean oil (Flyteck-2[®]), neemseed oil (Neemark[®]) and a washing powder (Nirma[®]) reduced numbers of adult whiteflies 1 day after treatment. Three days after treatment, the cottonseed oils and the castorbean oil were superior to neemseed oil and the washing powder. At 5 and 7 days, all treatments except neemseed oil significantly lowered the number of adults. The number of nymphs, as measured by spots on water-sensitive paper, were reduced following the treatment of individual leaves with cottonseed and castorbean oils at 2.0%, neemseed oil at 0.5, 1.0 and 2.0% and washing powder at 1.5, 15.0 and 30.0 ml/l. The under-leaf coverage obtained on top, middle and lower locations of cotton plants treated with knapsack, motorized mistblower and foot-operated sprayers were compared. The foot sprayer gave the best coverage of the middle leaves where older eggs and nymphs were located. Spray coverage on the undersides of leaves is essential and extra time and effort must be expended to accomplish this goal. Also shortening spray wands and decreasing nozzle offset may facilitate coverage. There was little phytotoxicity observed when individual leaves of ten cotton cultivars were sprayed with 5% cottonseed oil and Nirma washing powder at 15 and 30 ml/l.

INTRODUCTION

The sweetpotato whitefly (SPW), *Bemisia tabaci* Genn., is an economic pest that is widely distributed throughout tropical and subtropical countries of the world and is now a serious pest in all of the principal cotton growing areas in India. Losses due to SPW during the 1986-87 growing season were estimated to be 40% of the cotton crop in Gujarat and 20-30% in Maharashtra cotton production areas (RAJAK and DIVAKAR 1987). At favourable high temperatures, for cotton production the rate of SPW reproduction is also high and the positioning of the adults and immature stages on the undersides of cotton leaves, has made this pest extremely difficult to control with conventional insecticides applied with standard powder sprayers. In addition, SPW has developed resistance quickly to many of the commonly used insecticides (PRABHAKER et al. 1985).

The potential use of cottonseed oil for SPW control was first evaluated in green house studies in 1987 at the Western Cotton Research Laboratory, Phoenix, Arizona (BUTLER et al. 1988). The promising results of the greenhouse tests led to field testing on cotton in Israel in 1987 using an 18-row inflatable boom sprayer and mistblower sprayer for cottonseed oil applications that gave good SPW control (BROZA et al. 1988). Subsequent testing of aerial applications of cottonseed oil to cotton and lettuce for SPW control in Arizona (USA) were unsuccessful because oil sprays were not directed to the undersides of the leaves.

In India and many tropical countries, hand-held sprayer insecticide application methodology is used because of available low cost labour. Under these conditions spray materials can be directed to the undersides of leaves to attain sufficient coverage for potential control. Therefore, we conducted studies at Parbhani, Maharashtra State, India to determine the efficacy of three locally available plant-derived oil products and one commonly available soap product to control SPW.

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MATERIALS AND METHODS

Experiments were conducted in a field of cultivar 'LRA 5166' cotton during November 1990. Previous to this period, the monsoon climate was severe. As a result, SPW populations were relatively low. SPW populations were estimated in each experimental plot (6 rows x 10 m, 6 treatments replicated 4 times) by counting adults on the undersides of five cotton leaves from the upper, middle and lower portions of the plants in each plot. Leaf counts were made in early morning before flight began.

The effect of the sprays on SPW immature stages was determined on older cotton leaves. Leaves were first examined with a hand lens. Those with an abundant number of larvae and pupae, and no emerged pupae, were tagged and subsequently sprayed (test 1:10 treatments, 12 replicates; test 2:11 treatments, 15 replicates). One to two days after spraying, treated leaves were picked from the plants and brought to the laboratory. Each leaf was placed on a 26 x 38 mm piece of water sensitive paper (Spraying Systems Co., Wheaton, IL) for 20 minutes. The leaf was held in place in close proximity to the water-sensitive paper with a 50 x 9 mm plastic petri dish filled with sand. The number of discrete honeydew drops on each paper was counted with the aid of a binocular microscope. Honeydew drops in a cluster or in a line produced by a single individual were discounted.

Four natural oils were evaluated and included a cottonseed oil formulation, Flyteck-® (Sun Industries, Bombay, India) that contained non-phytotoxic, biodegradable 30% emulsifier. A second cottonseed oil emulsion formulated locally, MAU-CSO, was prepared by adding 66 ml of oil and 34 ml of emulsifiables and adjuvants. A castorbean oil formulation, Flyteck-2®, was also provided by Sun Industries, it apparently had different emulsifiers from the cottonseed oil and required some agitation to mix with water. The fourth plant-derived oil evaluated was a commercial neemseed product, Neemark®, (West Coast Herbochem Pvt Ltd, Bombay). An inexpensive washing powder, Nirma* (Patel Detergents, Ahmedabad, India) was also included in the experiments.

Oil and soap solutions were applied to individual leaves with a small pump sprayer (Ultramist®, Delta Industries, Philadelphia, PA), generally used for cosmetic purposes. Three larger sprayers commonly used by Indian cotton growers were evaluated for spray coverage efficiency on whole plants in the field. The sprayers in each case were operated by professional pesticide applicators using a 2% Flyteck-1 solution. The sprayers were (1) a knapsack sprayer (Sikar 59®), (2) an Aspee-bolo® Motorized Knapsack Mistblower, and (3) a foot-operated pump sprayer (Maruti®) which required one man to operate the foot pump, one man to handle the hose lines, and a third to manipulate the spray wand.

Sprays to evaluate the potential phytotoxic effects of 5% Flyteck-1 and Nirma soap at 15 m and 30 ml/l cotton foliage were applied with the small pump sprayer (Ultramist®) previously described. Individual leaves were tagged on four plants of each of ten cotton cultivars in a nursery with four replicates. One leaf of each cultivar, was treated with each of the three sprays with one leaf left untreated as a control. A rating of injury to the leaves was made 5 days after treatment with 1=no injury, 2=moderate injury and 3=severe injury. Data were analyzed using analysis of variance procedures, and Duncan's multiple range test ($P \leq 0.05$ level of significance) was used to separate the means.

TABLE 1: Mean^a number of *Bemisia tabaci* adults per 15 leaves following treatments applied by motorized mistblower on 21 November 1990.

Treatment	Conc.	No. days following treatment				
		1 day	2 days	3 days	5 days	7 days
Flyteck-1	2.0%	43.5 b	30.5 b	36.0 c	43.0 b	40.2 b
MAU-CSO	1.5%	68.2 b	35.5 b	31.2 c	40.0 b	39.0 b
Flyteck-2	2.0%	68.8 b	44.5 b	40.5 c	42.2 b	67.2 b
Nirma	30 ml/l	83.2 b	82.0 ab	97.2 b	60.5 b	56.5 b
Neemark	2.0%	98.5 b	84.8 ab	104.5 b	85.2 ab	84.5 ab
Untreated	-	193.5 a	121.8 a	160.2 a	127.0 a	132.5 a

a Means of 4 replications. Means in the same columns not followed by the same letter are significantly different (Duncan's multiple range test, $P \leq 0.05$).

RESULTS

The effect of the four natural oils and a washing powder spray on SPW adults when applied with a mistblower, presented in Table 1, revealed that one day after spray, all the treatments significantly reduced the number of adults. On third day following application, plants with cottonseed oil (Flyteck-1, and MAU-CSO) and castorbean oil (Flyteck-2) treatments had statistically fewer SPW adults than on plants with the untreated control and had fewer adults than plants with the Neemark (neemseed oil) or Nirma washing powder. On days 5 and 7 following treatment, numbers of SPW adults in the cottonseed or castorbean oil and Nirma-treated plants were significantly lower than those of the untreated leaves.

Two days after spraying all treatments significantly reduced the immature SPW populations on individually treated leaves, as determined by the number of honeydew spots on water-sensitive paper (Table 2). The under-leaf spray coverage obtained on leaves located on the top, middle and lower locations of cotton plants treated with the commonly used hand-held sprayers was comparable with the three sprayers evaluated. Coverage was best on the middle leaves that were treated with the foot sprayer (Table 3).

TABLE 2: Mean number of spots on water-sensitive paper as a measure of live *Bemisia tabaci* nymphs, 2 days following spraying of different treatments on individual leaves. 26-31 November 1990. Parbhani, Maharashtra.

Treatment	Conc.	Number of Spots	
		Test 1 ^a	Test 2 ^b
Flyteck-1	2%	2.4 b ^c	2.3 c
Flyteck-2	2%	2.2 b	2.0 c
MAU-CSO	2%	3.0 b	1.3 c
Neemark	0.5%	9.1 b	-
Neemark	1.0%	2.2 b	-
Neemark	2.0%	1.5 b	4.3 c
Nirma	7.5 ml/l	3.6 b	2.6 c
Nirma	15 ml/l	3.3 b	2.2 c
Nirma	30 ml/l	2.2 b	2.2 c
Untreated	-	88.8 a	37.7 a
Untreated	-	-	52.3 a

^a Mean of 12 replicates. ^b Mean of 15 replicates.

^c Means not followed by the same letter are significantly different (Duncan's multiple range test $P \leq 0.05$).

TABLE 3 Estimates^a of the spray coverage of 2% flyteck-1 on under-leaf surfaces of cotton leaves treated with three sprayers.

Sprayer	Top	Middle	Lower	Mean
Knapsack	54.3 bc	72.0 ab	56.4 bc	60.9 A
Mistblower	48.2 c	62.6 bc	52.8 c	54.5 A
Foot	58.0 bc	80.0 a	46.1 c	61.4 A
Mean	53.5 B	71.5 A	51.8 B	

^a Estimates were based on percentage coverage of 12 water sensitive cards in 4 cardinal directions in 4 replications. Means not followed by the same letter are significantly different (Duncan's multiple range test $P \leq 0.05$).

A small amount of phytotoxicity was observed with some of the sprays on certain cotton cultivars. An average rating of 2 was observed by the 30 ml/l Nirma on cultivar NHB12. This treatment also affected DHY286 (1.5 rating) and DCH-32 and NHH44, both with 1.25. The 15 ml/l Nirma treatment affected G67 and DHY268, both 1.25. Flyteck-1 at 5% affected KV468 and Pourima (rating 1.5) and NCU5 (rating 1.25). Only 9 of the 40 treated cultivars showed any damage and only one leaf had serious damage. These applications were made under cool winter conditions so caution should be exercised during hot summer months.

DISCUSSION

SPW control using the methodology described in the current paper is applicable in countries where hand labour is being used in crop production systems. Complete coverage on the undersides of cotton leaves is essential, and extra time (approximately double) to accomplish this, is required. Shortening the length of the spray wand for knapsack and foot-pump operated sprayers enable operators more flexibility to move the wand in and between cotton plants. The wand should be held so the nozzle directs spray upwards to obtain coverage of the undersides of leaves. Reduced nozzle orifice may give more adequate coverage, particularly with Nirma soap materials to prevent excessive run-off. The older leaves from which adults have emerged need not be sprayed. The very small leaves at the top of the plant are the ones on which eggs are being laid. However, because of minute dense hairs on the leaf surface, these are very difficult to wet. Their isolated position at the top of the plant necessitates spraying an excessive amount of spray into the air to get adequate coverage. Thus, it may be better to concentrate on the upper portion of the plant where the leaves are expanded. The hairs are not as dense and that is where the immature stages are concentrated. Some sprayers may have enough capacity and pressure to use a spray wand held in the center of the open row with a nozzle pointed in an upward angle to each side of the row. In the early season, extensions can be added to position each nozzle closer to the plants in each row.

A suitable, economical and locally available emulsifier should be identified and made available to farmers to enable them to prepare their own emulsifiable cottonseed oil or castorbean oil sprays.

The results of our studies indicated that plant-derived oils and Nirma soap solutions gave satisfactory SPW control, where hand-held spray equipment was routinely used to apply insecticides. Tractor-mounted sprayers with drop-pipes from the boom with nozzles pointing to the side and upward and a relatively high pressure and high volume of spray might have provided adequate coverage of the leaves to obtain good SPW control. However, a vigorous education program must be initiated to inform farmers and their applicators of the necessity to modify their application methodology to provide under-leaf coverage to obtain

acceptable SPW control. The use of plant-derived oils or soap solutions provide an important addition to the list of 16 other management measures listed by BASU (1990) to aid in the management of the whitefly to reduce the problem of stickiness of cotton in India.

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