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Evaluation of insecticides and oils on aphid vectors for the management of *papaya ringspot virus* (PRSV)

C. M. KALLESHWARASWAMY, N. K. KRISHNA KUMAR, M. R. DINESH, K. N. CHANDRASHEKAR AND M. MANJUNATHA

Department of Entomology,
College of Agriculture, Navile, Shimoga-577 201, Karnataka, India
Email: kalleshwara@yahoo.com

Abstract : A field experiment conducted at the Indian Institute of Horticultural Research, Bangalore to evaluate efficacy of different combination of insecticides and oils in reducing papaya ringspot virus (PRSV) transmission by aphids indicated that different combination of insecticides and oils differed in their effectiveness in delaying PRSV infection. A combination of reflective row cover, mineral oil and imidacloprid spray was the most effective treatment in delaying the infection. In any of the treatment combinations, complete protection could not be obtained, probably due to the non-persistent nature of virus transmission. The study clearly demonstrates that avoiding the early PRSV infection is crucial for enhancing the yield of papaya. The use of insecticides in managing this non-persistent virus and its effect on yield are discussed.

Key words: *Papaya ringspot virus*, aphids, insecticides

Introduction

Papaya ring spot is a serious viral disease of papaya transmitted by many species of aphids. This virus affects production and productivity in every region of the world. Papaya plants of all the ages are vulnerable to PRSV and generally exhibit symptoms after three to four weeks of infection. Aphids transmit *Papaya ringspot virus* (Family: Potyvidae) in a non-persistent manner. Epidemiological studies are relevant for virus disease incidence in order to design the management strategies which affect virus transmission by vectors. PRSV was first reported in 1995 (Byadgi, 1995) from south India. Within a decade, the disease has spread causing heavy yield loss. The studies indicated peak aphid population during March and April leading to increased fresh PRSV infection during April-May. *Aphis gossypii* Glover, *A. craccivora* Koch and Myzus persicae (Sulzer) are the three major vectors (Kalleshwaraswamy *et al.,* 2007). Among these, *A. gossypii* is the dominant and efficient vector of PRSV (Kalleshwaraswamy and Krishna Kumar, 2008). Hence, spray intervention may be targeted during the peak activity of *A. gossypii,* which may reduce the natural spread of PRSV. Identification of suitable chemicals hence forms a basis, if chemicals have to be used in the PRSV management. Hence, the present studies were carried out.

Material and methods

A field experiment was conducted from August 2004 to February 2006 using papaya hybrid Surya to evaluate efficacy of different combination of insecticides and oils in reducing PRSV transmission by aphids. Seven treatments (Table 1) were evaluated using a randomized block design with three replications having plot size of 1.8x1.8 m (3 rows and 4 plants per row; 12 plants). For treatment 1, black low density, shiny, metallic grey two polyethylene strips (videocassette tapes 2 cm wide and 10 µm thick) were set at a height of 30 cm above each papaya row of plants. These were used as reflective row covers to repel aphids. As mineral oil was commercially not available, 2T oil (SERVO®- 2 stroke engine oil) was used. All other treatments (insecticides and oils) were applied one month after transplanting and repeated at intervals of 15 days till the crop was removed (February 2006). A total of 29 sprays of different insecticides and oils were given for the entire period. Spray volume ranged from 0.05 liter per plant at the early stage to 0.3 liter at a later stage of the crop.Leaves were sprayed to the point of run-off using a high volume gator sprayer.

Results and discussion

The first appearance of PRSV infected plant was noticed in the month of March 2005 in control plot, six months after planting (Table 1). No plant was infected upto the 6th month in other treatments. During June, 9 months after planting, significantly high PRSV incidence (58.33%) was noticed in control plots. Significantly low incidence was recorded in T_1 [floating row cover + mineral oil 0.1% - imidacloprid 0.0053% (alternative fortnightly spray)] with 11.11 per cent incidence. This was on par with T_2 [(imidacloprid 0.0053% – mineral oil 0.1% (alternative fortnightly spray)] and T_6 (mineral oil only 0.1% (fortnightly spray) with 25.00 and 19.44 per cent incidence, respectively. These treatments were followed by T_3 (imidacloprid 0.0053% – deltamethrin 0.0014% (Alternative fortnightly spray), T_4 (acephate 0.1125% - deltamethrin 0.0014% (alternative fortnightly spray) and T_5 (neem oil 0.1% (fortnightly spray). By 12th month (September 2005), all the plants in control (T_7) were infected. However, only 22.22 per cent of plants were infected in T_1 which was significantly less than all other treatments. This was followed by T_2 with 44.44 per cent incidence. Mean PRSV incidence was more than 50 per cent by the 12th month in all treatments, except in T_1. Only after 15 months, PRSV incidence in T_1 was 55.56 per cent. No significant difference in per cent PRSV infection was observed among T_3, T_4, T_5, T_6 and control. Cent per cent PRSV incidence was noticed in T_4, T_5, and T_6 at 18 months after planting. However, its incidence was 83.33 and 86.11 per cent in T_1 and T_2, respectively. Further, when mean number of aphids trapped in each treatment was compared to control, no significant differences were observed.

Chemicals and oils significantly delayed the incidence of PRSV infection. This was encouraging, as escape from early infection is reported to avoid severe reduction in yield (Gonsalves, 1998). However, different combination of insecticides and oils differed in their effectiveness in delaying PRSV infection. A combination of reflective row cover, mineral

Table 1. Effect of floating row cover, insecticides and oils on number of aphids caught in yellow funnel water trap, incidence of *papaya ringspot virus* and fruit yield

Treatment	Per cent incidence of PRSV						Number of aphids/ trap	Number of fruits/ plant	Fruit yield (kg/ plant)
	3 MAP	6 MAP	9MAP	12MAP	15MAP	18MAP			
T_1	0.00	0.00	11.11	22.22	55.56	83.33	61.00	20.69[a]	11.29[a]
	(0.00)	(0.00)	(16.71)	(27.16)	(48.20)	(69.24)			
T_2	0.00	0.00	25.00	44.44	75.00	86.11	58.50	20.33[a]	8.08[b]
	(0.00)	(0.00)	(29.49)	(41.74)	(60.04)	(71.02)			
T_3	0.00	0.00	33.33	69.44	86.11	97.22	56.00	18.25[a]	8.24[b]
	(0.00)	(0.00)	(34.91)	(56.48)	(71.02)	(85.11)			
T_4	0.00	0.00	30.56	72.22	88.89	100.00	61.00	18.11[a]	9.66[ab]
	(0.00)	(0.00)	(32.91)	(58.26)	(76.29)	(90.00)			
T_5	0.00	0.00	36.11	88.89	88.89	100.00	65.50	21.69[a]	10.35[ab]
	(0.00)	(0.00)	(36.69)	(73.18)	(73.18)	(90.00)			
T_6	0.00	0.00	19.44	55.56	83.33	100.00	61.50	7.86 [b]	4.04[c]
	(0.00)	(0.00)	(22.87)	(48.39)	(68.87)	(90.00)			
T_7	0.00	2.78	58.33	100.00	100.00	100.00	63.50	4.00 [b]	2.16[c]
	(0.00)	(4.84)	(49.80)	(90.00)	(90.00)	(90.00)			
S.Em.±	-	-	7.07	4.64	7.40	5.83	-	1.72	0.96
C.D.(0.05)	NS	NS	14.85	9.73	15.55	12.24	NS	5.36	2.99

T_1- Floating row cover + mineral oil -0.1% - Imidacloprid 0.0053 % (Alternative fortnightly); T_2- Imidacloprid 0.0053 % – mineral oil -0.1% (Alternative fortnightly spray); T_3- Imidacloprid 0.0053 % – Deltamethrin 0.0014% (Alternative fortnightly spray); T_4- Acephate 0.1125%- Deltamethrin 0.0014% (Alternative fortnightly spray); T_5- Neem oil - 0.1% (Fortnightly spray); T_6- Mineral oil only -0.1% (Fortnightly spray); T_7- Control, MAP- Months after planting

oil and imidacloprid spray (T_1) was the most effective treatment in delaying the infection. However, the number of aphids caught in yellow funnel traps set in different treatments did not differ (Table 1), indicating none of these treatments were effective in repelling the aphids. Several earlier reports indicated that reflective row covers and floating row covers delay the appearance of virus diseased plants by excluding or repelling the aphids (Oronzco-Santos *et al.,* 1995). The videocassette tapes used as reflective row covers in the present study were not effective in excluding or repelling the aphids as indicated by trap catches. Only mineral oil (T_6) or neem oil (T_5) application did not protect the crop. This raises the possibility of frequent application or higher doses of oils covering entire foliage of the papaya. However, the preliminary studies indicated that both mineral oil and neem oil were phytotoxic to papaya seedlings at > 0.1 per cent. Hence, commercial formulations with less or no phytotoxicity may be necessary for longer protection to the papaya by inhibiting viruliferous aphids transmitting PRSV. The ecological and economic consequences may or may not permit this. They found mineral oil in combination with imidacloprid and deltamethrin applications were effective in reducing PRSV-W incidence in Zucchini. Complete protection could not be obtained by these chemicals, probably due to the non-persistent nature of virus transmission, where in, transmission generally occurs before the aphids obtain a lethal dose of aphicide.

Significantly higher number of marketable fruits were recorded in T_1 (Floating row cover + mineral oil (0.1%)-imidacloprid 0.0053% (alternative fortnightly spray) with 20.69 fruits per plant. However, this was on par with T_2 (20.33 fruits/ plant), T_3 (18.25 fruits/plant), T_4 (18.11 fruits/plant), and T_5 (21.69 fruits/plant) Least number of fruits were harvested in control (T_7). Significantly, a higher fruit yield was recorded in T_1 (11.29 kg/plant) which was on par with T_4 (9.66 kg/plant) and T_5 (10.35 kg/plant) These treatments were followed by T_3 (8.24 kg/plant) and T_2 (8.08 kg/plant). The fruit yield was significantly lower in control (T_7) (2.16 kg/plant) and T_6 (4.04 kg/plant) (Table 1).

The results of field studies on the effect of chemicals and oils on PRSV incidence clearly indicated that vector management using insecticides alone cannot effectively reduce PRSV disease incidence. Combination of imidacloprid and mineral oil/ imidacloprid and deltamethrin were effective in delaying the PRSV incidence contributing to increased yield. This indicates that vector management using timely chemical intervention as a component has a place in integrated management of PRSV.

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