Compiled by Hildegard Klein
ARC-Plant Protection Research Instititute

4. BIOLOGICAL CONTROL OF SOLANUM WEEDS (FAMILY SOLANACEAE: POTATO FAMILY)

4.1 Silverleaf nightshade/satansbos (*Solanum elaeagnifolium*)

ORIGIN OF THE WEED
The satansbos (fig.1) is indigenous to Southern U.S.A. and Mexico.

BIOCONTROL AGENTS
Read more about biological control in general in leaflet 1.3 in this series.

a. The satansbos leaf beetles, *Leptinotarsa texana* and *Leptinotarsa defecta*

Although these two leaf beetles do not have the potential to kill satansbos plants unaided, they are the most damaging natural enemies that are known not to pose a threat to the large number of crop plants in the family Solanaceae. As one component in an integrated control programme they can be very important, especially in dryland crops and in non-crop situations.

Background information on agents
Leaflet 4.2 in this series contains essential information on the life cycle of these insects, their potential as biological control agents and their implementation.

Leaf beetle damage to satansbos
In the northern part of the country, where satansbos is mainly a problem in dryland conditions, the insects have only recently started reaching high population numbers and up to now, the damage has been insignificant. In the Eastern Cape, however, the beetles (mainly *L. texana*) (fig. 3) have periodically caused complete defoliation of patches of plants (fig. 2), in cases extending over several hectares. The beetles do not damage the fruit or the root system, and damaged plants usually resprout from the extensive rootstocks. However, plants that have been defoliated repeatedly by the beetles are usually stunted and produce few fruit. This reduces the abundance of satansbos and alleviates the problem to some extent.

Figure 1. Satansbos with its characteristic blue flowers and yellow fruits.

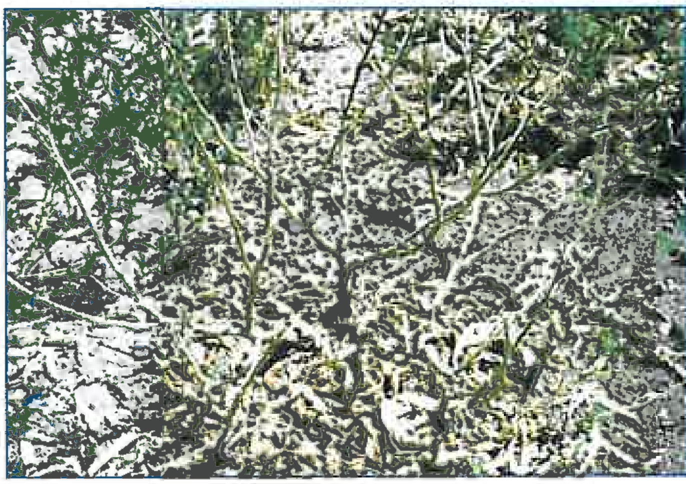

Figure 2. A satansbos plant that has been completely defoliated by the leaf beetles.

CONTROL STRATEGY	
In annual cash crops	• Chemical control - one treatment of 2,4-D before planting. • Biocontrol using leaf beetles on fence lines between fields.
In dryland crops	• Transform field into permanent perennial pasture. • Reduce competitive ability of satansbos by chemical control (2,4-D) and repeated harvesting or controlled grazing. • Alternatively, reduce competitive ability of satansbos through biological control (leaf beetles) and controlled grazing.
Beyond crop situations	• Biological control (leaf beetles)

The four available control methods (mechanical removal, herbicidal control, competition by crops or grasses, and biological control) should be combined in an integrated control strategy that will differ according to the situation.

4.1 Silverleaf nightshade/satansbos *(Solanum elaeagnifolium)*

In annual cash crops: One chemical treatment before planting and subsequent competition by the crop should control satansbos. The cost of the herbicide should be offset by higher crop yields. Where moisture is not a problem (e.g. under irrigation), competition by satansbos does not affect the crops as adversely as in dryland conditions and the weed can therefore be tolerated. Biological control is not an option within fields because ploughing destroys the pupae and adults in the soil and herbicides kill the insects on the plants. However, satansbos plants growing on fence lines between fields can foster a permanent population of beetles which will spread into the fields when conditions are suitable and therefore contribute, at least intermittently, to control of the weed.

In dryland crops: The low crop yields in these situations cannot offset the cost of chemical control, which is therefore not economically viable. The only method that will give permanent control is to transform infested fields into permanent, perennial pastures. Competition by vigorously-growing, permanent crops, can reduce the stands provided the crop plants are well established by the time that satansbos plants emerge in spring. Establish perennial pasture grasses such as Smuts finger grass *(Digitaria eriantha)* and blue buffalo grass *(Cenchrus ciliaris)* before satansbos starts growing actively, i.e. in autumn, winter or early spring. One application of an affordable broadleaf herbicide such as 2, 4-D (or two applications in exceptional cases) can be used to reduce the competitive ability of satansbos further. Satansbos has been known to disappear completely 5 years after this treatment. Dryland lucerne can also compete successfully with satansbos, and should be established in late summer or autumn. Because lucerne is a broadleaf crop, broadleaf herbicides cannot be used to reduce the competitive ability of satansbos. Repeated harvesting or controlled grazing can help to suppress the vigour of satansbos and to exhaust its underground nutrient reserves.

The two *Leptinotarsa* species serve the same purpose as a broadleaf herbicide, *viz.* to remove the above-ground growth and exhaust the root system. They remain in the area permanently and therefore cause repeated defoliation, apart from a broadleaf herbicide devouring the bark and stems. Therefore, their effect is more substantial than that of herbicides. Other management practices have to be adapted to accommodate the insects. If the fields are ploughed in winter, most of the beetle population in the soil will be destroyed. It is therefore recommended not to plough all fields at the same time. Alternatively, strips of infested land between fields should be left so that the insects can multiply undisturbed and spread into the arable lands once satansbos plants start growing. Biological control should be seen as part of an integrated approach and not as the final solution.

Beyond crop situations: Satansbos plants in non-arable areas could support permanent populations of the beetles. Because the cost of herbicides or mechanical operations cannot be defrayed, landowners usually do not tackle satansbos in these situations. It is essential to prevent seed production by the weed in non-arable lands, especially along watercourses, to contain the spread of the weed. Biological control is the most economical solution to the satansbos problem and the beetles should be introduced into these areas. Because neither herbicides nor clearing operations are justified in non-arable lands, these areas provide an ideal habitat for the insects.

Figure 3. An adult (right) and larva (left) of the leafbeetle, *Leptinotarsa texana* feeding on the leaves of satansbos.

CONTACT PERSONS

Consult leaflet 1.4 in this series for the most updated contact details.

- Biocontrol research: Weeds Research Division, ARC-PPRI (Rietondale), Private Bag X134, Pretoria 0001; Tel (012) 329 3269; Fax (012) 329 3278; e-mail weeds@plant2.agric.za.
- Supply of biocontrol agents: National Department of Agriculture, Directorate of Agricultural Land Resource Management (D:LRM), North-West Province

FURTHER READING

OLCKERS, T., HOFFMANN, J. H., & MORAN, V.C., IMPSON, F.A.C. & HILL, M.P. 1999. The initiation of biological control programmes against *Solanum elaeagnifolium* Cavanilles and *S. sisymbriifolium* Lamarck (Solanaceae) in South Africa. In: Olckers, T. & Hill, M. P. (Eds) *Biological Control of Weeds in South Africa (1990-1999). African Entomology. Memoir No. 1.* 55-63.

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ARC-Plant Protection Research Institute

4. BIOLOGICAL CONTROL OF SOLANUM WEEDS (FAMILY SOLANACEAE: POTATO FAMILY)

4.2 The satansbos leaf beetles *(Leptinotarsa texana* and *Leptinotarsa defecta)*

ORIGIN

The satansbos leaf beetles are indigenous to North America.

Life cycle

The adults are dome-shaped, up to 8 mm in diameter, pale yellow beetles with prominent, black stripes along the front wings. The two species are easily distinguishable because *L. texana* (figs.1a and 2) has four dark stripes on each wing while *L. defecta* (fig. 3) has two stripes per wing.

The adult beetles emerge from their pupal chambers in the soil when conditions are favourable, and immediately start feeding on the leaves of satansbos. The beetles may mate several times with different partners and the females start laying eggs about two weeks after emergence.

The adult female lays clusters of about 20 to 40 eggs, which are attached to the lower surface of satansbos leaves (fig. 1b). Each female produces about 300 eggs in her lifespan of 3 to 4 months. The eggs of *L. texana* are pale yellow, almost cream coloured and are larger than the bright yellow eggs of *L. defecta*.

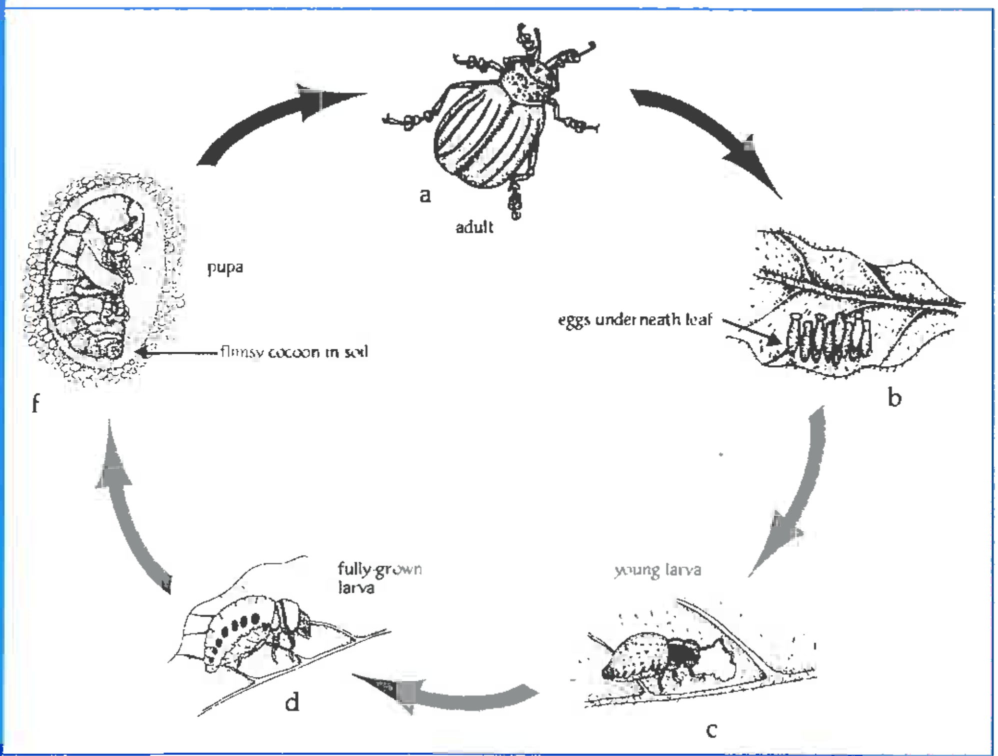

Figure 1. Life cycle of a satansbos leafbeetle.

Larvae hatch from the eggs after approximately 4 days and feed on the eggshells from which they have just emerged. They then start feeding on the satansbos leaves. All the larvae from an egg batch normally remain together and feed as a group until the final stages of development when they split up and feed on their own. The larvae feed mostly on leaves but also destroy flowers and buds but not the fruit. The young larvae are soft and almost black (figs. 1c and 4), but the colour changes first to dark grey and later to light grey (figs. 1d and 5), with two rows of black dots along the sides of the body.

After having moulted (shed their skins) three times, the larvae of *L. texana* have orange heads and can be easily distinguished from *L. defecta* larvae which have black heads. After 12 to 14 days and four moults the larvae stop feeding and become prepupae, which leave the host plant and burrow into the soil where they pupate (fig. 1e). Adults emerge after approximately 10 days. Several generations can be completed during the summer months and the beetles therefore become extremely abundant under favourable conditions.

Because the two beetle species are host-specific and can only survive on satansbos, which dies back during winter, the insects have to overwinter without feeding. During autumn, when the days become shorter and the quality of the satansbos leaves deteriorates, the adult beetles burrow into the soil where they enter into a winter sleep (diapause) until the following spring. They normally emerge shortly after the first spring rains (in summer rainfall regions), or when satansbos plants start to produce new growth.

The two *Leptinotarsa* species have very different dispersal abilities. *Leptinotarsa texana* is a reluctant flier and does not move much. As a result, the beetles may become extremely crowded in certain areas and their food supply becomes exhausted. At this stage, dense aggregations of beetles begin to move outwards forming a "wave" and stripping the satansbos plants as they move. By contrast, *L. defecta* flies readily and the adults disperse widely. Consequently, *L. defecta* does not reach high densities. This type of behaviour allows *L. defecta* to use isolated plants as a food source without having to compete with *L. texana*.

How to tell whether the satansbos leaf beetles are present

Yellow beetles with black lines along their wings are conspicuous on the satansbos plants. The pale yellow egg clusters of *L. texana* or the bright yellow ones of *L. defecta* are easy to find on the underside of satansbos leaves, as well as the large, grey larvae on the leaves. Irregularly-shaped feeding damage is noticeable on the leaves and partially-eaten leaves lie scattered on the ground around the plants. On closer examination, fine, light brown to green faeces may be noticed scattered on the damaged leaves and around the plants. When beetle densities are very high, all the leaves and even the bark are stripped from the plants, leaving only skeletonised stems (fig. 6) with the fruit intact.

4.2 The satansbos leaf beetles (*Leptinotarsa texana* and *Leptinotarsa defecta*)

Leaf beetle damage to satansbos

In the northern part of the country, where satansbos is mainly a problem in dryland conditions, the insects have only recently started reaching high population numbers and up to now, the damage has been insignificant. In the Eastern Cape, however, the beetles (mainly *L. texana*) have periodically caused complete defoliation of patches of plants, in cases extending over several hectares. The beetles do not damage the fruit or the root system, and damaged plants usually resprout from the extensive rootstocks. However, plants that have been defoliated repeatedly by the beetles are usually stunted and produce few fruit. This reduces the abundance of satansbos and alleviates the problem to some extent.

Figure 4. Young leafbeetle larvae (black) feeding on a leaf of satansbos.

Figure 2. Adult of the leafbeetle, *Leptinotarsa texana*, with four black stripes per wing.

Figure 5. A fully-grown larva (light grey) (left) and adult beetle (right) of *L. texana*.

Figure 3. Adult of the leefbeetle, *Leptinotarsa defecta*, with two black stripes per wing.

Figure 6. A satansbos plant that has been defoliated and stripped of its bark by larvae and adults of the leafbeetles.

4.2 The satansbos leaf beetles *(Leptinotarsa texana and Leptinotarsa defecta)*

Collection and redistribution of leafbeetles

The beetles should be collected during mid or late summer in an area where they are already abundant. Contact D:LRM, North West Province, to find out where to collect them. Adult beetles as well as larvae should be collected in ventilated containers or cheesecloth bags containing a few leafy stems of satansbos and a sheet of crumpled paper towel. Do not handle the larvae more than is necessary, but rather collect them together with the entire leaf. Do not leave the container in direct sunshine or in a hot car. If kept cool and dry, and supplied with food, the insects can survive in a container for about a week. A few drops of water can be sprayed into the container once a day for the beetles to drink, but make sure that enough paper towels are supplied to absorb any excess moisture. Ventilation is important because decaying plant material produces fumes that can be lethal to insects.

When releasing the beetles, select a site that will not be ploughed, mowed or treated with herbicides within at least the next 2 years, to give the insects a chance to become well established. Gently shake the insects out of the container onto healthy satansbos plants, making sure that all the larvae land on plants. Release as many beetles as possible at one spot, rather than distributing them more widely.

CONTACT PERSONS

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FURTHER READING

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OLCKERS, T. & ZIMMERMANN, H.G. 1991. Biological control of silverleaf nightshade, *Solanum elaeagnifolium*, and bugweed, *Solanum mauritianum* (Solanaceae) in South Africa. *Agriculture, Ecosystems and Environment* 37: 137-155.

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