Section VII
Section name: Foliage & Seed Insects

BASICS OF THE MOLLUSCICIDE A.I. METALDEHYDE

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Metaldehyde has been used in molluscicide formulations for almost 70 years. Recent studies have now revealed the basics of its mode of action that explain why metaldehyde has a favorable environmental profile in relation to alternative pesticides for use against slugs or snails.

Mode of action

Metaldehyde poisoning is characterized by excess mucus secretion. This is the first symptom of poisoning. Physiologically, this is a detoxifying reaction by the animal in order to flush the toxicant out of its body. On the histological level, metaldehyde damages membranes and organells of the mucus producing cells found in the foot, digestive tract and dermal layers that allow locomotion, digestion and protection (Triebskorn *et al.*, 1998).

The consequences are manifold: The excess mucus production weakens the slug while depleting energy reserves. Feeding ceases rapidly and the slug is immobilized. The damage on the mucus cells is irreversible and lethal. Even ambient water (dew or rain) cannot reverse the effect as metaldehyde does not cause dehydration but complete destruction of the mucus producing tissue. Dehydration occurs as a secondary effect when the slug is immobilized and unable to seek shelter in order to hide from sunlight or drying winds.

This specific mode of action on the mucus producing cells explains the low effect on non-target animals such as carabid beetles (Samsoe-Petersen *et al.*, 1992) that are predator on slugs and eggs and earthworms Bieri *et al.*, 1989). Metaldehyde is rapidly broken down into acetaldehyde that enters into the Krebs cycle providing metabolic energy. This explains why metaldehyde poisoned slugs do not pose a risk to small mammals or birds that feed on them occasionally. In the soil metaldehyde is fully decomposed by microorganisms to CO_2 and H_2O.

The observation of the first symptoms of poisoning (excess mucus secretion) has led to the hypothesis that metaldehyde does not kill directly but anesthetizes and leads to dehydration and, therefore, is characterized by lack of efficacy under wet conditions. Triebskorn *et al.* and earlier

studies have disproved this hypothesis. In addition, the use of metaldehyde to control aquatic snails proves its molluscicidal ability even in immersed conditions (Litsinger and Estano, 1993).

The specific action on the mucus producing cells together with a total decomposition to CO_2 and H_2O result in the favorable environmental profile of metaldehyde as a molluscicide.

Relevant factors for a good product efficacy

Since it has been shown that metaldehyde is toxic to slugs or snails in principle and just not an irritating agent it is important to identify further factors determining the efficacy of a treatment. The active substance is not being applied on the target pest directly but via a bait. First of all the bait preserves the active ingredient and second it provides a vector to the target pest animal. The part in this system crucial for a good efficacy is the carrier material used in the bait. It should match the usual diet of the slug.

Since slugs forage mainly on living plant material an organic carrier material of high nutritional content should dominate the composition of the bait. Further, human and animal repellents, preservatives and agents stabilizing the pellet should not reduce the palatability of the formulation to the slug and snail. Recovery of slugs observed after baiting is due to the ingestion of a sub-lethal dose of the active ingredient. This happens independently from the type of active ingredient and is likely in the case of baits of poor quality that contain cheap carrier material of low palatability to slugs or snails.

Slugs and snails forage on a random basis and are able to locate a food source within only very limited distances of 2 to 3 inches (Teyke, 1995). It is crucial to avoid a failure while treating to provide enough baiting points to allow the slugs to hit a bait rapidly. A bait density of 4 to 5 per sq ft is suggested to be the minimum. A lower density will reduce efficacy over proportionally. On the other hand re-applying the full rate after 2 weeks enhances efficacy over time whilst doubling the rate for one application will not give a better plant protection.

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