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Chemical control of the tomato russet mite on tomatoes in the dry tropics of Queensland

I. R. Kay[1] and R. K. Shepherd[2]

[1] Department of Primary Industries, PO Box 591, Ayr, Q. 4807, Australia.

[2] Oonoonba Veterinary Laboratory, Department of Primary Industries, PO Box 1085, Townsville, Q. 4810, Australia.

Abstract

Seven trials were conducted from 1982 to 1985 to test the efficacy of 14 acaricides in controlling the tomato russet mite, *Aculops lycopersici* (Massee), on tomatoes in north Queensland.

The most effective acaricides (dose rate in g a.i./ha) in controlling an established infestation of *A. lycopersici* were dicofol (500), SLJ 0312 (500), cyhexatin (200), azocyclotin (200), sulprofos (720), and monocrotophos (400, 600). Fenbutatin oxide (220) was moderately effective but demeton-S-methyl (275), dimethoate (300), DPX 3792 (300), endosulfan (735), methamidophos (1102), propargite (300), and sulphur (3000) were ineffective.

Weekly or fortnightly applications of an effective acaricide were necessary to prevent a damaging infestation of *A. lycopersici* from developing. Three-weekly or monthly applications were not sufficient. Dicofol (500) and cyhexatin (200) were the most effective preventative treatments, and sulprofos (720) and monocrotophos (400) were also effective. Sulphur (3000) was ineffective.

INTRODUCTION

The tomato russet mite, *Aculops lycopersici* (Massee), damages the foliage, stems, and fruits of tomato plants and can eventually kill the plants.

A. lycopersici was an important and common pest of tomatoes in Queensland before 1970 (Sloan 1938; Smith and Saunders 1956). During the decade to 1980 the incidence of *A. lycopersici* declined in commercial tomato plantings, and Smith (1977) attributed this decline to the use of dithiocarbamate fungicides such as maneb and propineb in disease control schedules on tomatoes. It is probable that the use of organophosphorous insecticides such as methamidophos for *Heliothis* spp. control also helped to suppress the mite.

Since 1980 the incidence of *A. lycopersici* infestations on tomatoes has increased despite the continued use of dithiocarbamate fungicides and methamidophos. In north Queensland infestations are most severe during the peak production months from July to November and specific control measures are essential to prevent severe damage to tomato crops.

Smith and Saunders (1956), in the most recently published trial work in Australia, found sulphur and parathion effective against *A. lycopersici* at Bowen. Demeton-S-methyl, dicofol, and sulphur were recommended to control the mite in Queensland (Anon. 1979).

The re-emergence of *A. lycopersici* as a serious pest and the apparent ineffectiveness of some of the recommended acaricides made it essential to reappraise control measures against the mite. This paper reports the results of a series of trials carried out from 1982 to 1985 in the Bowen and Ayr districts of north Queensland. The trials investigated the efficacy of a range of acaricides in controlling *A. lycopersici*, and the frequency of treatment necessary to prevent damaging mite infestations from developing.

MATERIALS AND METHODS

Seven trials were conducted. Trials 1 to 5 were carried out from August to November 1982, Trial 6 from August to October 1983, and Trial 7 from September to November 1985.

The tomato cultivar Flora-Dade was used in Trials 1 to 6, and a breeding line, 9-2-7-4, similar to Flora-Dade and to cultivar Delta Contender (D. McGrath, pers. comm. 1985) was used in Trial 7. In all the trials the tomatoes were grown as irrigated ground crops.

All trials were randomised block designs with four replicates. Chemical treatments were applied in 1000 L/ha of water using a Rega pneumatic sprayer fitted with a single hollow cone nozzle and operated at 200 to 250 kPa.

Acaricides used were:

azocyclotin	250 g/kg	wettable powder
cyhexatin	500 g/kg	wettable powder
demeton-S-methyl	250 g/L	emulsifiable concentrate
dicofol	240 g/L	emulsifiable concentrate
dimethoate	300 g/L	emulsifiable concentrate
*DPX 3792	250 g/kg	wettable powder
endosulfan	350 g/L	emulsifiable concentrate
fenbutatin oxide	550 g/L	suspension concentrate
methamidophos	580 g/L	emulsifiable concentrate
monocrotophos	400 g/L	emulsifiable concentrate
propargite	300 g/kg	wettable powder
sulphur	800 g/kg	wettable sulphur
sulprofos	720 g/L	emulsifiable concentrate
*SLJ 0312	500 g/kg	wettable powder

(* experimental chemicals)

Trials 1 to 4

These trials were done to quickly screen 14 potential acaricides in commercial tomato crops heavily infested with *A. lycopersici* and showing obvious damage. Dicofol was included in each trial as a standard treatment. Rates of chemical commonly used to control mites were used. Plot size was one row by 5 m. *A. lycopersici* numbers were counted at 1 day pre-treatment and at 3, 5 and 8 days post-treatment, except in Trial 1 in which one post-treatment count was done at 5 days.

Trial 5

In Trial 5 a heavily infested tomato crop was sprayed twice (on day 0 and day 6) with the seven most promising chemicals from Trials 1 to 4. Mites were counted on day −1, day 5, day 11, and day 14. Plot size was one row by 5 m.

Trial 6

Trial 6 investigated the frequency of acaricide application required to prevent an infestation of *A. lycopersici* from developing to damaging levels. Acaricide treatments, which began one week after seedlings were transplanted to the field, were weekly, fortnightly or monthly applications of dicofol, or three-weekly applications of sulprofos. Plot size was two rows by 10 m and plots were separated by single untreated guard rows. The whole trial area was sprayed at weekly intervals with permethrin to control *Heliothis* spp. and with mancozeb for disease control.

A. lycopersici numbers were counted at five weeks and nine weeks after field planting.

Tomatoes were harvested from 5 m of each row per plot; that is, 10m per plot, in two picks. Coloured and green-mature fruit were harvested in the first pick nine weeks after field planting, and all remaining fruit were harvested a week later. Fruit were counted and weighed, and results from the two picks were bulked for analysis. Fruit quality was not assessed.

Trial 7

In Trial 7 the efficacy of cyhexatin, dicofol, monocrotophos, sulphur and sulprofos as preventative treatments was investigated. Sulphur was included here as it is a commonly used miticide and it was deemed necessary to test its prophylactic properties despite its ineffectiveness in Trial 3. The acaricides were applied at fortnightly intervals starting one week after seedlings were transplanted into the field, and a total of five applications were made. Plot size was one row by 10 m. The whole trial was sprayed at weekly intervals with permethrin for *Heliothis* spp. control and mancozeb for disease control.

A. lycopersici numbers were counted at five, seven and nine weeks after field planting.

At nine weeks post-planting the lower stems of plants in each plot were examined for symptoms of *A. lycopersici* damage (lack of hairs and russetting of stem) and the plot was rated from 0 = no damage to 5 = severe damage.

Tomatoes were harvested from 6 m of row per plot in three picks, each separated by a week, starting ten weeks after field planting. Coloured and green-mature fruit were harvested in the first two picks, and all remaining fruit were harvested in the final pick. Fruit were counted and weighed, and the data from the three picks were bulked for analysis. Fruit quality was not assessed.

Numbers of *A. lycopersici*

The method of counting *A. lycopersici* was the same for each trial. Ten leaf discs (each 29 mm^2) per plot were punched from leaves near the base of plants if damage was not obvious, or from just above obvious plant damage. The leaf discs were placed with the underside of the leaf upwards in a holding card which was then wrapped in Glad Wrap® to prevent desiccation. The leaf punch and holding cards were similar to those described by Hoffman *et al.* (1970) for collecting and holding lepidopterous eggs. The cards were taken to the laboratory and the numbers of living *A. lycopersici* adults and nymphs on the leaf discs were counted with the aid of a Wild M8 stereomicroscope at 40 × magnification. Counts for the 10 discs per plot were bulked. Mites on the underside only of leaves were counted as preliminary work had shown much higher numbers on the underside than on the topside of leaves.

Statistical analysis

Analyses of variance were used to test for treatment differences. If significant treatment differences were detected ($P<0.05$), pairwise comparisons were made using Student's *t*-test. A logarithmic transformation was used on the mite count data before analysis. Pre-treatment mite count was used as a covariate in the analyses of post-treatment counts for Trials 1 to 5. The results of the covariance analysis were used only if the covariate was significant. Only back transformed means and the coefficient of variation from the analysis of the transformed data are presented in each table.

RESULTS AND DISCUSSION

Trials 1 to 4

The results of these trials (Table 1) allowed separation of the 14 miticides into those that were effective against *A. lycopersici* (cyhexatin, dicofol, monocrotophos at both rates, and sulprofos) and those for which the evidence was inconclusive (azocyclotin and SLJ 0312) or that were ineffective (fenbutatin oxide, dimethoate, demeton-S-methyl, DPX 3792, endosulfan, methamidophos, propargite, and sulphur).

The lack of effectiveness of methamidophos, propargite and sulphur in these trials confirmed the experience of commercial growers who reported poor results after using them. Abou-Awad and El Banhawy (1985) reported that *A. lycopersici* in Egypt had developed resistance to methamidophos which had been used for its control. The failure of methamidophos to control *A. lycopersici* in Trial 4, and in commercial situations, raises the possibility that the mite has developed resistance to the chemical in north Queensland.

Demeton-S-methyl, which had been recommended for *A. lycopersici* control (Anon. 1979) was ineffective in Trial 2 and in a subsequent small field test (I. R. Kay, unpub. data 1982).

The results of Trials 1 to 4 demonstrated that a single application of even the most effective acaricides was not sufficient to completely control an established infestation of *A. lycopersici*. Survivors and newly hatched nymphs meant unacceptable numbers of mites remained.

Trial 5

All chemicals caused some reduction in mite numbers compared to the untreated check after the first application, although the difference was not significant ($P>0.05$) in some cases and numbers in the fenbutatin oxide treatment actually increased (Table 2). After the second application all the chemical treatments, except fenbutatin oxide on day 11 had significantly fewer ($P<0.05$) mites than the untreated check. The second application of all chemicals provided improved control, except for monocrotophos where the numbers remained almost constant.

Dicofol, SLJ 0312, and cyhexatin were the most effective treatments against *A. lycopersici* after two applications. Azocyclotin performed better than in the previous trials. Sulprofos and monocrotophos gave reasonable control of *A. lycopersici* in this trial. Both these chemicals (monocrotophos at 1000 g a.i./ha) are effective in controlling *Heliothis* spp. on tomatoes (Kay 1983), and their use in a *Heliothis* control spray programme may obviate the need to apply specific acaricides to control *A. lycopersici*.

Trial 6

A. lycopersici numbers were low at five weeks post-planting but numbers were high and damage obvious at nine weeks post-planting. Numbers of *A. lycopersici* decreased significantly ($P<0.05$) with increasing frequency of acaricide application (Table 3). Control provided by weekly and fortnightly applications was good, but three-weekly and monthly applications allowed the mite population to increase.

Table 1. The effect of acaricide treatments on numbers of *A. lycopersici* in Trials 1 to 4

Treatment (g a.i./ha)	Mean number* of *A. lycopersici*			
	Pre-treatment	Day 3	Day 5	Day 8
Trial 1				
Untreated check	381*a*†	n.a.	514*a*	n.a.
Dicofol (500)	437*a*	n.a.	164*b*	n.a.
Sulprofos (720)	279*a*	n.a.	117*b*	n.a.
Cyhexatin (200)	287*a*	n.a.	150*b*	n.a.
Endosulfan (735)	340*a*	n.a.	205*b*	n.a.
CV‡	7.2	n.a.	10.9	n.a.
Trial 2				
Untreated check	98*a*	82*ab*§	151*ab*§	154*ab*
Dicofol (500)	93*a*	44*b*	96*b*	83*b*
Demeton-S-methyl (275)	101*a*	90*ab*	152*ab*	176*a*
Monocrotophos (600)	123*a*	6*c*	7*c*	5*c*
Azocyclotin (200)	100*a*	63*ab*	99*b*	89*b*
Propargite (300)	69*a*	116*a*	220*a*	192*a*
CV	9.9	12.2	8.3	10.5
Trial 3				
Untreated check	58*a*	72*a*§	146*a*	144*ab*
Dicofol (500)	56*a*	24*cd*	65*bc*	55*c*
Dimethoate (300)	54*a*	56*ab*	76*bc*	116*ab*
Monocrotophos (400)	75*a*	14*d*	20*d*	16*d*
Fenbutatin oxide (220)	52*a*	68*a*	57*c*	108*ab*
Cyhexatin (200)	52*a*	30*bc*	52*c*	51*c*
DPX 3792 (300)	73*a*	61*a*	108*ab*	206*a*
SLJ 0312 (500)	60*a*	58*ab*	71bc	85*bc*
Sulphur (3000)	71*a*	51*ab*	90*abc*	125*ab*
CV	7.4	12.2	9.2	10.3
Trial 4				
Untreated check	137*a*	170*a*	213*a*	337*a*
Dicofol (500)	135*a*	92*bcd*	81*cd*	72*c*
Sulprofos (720)	97*a*	57*d*	64*d*	72*c*
Endosulfan (735)	117*a*	172*a*	167*ab*	247*a*
Methamidophos (1102)	142*a*	129*ab*	176*a*	243*a*
SLJ 0312 (500)	129*a*	110*ac*	98*bcd*	106*bc*
Azocyclotin (200)	120*a*	78*cd*	126*ac*	110*b*
CV	5.0	7.2	6.5	5.4

* Back transformed means after $\log_e$ transformation.

† For each trial, in each column treatments not followed by the same letter are significantly different ($P<0.05$).

‡ Coefficient of variation of transformed data.

§ Covariate corrected means using pre-treatment count as covariate.

n.a. = not available.

The adverse effect of *A. lycopersici* on yield is demonstrated by the reduction in yield in the unsprayed check compared with any of the acaricide treatments. The monthly dicofol treatment yielded less than the weekly or fortnightly treatments. The three-weekly sulprofos treatment also had a significantly higher ($P<0.05$) yield than the monthly dicofol treatment, but it was not significantly different from the more frequent dicofol treatments. Improved control of *Heliothis* spp. provided by the sulprofos may have contributed to the high yield in this treatment despite the build up of mites.

Table 2. The effect of acaricide treatments on numbers of *A. lycopersici* in Trial 5. Treatments were applied on day 0 and day 6

Treatment (g a.i./ha)	Mean number* of *A. lycopersici*			
	Day−1	Day 5	Day 11	Day 14
Untreated check	165*a*†	310*a*	268*a*	281*a*
Fenbutatin oxide (220)	148*a*	211*ab*	111*ab*	77*b*
Monocrotophos (400)	214*a*	80*c*	51*bc*	64*b*
Sulprofos (720)	215*a*	204*ab*	47*bc*	38*bc*
Azocyclotin (200)	214*a*	163*ac*	38*bc*	15*cd*
Cyhexatin (200)	174*a*	92*c*	21*cd*	9*de*
SLJ 0312 (500)	225*a*	145*bc*	11*d*	5*de*
Dicofol (500)	189*a*	159*ac*	10*d*	4*e*
CV‡	6.1	9.8	20.6	25.8

* Back transformed means after $\log_e$ transformation.

† In each column treatments not followed by the same letter are significantly different ($P<0.05$).

‡ Coefficient of variation of transformed data.

Table 3. The effect of frequency of acaricide treatment on *A. lycopersici* numbers and tomato yield in Trial 6

Treatment (g a.i./ha)	Number of sprays applied	Mean number of *A. lycopersici*		Mean yield of tomatoes	
		5 weeks post-plant	9 weeks* post-plant	Weight (kg)	Number of fruit
Untreated check	0	0 (†)	284*a* (−)‡	27.3*a*	244*a*
Dicofol weekly (500)	9	0 (1)	1*e* (1)	40.1*c*	385*c*
Dicofol fortnightly (500)	5	0 (2)	5*d* (2)	38.0*c*	339*bc*
Dicofol monthly (500)	3	0.3 (4)	75*b* (4)	32.4*b*	313*b*
Sulprofos 3-weekly (720)	3	0 (1)	31*c* (2)	39.8*c*	378*c*
CV§		n.a.	14.6	10.1	12.4

* Back transformed means after $\log_e (x + 1)$ transformation.

† Weeks since last spray.

‡ In each column treatments not followed by the same letter are significantly different ($P<0.05$).

§ Coefficient of variation.

n.a. = Not analysed.

Trial 7

Numbers of *A. lycopersici* were low in all treatments at five and seven weeks post-planting and the counts were not analysed. Mite numbers had increased at nine weeks post-planting (Table 4) and plant damage was conspicuous in the field.

Sulphur was not effective as a preventative treatment, allowing mite numbers to increase and damage to occur. These results, coupled with those recorded in Trial 3, show that it is no longer effective against *A. lycopersici*. Sulprofos and monocrotophos adequately protected the plants from *A. lycopersici*, and dicofol and cyhexatin gave excellent control.

No significant differences in yield between the treatments were recorded. The harvest data show that over half of the fruit from the check and sulphur treated plots were harvested in the first two picks compared to between 27% and 39% for the other treatments. Since heavy rain fell between the second and third picks and caused loss of fruit due to rotting it is likely that the loss due to rotting was higher in the treatments with better mite control. Hence it is likely that significant yield increases due to improved mite control were masked by the fruit loss due to rotting. Although fruit quality was not assessed it was obvious that many of the fruit in the untreated check and sulphur treatments were blotchy because of mite damage, and sunburnt because of defoliation resulting from mite damage to the leaves.

Table 4. The effect of acaricide treatments on *A. lycopersici* numbers, stem symptom rating, and tomato yield in Trial 7

Treatment (g a.i./ha)	Mean number of *A. lycopersici*			Stem symptom rating	Mean yield of tomatoes	
	5 weeks post-plant	7 weeks post-plant	9 weeks* post-plant		Weight (kg)	Number of fruit
Untreated check	0	1.5	63.2*a*†	4.6*a*	30.6*a*	254*a*
Sulphur (3000)	0	3.5	27.2*a*	3.9*a*	31.3*a*	267*a*
Sulprofos (720)	0.3	0	5.9*b*	2.6*b*	41.9*a*	345*a*
Monocrotophos (400)	0	0	5.5*b*	2.9*b*	37.9*a*	326*a*
Cyhexatin (200)	0	0	0.6*c*	0.5*c*	40.1*a*	345*a*
Dicofol (500)	0.3	0	0.4*c*	1.1*c*	36.6*a*	318*a*
CV‡	n.a.	n.a.	34.9	23.2	22.6	23.3

* Back transformed means after $\log_e (x + 1)$ transformation.

† In each column treatments not followed by the same letter are significantly different ($P<0.05$).

‡ Coefficient of variation.

n.a. = not analysed.

Based on the results of these seven trials, recommendations have been made for the control of *A. lycopersici* on tomatoes. Dicofol is recommended to control (with two applications) or to prevent (with fortnightly applications) an infestation of the mite. Alternatively, the inclusion of sulprofos or monocrotophos, at least fortnightly, in a spray programme against *Heliothis* spp. is suggested to prevent the build up of damaging mite populations.

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