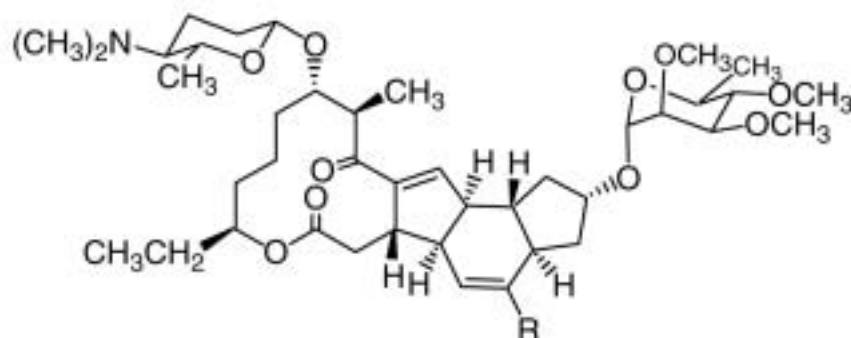


## 2:167 spinosad *Micro-organism-derived insecticide*

*The Pesticide Manual* Thirteenth Edition entry number: 737



spinosyn A, R = H-

spinosyn D, R = CH<sub>3</sub>-

**NOMENCLATURE:** Approved name: spinosad (BSI, ANSI, ISO).

**Development codes:** XDE-105; DE-105. **CAS RN:** [168316-95-8] spinosad; [131929-60-7] spinosyn A; [131929-63-0] spinosyn D.

**SOURCE:** The commercial product is a mixture of spinosyn A and spinosyn D. Both compounds are secondary metabolites of the soil Actinomycete, *Saccharopolyspora spinosa* Mertz & Yoa. The organism is composed of long, yellowish-pink aerial chains of spores encased in distinctive, spiny spore sheaths. The bacterium is aerobic, Gram-positive, non-acid-fast, non-motile, filamentous and differentiated into substrate and aerial hyphae. The aerial mycelium is yellowish-pink and the vegetative mycelium is yellow to yellowish-brown. The parent strain was originally isolated from an abandoned rum still in the Caribbean.

**PRODUCTION:** Spinosad is obtained from a whole broth extraction, following fermentation of the organism on a feedstock of water, vegetable flours, sugar and animal fat.

**TARGET PESTS:** Recommended for the control of caterpillars, leaf miners, thrips and foliage-feeding beetles. Species controlled include caterpillars (*Ostrinia nubilalis* (Hübner), *Helicoverpa zea* Boddie, *Trichoplusia ni* (Hübner), *Plutella xylostella* (L.), *Spodoptera* spp., *Heliothis* spp., *Pieris rapae* (L.), *Keiferia lycopersicella* (Walsingham), *Lobesia botrana* (Denis & Schiffermüller), *Agrotis ipsilon* (Hufnagel), *Parapediasia teterrella* (Zincken), thrips (*Frankliniella occidentalis* (Pergande), *Thrips palmi* (Karny)), flies (*Liriomyza* spp., *Ceratitis capitata* (L.)), beetles (*Leptinotarsa decemlineata* (Say)), drywood termites (*Cryptotermes brevis* (Walker), *Incisitermes snyderi* (Light)), fire ants (*Solenopsis* spp.) and grasshoppers. Under development for control of chewing and sucking lice (e.g. *Linognathus vituli*, *Bovicola ovis* (Schrank), *Solenopotes capillatus* Enderlein) and flies (e.g. *Haematobia irritans* (L.), *Lucilia cuprina* (Wiedemann)), and for control of nuisance flies (e.g. *Stomoxys calcitrans* (L.), *Musca domestica* L.).

**TARGET CROPS:** May be used on row crops (including cotton), vegetables, fruit trees, turf, vines and ornamentals. No crop phytotoxicity has been observed. Under development for use on livestock animals and in livestock premises.

**BIOLOGICAL ACTIVITY: Mode of action:** Spinosad effects on target insects are consistent with the activation of the nicotinic acetylcholine receptor, but at a different site than nicotine or the neonicotinoids. Spinosad also affects GABA ( $\gamma$ -aminobutyric acid) receptors, but their role in the overall activity is unclear. There is currently no known cross-resistance to other insecticide classes. **Efficacy:** The mode of action causes a rapid death of target phytophagous insects. Its moderate residual activity reduces the possibility of the onset of resistance, but it is strongly recommended that it be used within a strong, proactive resistance management strategy. Spinosad is recommended as an ICM tool, as it shows no effects on predatory insects such as ladybirds, lacewings, big-eyed bugs or minute pirate bugs. It has reduced activity against parasitic wasps and flies. It is toxic when sprayed directly onto honeybees and other pollinators, but, once dry, residues have little effect. Spinosad is effective as a bait for fruit flies (*Ceratitis* spp., *Bactrocera* spp., etc.) and some ants (*Solenopsis* spp.). **Key references:** 1) H A Kirst, K H Michel, J S Mynderse, E H Chio, R C Yao, W M Nakasukasa, L-V D Boeck, J L Occlowitz, J W Paschal, J B Deeter & G D Thompson. 1992. Discovery, isolation, and structure elucidation of a family of structurally unique, fermentation-derived tetracyclic macrolides. In *Synthesis and Chemistry of Agrochemicals III*, Chapter 20, D R Baker, J G Fenyes & J J Steffens (eds.), pp. 214–25, American Chemical Society, Washington DC, USA. 2) D J Porteus, J R Raines & R L Gantz. 1996. In *1996 Proceedings of Beltwide Cotton Conferences*, P Dugger & D Richter (eds.), pp. 875–7, National Cotton Council of America, Memphis, TN, USA. 3) T C Sparks et al. 1996. In *1996 Proceedings of Beltwide Cotton Conferences*, P Dugger & D Richter (eds.), pp. 692–6, National Cotton Council of America, Memphis, TN, USA. 4) V L Salgado. 1997. In *Down to Earth*, **52:1**, pp. 35–44, DowElanco, Indianapolis, IN, USA. 5) G D Thompson, R Dutton & T C Sparks. 2000. Spinosad - a case study: an example from a natural products discovery programme, *Pest Management Science*, **56(8)**, 696–702.

**COMMERCIALISATION: Formulation:** Sold as an aqueous based suspension concentrate (SC) formulation. **Tradenames:** 'Conserve', 'Entrust', 'Success', 'SpinTor', 'Tracer', 'GF-120', 'Justice', 'Laser', 'Naturalyte' and 'Spinoace' (Dow AgroSciences), 'Racer Gold' (Agri Life), 'Extinosad' (veterinary use) (Elanco). **Patents:** US 5,202,242 (1993); EPO 375316 (1990).

**APPLICATION:** The compound is applied at rates of 5 to 150 g per hectare. Apply when pest pressure demands treatment. The active ingredient does not dissolve in water and continual agitation is required to prevent the active ingredient from settling out in the spray tank. The addition of adjuvants has not been shown to improve or reduce the performance of spinosad consistently, with the exception of leaf miner control and the penetration of closed canopies, where emulsified vegetable oils have helped.

**PRODUCT SPECIFICATIONS: Purity:** The commercial product is composed of spinosyn A and spinosyn D. Analysis is undertaken by hplc or immunoassay (details from Dow AgroSciences). **Storage conditions:** Spinosad is stable over a wide range of temperatures.

Protect from freezing. Shake well before use. **Shelf-life:** The formulated product has a shelf-life of 3 years.

**COMPATIBILITY:** No compatibility problems have been identified to date when tank-mixing spinosad with other crop protection products, foliar fertilisers or adjuvants. A jar test for compatibility is recommended prior to use.

**MAMMALIAN TOXICITY:** **Acute oral LD<sub>50</sub>:** male rats 3 783, female rats >5 000 mg/kg. **Acute dermal LD<sub>50</sub>:** rabbits >5 000 mg/kg. **Inhalation:** LC<sub>50</sub> (4 h) for rats >5.18 mg/litre. **Skin and eye:** Non-irritating to skin, but slight irritation to eyes (rabbits). Not a skin sensitiser (guinea pigs). **NOEL:** for dogs, mice and rats, following 13 weeks of dietary exposure to spinosad, was 5, 6 to 8 and 10 mg/kg/day, respectively. **ADI:** 0.02 mg/kg b.w. [2001]; (US) 0.027 mg/kg b.w.; (Japan, Australia) 0.024 mg/kg b.w. **Toxicity class:** WHO (a.i.) U; EPA (formulation) IV (tech.), IV ('Tracer'). **Other toxicological effects:** In acute and sub-chronic tests, spinosad did not demonstrate any neurotoxic, reproductive or mutagenic effects on dogs, mice or rats.

**ENVIRONMENTAL IMPACT AND NON-TARGET TOXICITY:** **Bird toxicity:** Spinosad is considered practically non-toxic to birds. The acute oral LD<sub>50</sub> for both bobwhite quail and mallard ducks is >2 000 mg/kg. Acute dietary LC<sub>50</sub> for bobwhite quail and mallard ducks >5 156 ppm. **Fish toxicity:** Spinosad is considered slightly to moderately toxic to fish. The acute 96-hour LC<sub>50</sub> for rainbow trout, bluegill sunfish, common carp, Japanese carp and sheepshead minnow were 30, 5.9, 5, 3.5 and 7.9 mg/litre, respectively.

**Other aquatic toxicity:** EC<sub>50</sub> (48 h) *Daphnia* for 14 ppm. EC<sub>50</sub> (96 h) for Eastern oyster 0.3, grass shrimp >9.76 ppm. EC<sub>50</sub> for *Lemna gibba* 10.6 ppm. EC<sub>50</sub> for algae - *Selenastrum capricornutum* >105.5, *Skeletonema costatum* 0.2, *Navicula pelliculosa* 0.09, *Anabaena flos-aquae* 8.9 ppm. **Effects on beneficial species:** Spinosad is considered highly toxic to honeybees, with less than 1 µg/bee of technical material applied topically resulting in mortality. Once residues are dry, they are non-toxic. **Metabolism:** Feeding studies produced no residues of spinosad in meat, milk or eggs. The half-life on plant surfaces ranged from 1.6 to 16 days, with photolysis as the main route of degradation.

**Behaviour in soil:** Spinosad is rapidly degraded on soil surfaces by photolysis and, below the soil surface, by soil micro-organisms. **Key reference:** D G Saunders & B L Bret. 1997. In *Down to Earth*, 52:1, pp. 14–21, DowElanco, Indianapolis, IN, USA.

**Accepted for use in organic farming:** Yes.