



# Is the worm *chemical die cast?*

Dr Terry Mabbett looks at what is left to defend against worms. It's a dwindling arsenal!

**Professional sports turf has exacting requirements and none more so than control of surface casting earthworms.**

All earthworms irrespective of species and soil profile activity are normally a source of good, but three of UK's 28 native species including the largest *Lumbricus terrestris* cause havoc with surface casts. Worm casts ruin play, create slippery conditions, smother fine turf grasses and provide ideal germination sites for coarse grasses and broadleaved weeds. Weeds may arrive as windborne seed or from inside the cast, previously ingested with turf debris, fallen leaves and soil during worm burrowing and feeding. Worm casts appear remarkably resistant to weathering and were still largely intact after heavy snow cover in December 2009 and January 2010.

Killing earthworms with chemicals is an emotive subject clearly not appreciated or understood by environmentalists or the public at large, and more so now when chemical pesticides are 'on trial' in 'Brussels'.

How do you convince 'Joe Public' that killing earthworms with chemicals is acceptable when improvement in soil structure and fertility from earthworm activity is one of the first lessons in school biology?

Charles Darwin said "It may be doubted whether there are many other animals which have played so important a part in the history of the world, as have these lowly organised creatures."

Their contributions to soil as a growing medium for grass include break down of organic matter into plant available nutrients and improvement of soil structure and friability through crumb formation, including aggregation of mineral fractions with humus to form soil particles.

Benefits are generated during burrowing and ingestion of plant organic matter and soil. Earthworm burrowing activity improves soil aeration, permeability and drainage as well as general overall structure, benefitting plant root systems and therefore turf establishment and maintenance.

But 'what goes into the worm must come out' as a thin-convoluted stream representing the bulk indigestible remains of the worm's diet and colloquially called a cast. The majority of earthworm species present no problem from casting which is actually beneficial because the nutrient rich casts are 'dumped' underground in worm burrows.



Surface casting species present few problems for 'run of the mill' grass swards but on fine-turf playing surfaces can cause huge operational problems and potentially most serious on golfing greens where ball roll and bounce is critical to any meaningful play. That said modern green construction and maintenance with drainage carpet and general year round pampering with surfactants and other chemicals that deter earthworm activity means tees and fairways tend to suffer more in practice. In the past greens received a high level of incidental protection when thiophanate methyl and carbendazim were widely used to control Fusarium patch and other turf diseases. Carbendazim is still on the market today but only for use as a wormicide.

### Worm caste management

Good management practice helps to minimise problems but cannot deal with worm casting cleanly and quickly. Turf industry is faced with an impossible task of convincing European Union (EU) legislators and officials, increasingly hostile to pesticide use in general, that the most universally treasured soil animal is a worthy target. This conundrum is clearly apparent in the nature of past and present chemicals used suppress surface casting. None were 'dedicated' wormicides but conveniently happened to kill worms in addition to primary use as an insecticide or fungicide.

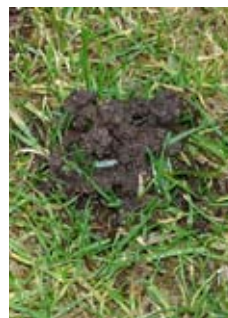
The organo-chlorine compounds 'chlordane' and 'gamma HCH (lindane)' and the carbamate 'carbaryl',

all now redundant in any capacity on turf, were broad spectrum insecticides with potent neurotoxin properties and not surprisingly they killed earthworms too. The two most recently used wormicides, thiophanate methyl (withdrawn) and carbendazim (still on the market), are systemically acting fungicides with a chemical structure conforming to the benzimidazole or MBC (methyl benzimidazole carbamate) grouping. Their wormicidal credentials became apparent during development trials in a totally unrelated sphere, namely control of fungal disease in top fruit orchards some 35 to 40 years ago.

Both were registered for dual fungicide and wormicide use in managed turf. Thiophanate methyl has been withdrawn from any use on managed turf and carbendazim is only approved for use at a specific application rate for suppression of surface casting earthworms. The 'EU' axe still threatens carbendazim which is hardly surprising since it has the same basic chemical structure and mode of action as thiophanate methyl. Thiophanate methyl is a precursor of carbendazim which is also called MBC. When thiophanate methyl degraded it formed MBC (methyl benzimidazole carbamate) the active principal that targeted and killed earthworms.

### Fingers crossed for carbendazim

It's one thing to speculate on the future of a turf pesticide but when a key supplier expresses fears for the future you have to sit up and take



**INSET ABOVE:** Weathered worm cast on a green surround showing a high concentration of sand grains from a typical sandy well drained soil

**MAIN ABOVE:** Close up on a worm cast (Photo courtesy Bayer)

**TOP RIGHT:** Worm casts, freshly deposited (right) and slightly weathered (left) (Picture courtesy Sherriff Amenity)

**BELOW TOP RIGHT** Worm casts smeared on the green surround

**PREVIOUS SPREAD:** Spraying with carbendazim still provides the only quick clean way of suppressing surface casting earthworms (Picture courtesy Sherriff Amenity)



### about the author

Dr Terry Mabbett has experience in grassland agronomy, and tree protection in forestry, horticulture and amenity. He has worked as consultant and technical writer in these fields for 20 years with a strong focus on pest, disease and weed management

notice. Sheriff Amenity markets carbendazim as 'Caste Off' (500g/l carbendazim) for suppression of surface casting earthworms at an application rate of 4 l/ha. The company held a 'turf technology and sustainability' seminar in December 2009 called 'Sheriff Amenity True Solutions Roadshow' where Sales Manager, Neil Pullen, spoke frankly about carbendazim. He said, "the future of carbendazim, like any approved pesticide, is uncertain. At the present time it is registered until 2013 and we are hoping to keep it on the market beyond this date."

Turf industry officials expressed concern about possible loss of carbendazim which would leave greenkeepers with few practical and economic options. BIGGA Immediate Past Chairman, Peter Todd, said many golf courses and especially those on soils with an inherently alkaline reaction would be in crisis. Neil Tuck, Technical Director of BALI (The British Association of Landscape Industries) said the carbendazim situation had simmered for years but now looked like coming to a head following an important change in the criteria used by EU to risk assess pesticides.

Carbendazim is under review by The Chemicals Regulation Directorate which is considering the active ingredient against a new set of criteria used for assessment of environmental and human risk. They include - wait for it - how harmful carbendazim is to earthworms and bees. This means future use of the only chemical approved for suppression of surface-casting earthworms hinges on whether



or not it is harmful to those very earthworms - you couldn't make it up if you tried. Nobody knows for sure what the eventual outcome for carbendazim will be, but not surprisingly the industry doesn't sound optimistic.

Be that as it may, carbendazim is still on the market and doing the job so what are the key features of its activity and continuing success. One person who knows first-hand and better than most is Sheriff Amenty's, Graham Paul, who worked for May & Baker during early development work on thiophanate methyl (precursor of carbendazim) as a top fruit fungicide. It was during these trials that an additional 'lumbricide' (wormicide) dimension to MBC activity was discovered by accident.

"In the 1970's 'Mildothane' (thiophanate methyl) was one of the best selling fungicides for use in apple orchards," said Graham, "offering good control of powdery mildew and apple scab diseases with additional activity against red spider mite." Earthworms were long known for their ability to clear fallen apple leaves from the orchard floor from autumn through to spring. But after 'Mildothane' had been used for two or three seasons researchers noticed leaf litter was not disappearing from apple orchards at the usual rate.

Further investigation showed surface feeding species were absent from the soil inside treated orchards because they had been killed by thiophanate methyl residues left on the leaves from repeated sprays throughout the growing season. Thiophanate methyl and then car-

**MAIN ABOVE:** Worm casts provide germination sites weeds and may allow establishment of weeds that are not normally found in turf like the dock seedling (Rumex) shown here

**TOP LEFT:** Worm casts still largely intact in January 2010 after a heavy covering of snow

**BELOW TOP LEFT:** Worm casts are trodden along the fairway

bendazim were subsequently developed and marketed as wormicides but unlike earlier-used chemicals such as chlordane, which killed worms by skin contact, the MBC's killed worms through ingestion.

### Getting the best from carbendazim

Graham Paul says full of understanding earthworm behaviour and mode of MBC action allows greenkeepers' to obtain the very best from carbendazim. Most effective control of surface feeding and casting species is obtained when grass clippings from the first few cuts after spraying with carbendazim can be left on the surface, so that worms can feed on them for as long as possible. Established recommended practice of boxing clippings during mowing should be carried out at all other times. Leaving grass clippings on other premium sports surfaces like cricket tables is not so much of a problem, because they are not used in early spring and autumn when worm casting is most severe. Golf courses on the other hand are used year round and for regular high profile competition golf.

Graham's advice clearly makes sense. Spray droplets alighting on the turf may stay on the leaf surface or move inside the leaf, while that running off into the soil can be absorbed by the grass roots and translocated acropetally (upwards) into the leaves. What's the point in securing active ingredient on or inside the grass leaves only to remove it soon after by mowing says Graham adding how greenkeepers may have to choose between the

worst of two evils, "wet earthworm casts smearing and spreading during play or a few very short grass clippings."

Greenkeepers should add an appropriate adjuvant (water conditioner) to the spray tank to ensure the mixture remains at the optimum pH to achieve maximum efficacy, says Graham. Carbendazim breaks down rapidly at pH of 9.0 (alkaline) recording a half life of just 12 minutes. In practical terms this means 50% of the carbendazim is rendered inactive within that 12 minute period. At pH 5 (acid) carbendazim has a half-life of 30 hours so spray mixtures buffered at this pH using a water conditioner can slow down alkaline hydrolysis. Deposits of carbendazim drying on the leaf will not suffer fast breakdown and therefore stay active to suppress surface casting earthworms.

Evidence of greenkeepers and groundsmen using carbendazim in the most efficient way should go in its favour, but EU decisions on the future of chemical pesticides are not always logical. Surface casting earthworms are clearly a big problem for greenkeepers and require pro-active control. Carbendazim is the 'last chance saloon' for pro-active chemical control of surface casting earthworms. If carbendazim goes it is difficult to see any other chemical getting through the environmental safety screen now used to risk assess pesticides, and therefore any chemical company prepared to take necessary development investment risks. Best hope for cast-free courses is that those who hold the future of carbendazim in their hands also play golf.



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