BLOWFLY INSECTICIDE RESISTANCE

RESEARCH RESULTS AND ADVICE FOR WOOLGROWERS

KEY POINTS

- Results from a recently completed collaborative AWI project with the NSW Department of Primary Industries (NSW DPI) demonstrated that the number of samples found to be dicyclanil or cyromazine resistant had increased from the survey last done in 2013.
- If woolgrowers already have resistance on their property, this could result in shorter periods of protection than what they could normally expect, rather than a complete loss of effectiveness.
- With the warm summer months upon us, the risk of flystrike is increased, so it is more critical than ever that all woolgrowers continue to closely monitor their flocks and consider modifying their flystrike management program if they have outbreaks that are difficult to manage and control.

With woolgrowers relying less on mulesing for flystrike control, it is increasingly important for them to achieve good results from chemical treatments. This requires strict adherence to label instructions to ensure the correct dose rate is used, application equipment is working properly, and flystrike control products are carefully applied to all at-risk sheep.

Flystrike control products are carefully tested for efficacy and to justify label claims before they are registered. If treatments are applied strictly according to the label instructions, all products should give the protection periods listed on the label. However, there is one 'fly in the ointment': the occurrence of resistance in sheep blowfly populations.

There is a long history of resistance to flystrike control chemicals, including organochlorine compounds, organophosphates, carbamates and to benzoyl phenyl urea growth regulators. Long term use and over reliance on a particular chemical group for any type of pest control almost inevitably results in resistance if good resistance management programs aren't put in place. In the case of sheep blowflies, resistance results in reduced periods of protection from preventative treatments and, in the case of flystrike treatment products, reduced efficacy in killing maggots.

While there are several different flystrike treatments available, an AWI-funded survey in 2019 of woolgrower parasite control practices showed that 64% of respondents nationally used flystrike treatments containing either cyromazine or dicyclanil.

Of Merino producers, 7.2% expressed concerns that some products may not be working as well as previously thought, with the highest concerns in Central NSW where 11.3% suspected the presence of resistance. In addition, a previous study as far back as 2001 indicated the existence of low-level resistance to cyromazine in a number of flocks.

A more recent study of resistance (completed in 2020) has been carried out by AWI in partnership with NSW DPI. Woolgrowers from throughout Australia were asked to send samples of maggots collected from struck sheep to the NSW DPI Elizabeth

Table 1: Survey samples and results: cyromazine or dicyclanil

STATE	SAMPLES TESTED	% SUSCEPTIBLE	% RESISTANT TO CYROMAZINE	% RESISTANT TO BOTH CYROMAZINE & DICYCLANIL
NSW	55	0	100	100
WA	21	24	76	28
SA	12	42	58	25
Vic	11	9	91	82
Tas	1	100	0	0
Overall	100	12	88	73

Macarthur Agricultural Institute for testing.

INSECTICIDE RESISTANCE SURVEY RESULTS

CYROMAZINE AND DICYCLANIL

Blowfly maggot samples were received from woolgrowers in most states and the majority of these samples came from properties with a history of either cyromazine or dicyclanil use. Of the submitted samples, 100 yielded live *Lucilia cuprina* flies that provided viable larvae for resistance testing.

The results from the resistance survey (see Table 1) suggested a high prevalence of dicyclanil (and cyromazine) resistance in NSW, with all strains tested resistant to both dicyclanil and cyromazine, and no susceptible strains were found. There was also a relatively high level of resistance in Victoria although one susceptible strain and one strain with resistance to cyromazine, but not to dicyclanil, was found. Dicyclanil-resistant strains were also found in both WA and SA, but at lower percentages than in the two eastern states (28%, n=6 for WA and 25%, n=3 for SA) and there were a number of strains with resistance to cyromazine, but not to dicyclanil (76%, n=16 for WA and 58%, n=7 for SA). Only one strain from Tasmania was tested and no samples were received from Queensland, possibly as a result of the dry conditions.

It should be noted that these were not a random selection of strains. Therefore, the results should not be interpreted as an estimate of the prevalence of resistance. However, the study does seem to confirm that although dicyclanil resistance was found in both WA and SA, it is more widespread in NSW and Victoria where there is a relatively higher and more consistent flystrike risk than the other states, and hence, higher historic use of these chemicals. It is also likely that there will be areas or flocks in both NSW and Victoria where there is relatively little resistance present.

Samples were also tested to determine if there had been changes in the other main flystrike control chemicals: diazinon, ivermectin, spinosad and imidacloprid.

DIAZINON

With diazinon, resistance in sheep blowflies has been well known for many years and has stabilised in the population. As organophosphates have now been withdrawn from use as preventative treatments, because of occupational health and safety concerns, any impact of resistance is probably minor and only on the efficacy of blowfly dressings in killing blowfly larvae.

IVERMECTIN AND SPINOSAD

With ivermectin and spinosad, results suggested that there was no functional fly resistance present to either chemical.

IMIDACLOPRID

With imidacloprid, results suggested a preliminary shift towards resistance in some flocks. This was most likely due to exposure of sheep blowflies to lice control treatments as imidacloprid has only relatively recently been registered for flystrike control and is not presently widely used in the industry for this purpose. There is no evidence at this stage that there has been any effect on efficacy for flystrike control.

These results underline the importance of having a good resistance management plan in place for ALL chemical products and, in particular, where chemicals from the same chemical group are also used to control other parasites.

EFFECT OF RESISTANCE ON PERIODS OF PROTECTION FROM PREVENTATIVE TREATMENTS

To assess the effect of resistance on field protection, the researchers used an implant trial to test the length of protection against two field-derived strains, a cyromazine- and dicyclanil-susceptible strain and a dicyclanil- and cyromazine-resistant strain whose resistance level was maintained by laboratory selection with dicyclanil. Groups of six sheep were exposed to blowfly larvae under a "high fly pressure" scenario, after treatment with the following products:

- Three dicyclanil spray on products:

  (a) 12.5 g/L dicyclanil, (CLiKZiN™ Spray-On)

  (b) 50 g/L dicyclanil (CLiK™ Spray-On)

  (c) 65 g/L dicyclanil (CLikExtra™ Spray-On)

- A cyromazine jetting fluid: 500 g/L cyromazine (Vetrazin™ Liquid); and
- An ivermectin-based jetting fluid: 16.0 g/L ivermectin (Coopers Blowfly and Lice™)

These results (see Table 2) show that with the dicyclanil and cyromazine products, the protection periods against the susceptible strain larvae were at least equal to the label claims in all instances. However, the resistant strain protection periods were less than half the period of the label claims.

With the ivermectin-based product, although it appeared that there may have also been some reduction in the protection provided, resistance was not indicated in the resistance assays. As the implant trial represents relatively high fly pressure and the original

Table 2: Efficacy of protection

CHEMICAL	CONCENTRATION OF ACTIVE	APPLICATION METHOD	LABEL CLAIMED PERIOD OF PROTECTION	PERIOD OF PROTECTION	
				SUSCEPTIBLE LARVAE	RESISTANT LARVAE
Dicyclanil	12.5 g/L	Spray-on	Up to 11 weeks	>11 weeks	< 3 weeks
"	50 g/L	Spray-on	18-24 weeks	>25 weeks	< 4 weeks
"	65 g/L	Spray-on	Up to 29 weeks	>28 weeks	< 9 weeks
Cyromazine	500 g/L	Jetting	Up to 14 weeks	>15 weeks	< 7 weeks
Ivermectin	16.0 g/L	Jetting	Up to 12 weeks	>12 weeks	< 8 weeks
Control (no treatment)	Nil	N.A.	N.A.	0	0

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label claim was for up to twelve weeks under low to moderate fly pressure, this seems to indicate that the level of susceptibility to ivermectin has not changed significantly. However, the possibility of cross resistance with dicyclanil requires further investigation.

It should be noted that the method used for this study is a more severe challenge than likely in most field situations and provides something of a worst-case scenario. Firstly, the resistant strain comprised a strain of flies developed from the most resistant strains found in the survey. On most properties, even where some resistance already exists, the level of resistance is likely to be lower than in the flies used here. In addition, even though the larval implant method gave protection periods in accordance with label claims when the susceptible strain of flies was tested, larval implants could be considered a more severe test than generally experienced in the field.

EFFECT OF RESISTANCE ON FLYSTRIKE DRESSINGS

The study also tested the effect of dicyclanil resistance on the efficiency of flystrike treatment products. Whilst resistance produced a difference, it was not large. This was not surprising as even with susceptible strains of larvae, in most instances just applying a treatment product will not usually kill all maggots unless other measures such as shearing the wool away from the struck area and physically removing maggots are also used. B

MORE INFORMATION

The AWI/NSW DPI final project report is available at **www.wool.com/flystrikelatest#research-management**
For managing insecticide resistance, refer to **www.flyboss.com.au/sheep-goats/treatment/insecticide-resistance**
Resources available include:

- Resistance management strategy for the Australian sheep blowfly (4-page factsheet, April 2019)
- A Fly in the Ointment – an article about managing insecticide resistance in blowflies (updated November 2020).

HOW DOES THIS CHANGE MY **BLOWFLY CONTROL PROGRAM?**

"Not very much if you are following the resistance management rules," said NSW DPI researcher, Narelle Sales. "If you have resistance on your property and you are applying the chemical correctly, this doesn't mean that the products have totally lost effectiveness, it just means that the period of protection may be less than what you have previously expected – and the degree to which the protection period has been shortened may vary between properties."

When shortened protection periods are noticed, often this is due to poor application or failure to follow label instructions, so the first thing is to check the label and check your application method.

"Resistance is not the end of the road for flystrike control, but it is important to recognise when it is present and manage your flystrike program accordingly."
Narelle Sales, NSW DPI

However, it is more critical than ever to keep a close eye on your flocks, especially with the current Eastern Australian seasonal conditions and a predicted La Nina likely to produce ideal, warm, wet conditions for flies during the high-risk summer/early autumn period.

Close monitoring will allow you to detect strikes quickly if protection starts to break down earlier than expected. In situations where only a few sheep are becoming struck, it will be enough to treat individual strikes as they occur. In other cases, particularly if it is only part way through the flystrike season, it may be necessary to apply an extra flock treatment.

Even on properties where there is currently no resistance, the resistance management rules are the same. Producers should follow the below eight-step insecticide resistance strategy (outlined in more detail on the opposite page), which was developed by AWI's Sheep Blowfly Resistance Management Strategy Working Group:

1. Use an integrated approach to reduce reliance on insecticides.

2. Know your chemical groups.

3. Rotate chemical groups where practical.

4. Minimise the number of treatments applied in a season.

5. Consider treatments for other parasites, particularly lice treatments.

6. Apply insecticides carefully and strictly as specified on the label.

7. Monitor for flystrike frequently.

8. Collect and kill all maggots from flystruck sheep.

FLYSTRIKE RESISTANCE TESTING AVAILABLE

NSW DPI is currently offering sheep blowfly insecticide resistance testing to woolgrowers.

For details, contact Narelle Sales via email at narelle.sales@dpi.nsw.gov.au or phone (02) 4640 6446.

It is vital that sheep producers prudently manage their use of flystrike insecticides, to maintain protection for their flocks and slow the development of resistance within their local fly populations.

INSECTICIDE RESISTANCE STRATEGY TO MAXIMISE FLYSTRIKE CONTROL

1. USE AN INTEGRATED APPROACH TO REDUCE RELIANCE ON INSECTICIDES

- Breed for resistance to all types of flystrike: poll, pizzle, body and breech (breeding for polled animals; low wrinkle, cover, urine stain, dags; and white wool colour. Cull struck sheep).
- Shear or crutch at times that maximise protection against flystrike.
- Dock tails to the correct length.
- Manage sheep to minimise scouring.
- Use breech modification if required, until sheep are genetically resistant to flystrike.
- Use chemicals sparingly.
- Where the above approaches are insufficient, mules with pain relief.

2. KNOW YOUR CHEMICAL GROUPS

- Insecticides used for flystrike control fall into different groups or chemical families; see Table 3 below.
- Flies resistant to one insecticide in a particular chemical group are likely to be resistant to other insecticides in the same group.
- Different flystrike products may contain the same chemical or a related chemical from the same chemical group. When looking for alternatives, change to a different chemical group, don't just change insecticide brands.
- Use the FlyBoss Fly and Lice Products Tool at www.flyboss.com.au/tools/products.php to search for flystrike products, determine their chemical group and make your selection.

3. ROTATE CHEMICAL GROUPS WHERE PRACTICAL

Insecticide choice should be tailored to your particular location and management.

- Consider rotating insecticide products from different chemical groups to slow the development of resistance.
- Use a different chemical group for treating struck sheep to that used for flystrike prevention.
- Successive treatments within the fly season should generally be different chemical groups.
- Choose a product with the appropriate protection period and time of application.
  - A product that provides a shorter period of protection may be sufficient in some instances. For example, when sale of sheep or lambs for slaughter is imminent, when sheep are soon to be crutched or shorn, or when close monitoring of sheep is not possible for a short period because of other farm tasks or holidays.
  - The Flyboss Fly and Lice Products Tool can help you select a chemical group that will provide the length of protection that is required.

4. MINIMISE THE NUMBER OF INSECTICIDE TREATMENTS APPLIED IN A SEASON

- Optimise the timing of treatment to provide full protection during high risk periods.
- Utilise other management strategies, such as shearing and crutching, to minimise the length of time flies may be exposed to inadequate levels of insecticides on the sheep. However, ensure that you abide by wool harvesting intervals so that there are no unacceptable chemical residues in the wool.

5. CONSIDER TREATMENTS FOR OTHER PARASITES, PARTICULARLY LICE TREATMENTS

- Exposure to insecticides used for treatment of other parasites (particularly lice) can contribute to resistance selection in blowflies, and vice versa.
- Where possible, use a different chemical group to treat flies and lice.
- Aim to eradicate lice and avoid the need for lice treatments.

6. APPLY INSECTICIDES CAREFULLY AND STRICTLY AS SPECIFIED ON THE LABEL

- Shorter protection periods are often due to poor application, not resistance. Be sure to apply insecticides carefully according to the label instructions.
- Poor application can expose flies to sub-lethal levels of insecticides; this can contribute to an increase in resistance.

7. MONITOR FOR FLYSTRIKE FREQUENTLY

- Check every 2–3 days during high risk periods to identify struck sheep early.
- Treat sheep and kill maggots before they become larger and are harder to kill.
- Record when strike occurs in relation to preventive treatments.
- Notify the product manufacturer if you suspect resistance.

8. COLLECT AND KILL ALL MAGGOTS FROM FLY STRUCK SHEEP

- Place maggots and shorn wool into a sealed plastic bag and leave in the sun so the maggots are killed.
- If maggots are not collected or destroyed the most resistant ones can burrow into the soil, complete development and contribute to the next generation of flies.

Table 3. Chemical groups and actives available for flystrike control and their application methods

CHEMICAL GROUP	CHEMICAL ACTIVE	APPLICATION METHOD[1]			
		Spray-on	Jetting	Dipping	Dressing
Insect Growth Regulator (IGR)	Cyromazine	Yes	Yes	Yes	Yes
	Dicyclanil	Yes	No	No	No
Neonicotinoid	Imidacloprid	Yes	No	No	No
Spinosyn	Spinosad	No	Yes	No	Yes
Macrocyclic Lactone (ML)	Ivermectin	No	Yes	No	Yes
Synthetic Pyrethroid (SP)	Alpha-cypermethrin[2]	Yes	No	No	No
Organophosphate (OP)	Diazinon, Propetamphos & Chlorfenvinphos	No	No	No	Yes

[1] Always follow label directions

[2] Registered for prevention of body strike only