Biological control of *Cereus jamacaru* (queen of the night cactus) in the Thornveld of the Limpopo Province, South Africa

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Cereus jamacaru (queen of the night) was introduced to South Africa as an ornamental and a barrier plant. The plant is a large, perennial, upright-growing, evergreen, cylindrical cactus species of South American origin. Because of its attractive shape, its large, white flowers and edible fruits, it is a popular ornamental plant in many gardens in South Africa. This cactus is now a serious alien invader in some parts of South Africa, particularly Mpumalanga and certain areas in Limpopo. This cactus is also a problem plant in Namibia (Bromilow 2001).

It mainly occurs in terrestrial areas under temperate and sub-tropical climatic conditions, and as an environmental weed, it transforms the landscape and appears unattractive to tourists, while it can also be a health risk and cause physical injuries to man and livestock due to thorns. It also creates obstructions for livestock, game and humans (Wells et al. 1986).

During spring, the plant produces flowers that open mainly at night and close the next morning. It produces red fruit that are sought after by birds and monkeys, that act as the main seed distributors. The cactus has the ability to produce roots from small plant fragments, making it a highly successful invader (Bromilow 2001, Klein 2002a). *Cereus jamacaru* was proclaimed a Category 1 weed in South Africa in 1982 (Land Care South Africa 1993). The most common control method involves treating *C. jamacaru* plants with MSMA, anarsenic-based herbicide widely used for the control of various woody and succulent plant species. While small plants are sprayed as they are standing, large plants must be injected via holes made in the upright stems (vascular system) of mature plants, some 1.5 to 2.0 m apart (Vermeulen et al. 1991).

Two insect species were introduced to South Africa to control the harrisia cactus (Harissia martini), biologically but were also found to control *C. jamacaru*. They are the *harrisia cactus mealybug*, *Hypogeococcus pungens* and a *stem-boring cerambycid beetle, Alcidion cereicola*, both indigenous to Argentina and Paraguay.

The main topic of this study, the harrisia cactus mealy bug, was imported from Argentina via Australia during 1983. These insects live in colonies in distorted or actively growing stem tips of their host plants. They are apparently less effective in controlling large plants, but appear to be successful in controlling small plants (< 1.0 m) and seedlings.

Adult females are round, fat, light pink, about the size of a pin head, with short, weakly developed legs and long sucking mouth parts. They are covered in a woolly, white, waxy thread. Females are sessile, meaning that they cannot fly and walk only short distances. Males are tiny and pink with two semi- transparent wings and long tail filaments (Klein 2002b).

Approximately three weeks after fertilization, females lay single eggs at a rate of two to four a day, for a period of up to 35 days. Within 20 minutes, eggs hatch and produce nymphs, known as crawlers. Crawlers move to the ends of stem tips from where they are dispersed by wind. They group together at the base of spines and in cracks in the plant surface. They start feeding immediately by sucking plant sap out of the host, at the same time developing their waxy thread cover (Klein 2002b).

Male nymphs move to a more exposed part of their host just before their second moult, spin a white cocoon and pupate. After about a month, they emerge as sexually mature insects which fly away in search of females. Males do not feed at all and live only for a few days.

Female nymphs stay attached to one spot for their whole life (50 – 90 days). They continue producing wax and moult (3 times during their life cycle) and reach sexual maturity about a month after hatching (Klein 2002b).

First infection signs of the host include distorted stem tips. Thereafter, white, woolly masses appear on stem tips and areoles. Affected plants have few flowers and fruit. Mealy bugs also affect and stop tip growth. Distorted growth occurs where single insect individuals feed on one side of the growth tip only, while growth tips are killed when several insects are more evenly spread. Flower heads and fruit buds are also infested. To infect *C. jamacaru* plants with the *harrisia cactus mealy bug*, cuttings infected with the insect are placed on the cactus as close to growth points as possible. Attempts should be made to avoid placing the cuttings in direct sunlight. Plants must not treated by any other means after infection (Klein 2002c).

Methodology

A demonstration study was conducted at the Towoomba ADC during the period 2008 to 2012. The experimental site is situated at the Towoomba ADC, on the southern part of the Springbok flats, near Bela Bela in the Limpopo Province (24° 25'S, 28°21'E, 1 184 m above sea level). The long-term average rainfall is 630 mm per annum. The long-term daily average maximum and minimum temperatures vary between 30.2°C and 17.6°C for December and 21.0°C and 3.0°C for July respectively.

Two soil types were involved, namely a Hutton and an Arcadia form (Soil Classification Working Group 1991). The vegetation type of the Hutton soils is classified as Sourish Mixed Bushveld (Acocks 1988). The woody layer of the plant community is dominated by *Dichrostachys cinerea* and *Acacia* species. The grass layer is dominated by *Eragrostis* species (E. barbinodis and E. rigidior), *Panicum maximum*, *Themeda triandra* and *Heteropogon contortus*.The vegetation type of the Arcadia soils is classified as Turf Thornveld (Acocks 1988). The woody layer of the plant community is dominated by Acacia spp. (A.karroo, A. nilotica and A. tenuispina). The grass layer is dominated by *Aristida bipartita, Eragrostis spp.* and *Ischaemum spp.*

Thirty randomly chosen *C. jamacaru* plants of various heights and ages were treated the *harrisia cactus mealybug* during October 2008. Thirty were left untreated. During April 2012, all 60 plants were surveyed to determine the effectiveness of the treatments. Surveys included the determination of plant height, number of growth points infected, plant mortality, the occurrence of flowers and fruit during infestation and distances between infected and uninfected plants.

Results and discussion

All growth points of plants that were treated were successfully infected after four years (Table 1). On average, one stem per plant was originally treated, while six were infected, indicating that the insects had colonized adjacent stems. Typical symptoms that were encountered were the presence of insects as white, woolly masses on stem tips, areoles, flower heads and fruit buds (Figure 1).

Figure 1: *Hypogeococcus pungens* infection on growth points of *Cereus jamacaru*

No plants died during the four-year period. Results obtained in this experiment are thus similar to those published by Klein (2002b, 2002c), who indicated that it takes several months, and in some cases years, for a plant to die. According to Klein (2002b, 2002c), seedlings and young plants are more susceptible, an aspect that was confirmed by observations in this study. New growth and reproduction of all infected plants were severely retarded. Distorted growth occurred where plants were treated, compared to untreated plants, which grew and reproduced freely without any effect on plant growth.

The survey was conducted after all plants had finished flowering and the actual numbers of flowers plant^{-1} was thus not determined. Using the number of fruits plant^{-1} as the basis to determine successful flower inhibition, it was concluded that flowering and fruit set was affected by the insect treatments. During 2012, no fruit formation occurred on treated plants, while an average of three fruits plant^{-1} occurred on untreated plants.

	Untreated plants	Treated plants
Number of stems plant^{-1}	2 (1; 6)	1 (1; 6)
Number of growth points plant^{-1}	3 (1; 13)	6 (1; 24)
Number of stems treated plant^{-1}	0	1
Number of growth points plant^{-1} infected	0 (0; 2)	6 (1; 24)
Number of flowers plant^{-1}	0 (0; 3)	0
Number of fruits plant^{-1}	3 (0; 15)	0 (0; 2)
Estimated plant height (m)	2.0 (0.5; 6.0)	3.0 (0.8; 9.0)
Number of plants killed	0	0
Distance to the nearest uninfected plant (m)	8.0 (0.5; 36.0)	5.0 (0.5; 24.0)

Table 1: Survey data, expressed as averages, of treated and untreated C. jamacaru plants (numbers in brackets represent minimum and maximum values)

Unfortunately, the main source of control is the sessile female insects, which rarely spread to surrounding plants via the tiny, wind-dispersed crawlers. This resulted in the limited infection of untreated plants. Only two growth points on plants that were not treated appeared to be mildly infected. Both occurred within a 1.0 m radius of treated plants.

The actual aim of infecting *C. jamacaru* at the Towoomba ADC was to control the current *C. jamacaru* population at the station and for the Limpopo Department of Agriculture to have a nursery site available from which farmers in the area could obtain the biological control agent. The effectiveness of control was aimed towards more subjective observations than objective surveys, but collected data emphasized the ability of the biological agent to slow *C. jamacaru* encroachment down. Economically, the use of the *harissia cactus mealy bug* as a biological control agent of *C. jamacaru* has potential in communal areas and for developing farmers. Not only will herbicide costs be minimized, also a more ecologically friendly method of control. It appears as if each plant must be infected individually and that control is not immediate but takes several years. The fact that the rate of encroachment of *C. jamacaru* can successfully be kept to the minimum warrants the use of *harrisia cactus mealy bug* as a biological control agent of this invader species. To augment this impact, .the stem-boring beetle *Alcidion cereicola*, which is also potentially damaging, should also be introduced to invaded areas

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