

STRATEGIES FOR RESISTANCE MANAGEMENT

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Herbicides, fungicides and insecticides/miticides are all vital tools in turf management. Mismanagement and lack of knowledge has led to many products being ineffective. Many products work brilliantly to solve issues but, continuing the same strategy year on year out, you will run into problems. Many readers will no doubt be experiencing or aware of the *Poa* resistance at their facility, however, turf managers need to be aware that this can happen to other weeds, diseases, mites and insects. For all intents and purposes, I will be referring to a disease, insect, weed or mite as a pest. Control measures will be defined as a pesticide.

Resistance comes in different ways and does take time depending on your pest and how it can adapt to the pesticide chemistry mode of action. The rule of thumb is, the bigger the issue and the more often you have to treat it the quicker resistance will come in.

For instance, spring Dead spot that is sprayed yearly usually about 1-2 applications preventively will take a long time for any resistance to become an issue. Usually with spring Dead spot, issues for control occur due to timing and placement issues. Alternatively, diseases such as Dollar spot and anthracnose are more common throughout the year and require more applications due to their more frequent occurrence.

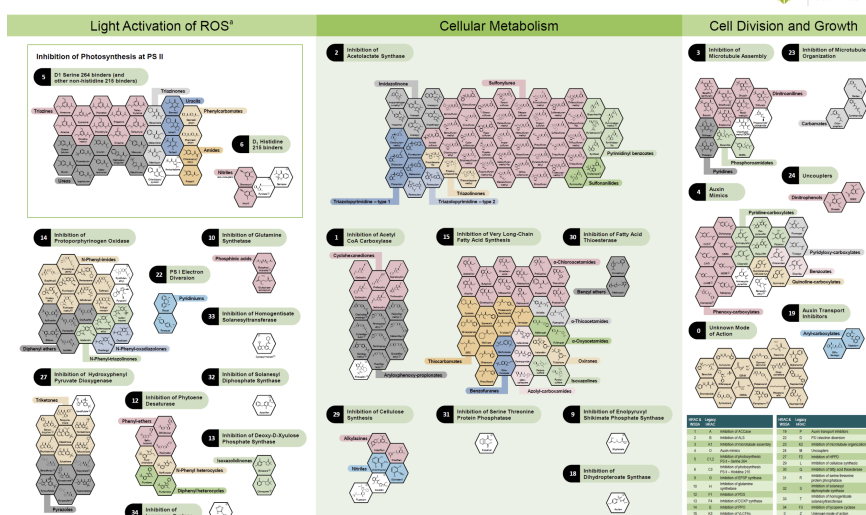
Remember, the only way to prove resistance is present is via scientific means. At the moment, Dr Peter Boutsalis does a great job on herbicide resistance testing and I encourage anyone out there who suspect they have issues to get in touch with him. Fungicide work can be looked at through DPI.

The consensus is very similar to managing resistance across all areas. It is rotate and tank mix differing mode of actions, I will talk about specifically for each category.

Weeds

HRAC (Herbicide Resistance Action Committee) Mode of Action Chart represents all chemical actives and groupings. Note Methiozolin still has an unspecified mode of action, not group 30 as in the chart.

HRAC Mode of Action Classification 2020



I'll concentrate on *Poa* as it's the most troublesome weed for turf managers.

Pre-emergent herbicides

They are a must in this day in age and there has been an increase in the use of these. There have been reports of resistance to all pre-emergent herbicides groupings in the US to *Poa* and this should serve as a warning to turf managers here. This does include indaziflam (Specticle) as an early post emergent (Brosnan, Vargas, Spesard, Netzbund, Zobel, Chene and Patterson). Note indaziflam has been registered in the US for some time now and resistance in Australia will take time but will be an issue.

Post emergent herbicides

We have many products available for *Poa* control but not a wide variety of groups. As you can see by the table, there are a lot of active ingredients with the same mode of action. With heavy reliance on Group B (ALS inhibitor) chemistry for *Poa* control, it was only a matter of time.

Active Ingredient	Common Tradename	Pre or Post Emergent	Resistance Group
Endothal	Poachek [®]	post	Z
Methiozolin	PoaCure [®]	post some pre	Z
Oxadiazon	Ronstar [®]	pre	G
Trifloxysulfuron	Monument [®]	post	B
Foramsulfuron	Tribute [®]	post	B
Idosulfuron	Destiny [®]	post	B
Rimsulfuron	Colesium [®]	post	B
Rimsulfuron/Metsulfuron	Negate [®]	post	B+B
Ethofumesate	Matrix [®]	pre & post	J
Propyzamide	Brek [®]	pre & post	D
Indaziflam	Specticle [®]	pre & post	O
Prodiamine	Barricade [®]	pre	D
S-Metolachlor	Pennmag [®]	pre	K
Oryzalin	Emabrgo [®]	pre	D
Dithiopyr	Dimension [®]	pre	D
Pendimethalin	Various	pre	D

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So, what do you do? Dr Jim Brosnan talks about a zone defence strategy for *Poa* control. There is no one shot control program for weeds. A mixture of control measures need to be used including tank mixes of more than one mode of action at the same time for spraying. This is similar to what I mention below with diseases. The advantage of this is to combat resistance but to also work on strengths of each product which could be mixing a pre and post emergent product. Many tank mixtures are being undertaken in research trials and Bayer have recently done some work in this area (<https://bit.ly/3kFt9P6>) in Australia.

Before going on and tank mixing herbicides:

- Do your research – what works well together. Make sure for instance when spraying for *Poa*, the products you are mixing are products that work on *Poa*. For example, mixing quinclorac + trifloxysulfuron has no added benefit for *Poa* control. However trifloxysulfuron + Prodiamine does.
- Make sure the mixture won't be detrimental to turf safety.
- Follow directions for application and make sure both products can work where they need to.

Another consideration, and to optimise strategy, is timing. Do not wait until weeds are at their strongest to kill them. Kill them early. This can reduce follow up applications as well as slow resistance. The bigger the weed, the more chemical applications it will need to control hence multiple applications may be needed. If in doubt, spray early.

Diseases

Firstly we have to understand there are two categories that the fungicides can be split into:

- Single site fungicides or
- Multi site fungicides

Single site (SS):

SS fungicides only stop the fungus from growing by attacking only one or a few vital systems of the fungus (Vargas). They work with a single mode of action. These types of fungicides are referred to as systemic fungicides (e.g. Triadimenol (Tridim®), Flutolanil (Monstar®) Iprodione (250GT) etc). With this in mind, SS fungicides only need a mutation of a single gene for the fungus to become resistant to the fungicide. These fungicides may be from different groupings, but each group has a specific single mode of action.

Multi site (MS):

MS fungicides attack many different vital systems of the fungus and have multiple modes of action. Common MS fungicides belong to Group M e.g. Thiram (Flowable TMTD®), Chlorothalonil (Dacogreen®). To become resistant to MS fungicides, a fungus has to have simultaneous mutations of the genes that control the metabolic pathways or conditions that the fungicide is interfering with. Hence this is the reason why resistance is difficult with this group. Some systemic products come into this class as well, such as Propamocarb (Proplant®), Foestyl (various), Fluazinam (Emerald®)

Two common strategies are:

- Use a combination of Single site systemic with a contact (Multi site)
- Alternate Single site systemic with a contact (MS)

According to Vargas, for these theories to work the MS (Multi site) fungicide will have to eliminate the resistant strain of the fungus that develops to the SS fungicide. MS fungicides do not do this. They do not select or eliminate one strain over another but remove the selective effort of the SS fungicide for the “resistant” strains. In natural systemics, the “Wild type Strain” is often the more aggressive of the two types and will out compete the “resistant” strain once the influence of the offending (often the SS fungicide) is removed.

When applying a SS systemic and a contact fungicide together, there is still selective pressure on the fungal population for at least 7-14 days. Why? Because the residual of contacts being 14 days and SS systemics being up to 28 days. For example, putting together a MS fungicide that controls Brown patch and Dollar spot with a SS product for Dollar spot may give you up to 28 days control for the Dollar spot but only up to 14 days control of Brown patch. This is due to the fact the MS fungicide controls Brown patch while the SS only does Dollar spot. Thus another spray for Brown patch is needed within two weeks of the application.

Pre-mix products

They are a great tool for helping to manage resistance and diseases in general. However, keep in mind that you still need to mix up your groups and not rely on a pre-mix just because it has 2, 3 or 4 mode of actions. Why? Each chemical in the product may be specific to a certain disease it controls; there is still possible overuse of a mode of action; and some pre-

mix products have a lower amount of active ingredient going out than the stand-alone product, which will increase resistance risk.

Do not be afraid to mix your own products from multiple modes of action even if you are using a pre-mix product.

Insects

Insect resistance is rife within horticulture and agriculture due to multiple generations of the same pests and the lack of proper resistance management in the past. In turf, we tend to see this with Argentine stem weevil more so than Scarab grubs. For scarabs, billbug etc., resistance will take quite some time, however, we still need to rotate here, and tank mix different mode of actions. For stem weevil, this is mandatory. So here, look at utilising all chemistries available as well as looking to tank mix some of them together.

Active Ingredient	Common Tradename	Mode of action	Resistance Group
		AS (Acropetal systemic- moves upwards) TS (Translaminar systemic- moves side to side) S (True Systemic- moves up and down) C (Contact)	
Bifenthrin	Biff ® Venom®	C	3A
Imadacloprid	Merit® Terim®	AS	4A
Thiamethoxam	Moxam ® Meridian® Columbus®	AS	4A
Imadacloprid/Betacyfluthrin	Tempo® Xtra	AS+C	4A+3A
Cyantraniliprole/Thiamethoxam	Spinner®	AS	28+4A
Chlorantraniliprole	Acelepryn®	AS	28
Indoxacarb	Provaunt®	C	22A
Chlofentezine	Apollo ®	C	10A
Abamectin	Thumper®	AS	6
Diafenthiuron	Higarn® Waldo®	AS	12A
Bacillus Thuringiensis Berliner subsp. Aizawai strain GC-91	Bacchus ® WG	C	11C
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Mites

Couch mites have a very short life cycle with evidence showing 5-7 days from nymph stage to adults. It is imperative that monitoring of damage be undertaken to help delay resistance. However, with this short life cycle, resistance will occur a lot quicker than any other issues mentioned. Mite resistance is very common in horticulture crops and they have been losing tools very quickly.

Strategy wise

- Mix up mode of action - don't rely on one group.
- Tank mix ovicides (e.g Apollo®) and adulticides (e.g Thumper®).
- Don't over spray and be patient - turf takes considerable time to recover from mite damage. It can take anywhere from 2-8 weeks for full recovery depending on damage and growth conditions. Just because turf hasn't recovered, don't spray for the sake of it.

Some final thoughts on what you need to understand is that brand new chemical mode of action are going to be rare in general and even rarer in turf. We need to take care in what we have now to use for years to come. I have outlined a summary of strategies here from a chemical point of view. All turf management practices need to be undertaken to aid control and recovery.

Useful websites

<http://www.weedscience.org/>

<http://resistPoa.org/>

www.plantscienceconsulting.com.au

<https://www.frac.info/>

<https://www.croplife.org.au/wp-content/uploads/2019/06/Herbicide-Resistant-Weeds.pdf>

https://www.croplife.org.au/wp-content/uploads/2017/12/RM_Herbicide_Infographic.pdf

https://www.croplife.org.au/wp-content/uploads/2017/11/RM_FungicideInfographic-2.pdf

https://www.croplife.org.au/wp-content/uploads/2017/12/RM_INsecticide_Infographic-CropLife-Aus.pdf

For full mode of action of pesticides please contact the author.

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References available on request



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