2023 Silverleaf whitefly resistance surveillance

A total of 19 field populations of *Bemisia tabaci* were collected in QLD and NSW and tested for resistance to high priority registered insecticides like pyriproxyfen and spirotetramat. Lower priority insecticides for example bifenthrin were tested against one population from each region only (Table1).

Table 1. Summary of insecticide resistance in whitefly collected from cotton in 2023.

	Pyriproxyfen	Spirotetramat	Buprofezin	Bifenthrin	Acetamiprid	Diafenthiuron	Dinotefuran	Emamectin
Emerald	*	*	*	*	*	*	*	*
Theodore	*	*	*	*	*	*	*	*
Chinchilla	*	*	*	*	*	*	*	*
Lockyer Valley	*	*	*	*	*	*	*	*
St George	***	***	***	*	***	***	*	*
Mungindi	**	**	**	*	**	***	*	*
Goondiwindi	***	***	***	*	***	***	*	*
Moree	***	***	***	*	***	***	*	*
Namoi valley	***	***	*	*	***	***	*	*
Warren	*	*	*	*	*	*	*	*

Each population tested is represented by a * symbol, with detected resistance designated by colour: none (*), low (*), moderate (*) or high (*)

To determine if a population has resistance, two responses in the bioassay results are evaluated:

1. Population survival at the discriminating dose, and
2. Insecticide concentration required to kill 50% of the tested population (LC_{50})

The discriminating dose is the concentration of insecticide in a laboratory bioassay that will kill 100% of a field population without resistance. Where there is survival, there is reasonable confidence that the population tested contains resistant individuals.

Reduced sensitivity in field populations to insecticides can be measured by dividing the LC_{50} of the field population by the LC_{50} of a known susceptible population. Called the resistance ratio, a value of 1 means there is no difference between the known susceptible population and the field

population. A resistance ratio of 10 means that the concentration required to kill 50% of population was 10 times the concentration to kill the known susceptible. The known susceptible population used for silverleaf whitefly resistance testing has been kept in a laboratory without contact with insecticides since the mid-1990s. Interpreting resistance ratios (RRs) can be difficult; the following system is usually used: susceptible (RR=1), tolerance to low resistance (RR=2-10), moderate resistance (RR=11-30), high resistance (RR= 31-100), very high resistance (RR>100). In the tables below resistant populations are highlighted in bold text.

Pyriproxyfen

Resistance was detected in three populations, one from Mungindi (RR 20.6), and two from the Lower Namoi valley (RR of both 10.2) (Table 2). This result is an improvement on the result from 2022 where resistance was detected in six populations out of 13 tested and five of the six populations had moderate levels of resistance (RRs 11.8 – 27).

Table 2. Toxicity of pyriproxyfen to whitefly collected from cotton in 2023.

Population	LC_{50} (mg/L)	Survival (%) at Discriminating Dose (10mg/L)	Resistance ratio
Emerald	0.06	0.0	2.9
Theodore	0.02	0.0	1.3
Chinchilla	0.13	0.0	7.1
Lockyer Valley	0.03	0.0	1.6
St George (1)	0.19	0.0	10.3
St George (2)	0.18	0.0	9.7
St George (3)	0.12	0.0	6.3
Mungindi (1)	**0.38**	**1.2**	**20.6**
Mungindi (2)	0.16	0.0	8.7
Goondiwindi (1)	0.11	0.0	6.2
Goondiwindi (2)	0.13	0.0	6.8
Goondiwindi (3)	0.10	0.0	5.5
Moree (1)	0.12	0.0	6.3
Moree (2)	0.09	0.0	4.9
Moree (3)	0.12	0.0	6.5
Namoi valley (1)	**0.19**	**0.4**	**10.2**
Namoi valley (2)	**0.19**	**0.9**	**10.2**
Namoi valley (3)	0.18	0.0	9.9
Warren	0.10	0.0	5.4

Spirotetramat

Resistance was detected in 8 populations out of 19 tested (Table 3). Moderate resistance was detected in the Lockyer valley (RR 15.8). Elsewhere resistance is at a very low level (RRs 0.7-1.7). The biggest change to the previous season is the increase in the number of populations with resistance, an indication that resistance is now widespread.

Table 3. Toxicity of spirotetramat to whitefly collected from cotton in 2023.

Population	LC_{50} (mg/L)	Survival (%) at Discriminating Dose (100 mg/L)	Resistance ratio
Emerald	**6.39**	**0.7**	**1.6**
Theodore	3.34	0.0	0.8
Chinchilla	**2.85**	**2.0**	**0.7**
Lockyer Valley	**64.38**	**33.6**	**15.8**
St George (1)	3.80	0.0	0.9
St George (2)	**6.56**	**0.7**	**1.6**
St George (3)	4.45	0.0	1.1
Mungindi (1)	10.06	0.0	2.5
Mungindi (2)	**6.85**	**2.7**	**1.7**
Goondiwindi (1)	5.58	0.0	1.4
Goondiwindi (2)	**4.76**	**1.4**	**1.2**
Goondiwindi (3)	5.27	0.0	1.3
Moree (1)	2.15	0.0	0.5
Moree (2)	3.65	0.0	0.9
Moree (3)	**2.96**	**3.2**	**0.7**
Namoi valley (1)	4.43	0.0	1.1
Namoi valley (2)	4.20	0.0	1.0
Namoi valley (3)	**3.23**	**0.8**	**0.8**
Warren	5.08	0.0	1.4

Buprofezin

Moree (3) had survivors at 32 mg/L, the highest concentration in our current bioassay. Moree (3) was selected for resistance with 200 mg/L (a dose we consider diagnostic) and no survivors were observed (Table 4).

Table 4. Toxicity of buprofezin to whitefly collected from cotton in 2023.

Population	LC_{50} (mg/L)	Survival (%) at (32 mg/L)	Resistance ratio
Emerald	0.50	0	0.5
Theodore	0.28	0	0.3
Chinchilla	0.93	0	0.9
Lockyer Valley	0.15	0	0.2
St George (1)	0.49	0	0.5
St George (2)	0.42	0	0.4
St George (3)	0.37	0	0.4
Mungindi (1)	0.55	0	0.6
Mungindi (2)	0.68	0	0.7
Goondiwindi (1)	0.46	0	0.5
Goondiwindi (2)	0.37	0	0.4
Goondiwindi (3)	0.34	0	0.3

Population	LC_{50} (mg/L)	Survival (%) at (32 mg/L)	Resistance ratio
Moree (1)	2.37	0	2.4
Moree (2)	1.52	0	1.5
Moree (3)	1.60	1	1.6
Namoi valley (1)	0.65	0	0.7
Namoi valley (2)	0.61	0	0.6
Namoi valley (3)	0.53	0	0.5
Warren	0.97	0	1.0

Acetamiprid

Bioassay results detected 3 populations with survival at 300 mg/L (Table 5). Previous to this year we have had only observed survivors at 300 mg/L on two other occasions, in 2017 and 2019. Both populations were collected from Goondiwindi. Selection pressure could not convert either of the populations into a resistant strain.

Table 5. Toxicity of acetamiprid to whitefly collected from cotton in 2023.

Population	LC_{50} (mg/L)	Survival (%) at (300 mg/L)	Resistance ratio
Emerald	4.50	0	1.1
Theodore	8.96	0	2.2
Chinchilla	6.30	0	1.6
Lockyer Valley	13.20	0	3.3
St George (1)	7.10	0	1.8
St George (2)	12.69	0	3.2
St George (3)	**17.11**	**1.2**	**4.3**
Mungindi (1)	8.12	0	2.0
Mungindi (2)	8.76	0	2.2
Goondiwindi (1)	11.14	0	2.8
Goondiwindi (2)	8.07	0	2.0
Goondiwindi (3)	10.55	0	2.6
Moree (1)	6.82	0	1.7
Moree (2)	9.63	0	2.4
Moree (3)	**8.77**	**1.18**	**2.2**
Namoi valley (1)	9.17	0	2.3
Namoi valley (2)	**12.46**	**2.06**	**3.1**
Namoi valley (3)	10.35	0	2.6
Warren	13.83	0	3.4

Bifenthrin

Seven populations out of the 10 tested via bioassay were resistant, with survivors at the discriminating dose (320mg/L). Overall resistance to bifenthrin remains low within the populations tested, based on resistance ratios < 10 fold (Table 6).

Table 6. Toxicity of bifenthrin to whitefly collected from cotton in 2023.

Population	LC_{50} (mg/L)	Survival (%) at Discriminating Dose (320 mg/L)	Resistance ratio
Emerald	1.53	0	0.5
Theodore	2.36	0	0.8
Chinchilla	**3.81**	**4.2**	**1.3**
Lockyer Valley	**20.32**	**9.2**	**6.8**
St George (2)	**4.83**	**4.5**	**1.6**
Mungindi (1)	**5.73**	**2.4**	**1.9**
Goondiwindi (3)	3.56	**1.2**	**1.2**
Moree (3)	**3.46**	**1.0**	**1.2**
Namoi Valley (3)	1.55	0	0.5
Warren	**2.81**	**0.9**	**0.9**

Diafenthiuron

No resistance was detected to diafenthiuron in any of the populations tested in 2023 (Table 7). All populations had 100% mortality at 30 mg/L (dose required to kill 100% of the lab susceptible strain) and in all cases resistance ratios were < 1.

Table 7. Toxicity of diafenthiuron to whitefly collected from cotton in 2023.

Population	LC_{50} (mg/L)	Survival (%) at (30 mg/L)	Resistance ratio
Emerald	2.25	0	0.7
Theodore	2.46	0	0.7
Chinchilla	2.51	0	0.8
Lockyer Valley	2.82	0	0.8
St George (1)	1.91	0	0.6
St George (2)	2.19	0	0.7
St George (3)	1.82	0	0.5
Mungindi (1)	1.80	0	0.5
Mungindi (2)	2.38	0	0.7
Goondiwindi (1)	1.51	0	0.5
Goondiwindi (2)	1.57	0	0.5
Goondiwindi (3)	2.40	0	0.7
Moree (1)	1.89	0	0.6
Moree (2)	2.94	0	0.8
Moree (3)	1.28	0	0.4
Namoi valley (1)	2.12	0	0.6
Namoi valley (2)	1.57	0	0.5
Namoi valley (3)	1.35	0	0.4
Warren	1.89	0	0.6

Dinotefuran

Eleven populations were tested by bioassay for resistance, only Mungindi (2) had survivors at 320 mg/L. Mungindi (2) was selected for resistance at 600 mg/L, and while a few adults survived this dose a viable resistant strain was not produced, therefore the conclusion is that this population was not resistant (Table 8).

Table 8. Toxicity of dinotefuran to whitefly collected from cotton in 2023

Population	LC_{50} (mg/L)	Survival (%) at (320 mg/L)	Resistance ratio
Emerald	8.29	0	0.7
Theodore	13.54	0	1.1
Chinchilla	9.39	0	0.8
Lockyer Valley	23.77	0	1.9
St George (3)	12.45	0	1.0
Mungindi (1)	6.31	0	0.5
Mungindi (2)	20.58	1.3	1.7
Goondiwindi (2)	8.85	0	0.7
Moree (3)	8.86	0	0.7
Namoi valley (3)	9.25	0	0.8
Warren	9.54	0	0.8

Emamectin benzoate

Thirteen populations were tested with no evidence of resistance detected. All field-collected populations recorded 100% mortality at 10mg/L (= dose required to kill 100% of lab susceptible strain) (Table 9).

Table 9. Toxicity of emamectin benzoate to whitefly collected from cotton in 2023

Population	LC_{50} (mg/L)	Survival (%) at (10 mg/L)	Resistance ratio
Emerald	1.92	0	2.1
Theodore	0.85	0	0.9
Chinchilla	1.35	0	1.5
Lockyer Valley	0.67	0	0.7
St George (1)	1.90	0	2.1
St George (2)	1.28	0	1.4
St George (3)	0.85	0	0.9
Mungindi (1)	1.36	0	1.5
Goondiwindi (2)	1.45	0	1.6
Goondiwindi (3)	2.35	0	2.6
Moree (3)	2.48	0	2.7
Namoi valley (3)	0.98	0	1.1
Warren	1.49	0	1.6