

## BIOLOGICAL CONTROL OF MOISTURE STRESSED *OPUNTIA AURANTIACA* USING *DACTYLOPIUS AUSTRINUS*

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### ABSTRACT

*Dactylopius austrinus* DeLotto (Hemiptera:Dactylopiidae) is being increasingly used to control *Opuntia aurantiaca* Lindley in New South Wales but conditions suited to control of this cactus by *D. austrinus* are still uncertain. Moisture stress of *O. aurantiaca* infested with *D. austrinus* was found to accelerate death of this cactus. The importance of this finding in relation to biological control of *O. aurantiaca* under dry conditions is discussed.

### INTRODUCTION

*O. aurantiaca* Lindley (Opuntiales:Cactaceae), tiger pear, is a major pest in New South Wales and South Africa and a minor pest in Queensland (Moran and Annecke 1979). Heavy infestations limit grazing potential of pastures and the barbed spines of this cactus injure stock. Handling of infested wool, hair, hides and animals is also a problem.

In New South Wales this cactus has been largely controlled by chemicals, but due to rising labour and chemical costs increasing reliance is being placed on biological control. Herbicide use has failed to prevent the spread of this pest (Hosking and Deighton 1979) and it is hoped that biological control will allow more time to be devoted to limiting spread rather than treating large existing infestations.

*Dactylopius austrinus* DeLotto (Hemiptera:Dactylopiidae), cochineal, is the main insect used to control *O. aurantiaca*. *Cactoblastis cactorum* (Berg) (Lepidoptera:Phycitidae) and *Tucumania tapiacola* Dyer (Lepidoptera:Phycitidae) also damage *O. aurantiaca* although they do not reduce infestations as much as does *D. austrinus*. The degree of control achieved by *D. austrinus* varies with locality and year.

This paper shows how dry conditions accelerate the rate of death of *O. aurantiaca* infested with *D. austrinus*. The importance of this finding is related to the amount of damage caused by *D. austrinus* under dry conditions.

### MATERIALS AND METHODS

The insects and plants used for this experiment were collected from Nemingha (near Tamworth). All plants were grown in pots and reduced to six mature cladodes at the beginning of the experiment. To compile a set of data on the effect of *D. austrinus* on moisture stressed *O. aurantiaca*, cacti with and without *D. austrinus* were maintained under various watering regimes and observed twice weekly to determine plant condition and stage of insect development. Other plants were destructively sampled at intervals after infestation to determine moisture content. Loose cladodes with and without *D. austrinus* were also observed twice weekly and results compared with those from rooted plants.

The experiment consisted of three groups of plants; those not watered and those watered to runoff every 7 or 28 days. Each group consisted of 15 plants;

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10 were infested with *D. austrinus* and 5 were left free of insects. Half of the infested plants were used to determine moisture content while all remaining plants were used to obtain data on insect development and plant condition. Additional plants were used to follow changes in moisture levels of plants free of insects. Loose cladodes (from recently watered plants) used in this experiment were divided into 2 groups of 20; one group was infested with *D. austrinus* while the other was left free of insects.

At the beginning of the experiment 24 first instar crawlers (first larval stage) were placed on each insect treated plant while six crawlers were placed on each insect treated loose cladode. As crawlers are negatively phototropic (Mann 1969) infested plants were placed in a darkened area for four days to ensure a fairly even spread of insects on the plants. The proportion of females on loose cladodes was variable so when the sex became evident the number of females was reduced to one or two per segment.

All plants and loose cladodes were held in a temperature controlled glasshouse which was programmed for a day (14 hour)/night (10 hour) temperature regime of 28/20°C. These conditions simulate those of late summer in much of the *O. aurantiaca* infested region of northern New South Wales.

Assessment of insect damage was made on the basis of cladodes being classed as alive (showing any life) or dead.

Moisture contents of cactus were determined by drying cladodes to constant mass in an oven held at 110°C.

## RESULTS AND DISCUSSION

*D. austrinus* readily established on all *O. aurantiaca* plants and loose cladodes. Figure 1 shows how different watering regimes change the death rate of cladodes.

Unwatered plants showed no growth while those watered every 7 or 28 days showed growth from day 15 to day 36. From this time *D. austrinus* caused death of cladodes. The time taken for complete death of plants varied considerably depending on the frequency of watering; where no watering occurred all cladodes died within 120 days while only slightly more than half the cladodes of plants watered every seven days died over this period. Loose cladodes died a little more slowly than unwatered plants but this was possibly due to the initially drier state of unwatered plants.

Plants without *D. austrinus* showed some initial growth when watered every seven days while those watered every 28 days and those without water showed no growth. During the course of this experiment no cladodes died on plants free of *D. austrinus*.

*D. austrinus* reached the reproductive stage between 46 and 50 days after crawlers were placed on cladodes. The *D. austrinus* population increased rapidly from this time as mean crawler production per female was high; under some conditions reproduction levels higher than 1000 crawlers per female have been recorded (Moran and Cobby 1979). Offspring from the original females caused considerable death of cladodes, particularly as these insects reached maturity.

Cladodes often became separated from plants as a result of *D. austrinus* attack. These cladodes died more rapidly than those attached to plants. For example, no cladodes became detached from plants watered weekly but free of *D. austrinus* while 25 out of 34 cladodes became detached from infested plants watered weekly. Of these cladodes 19 out of the first 20 to die were separated from plants.

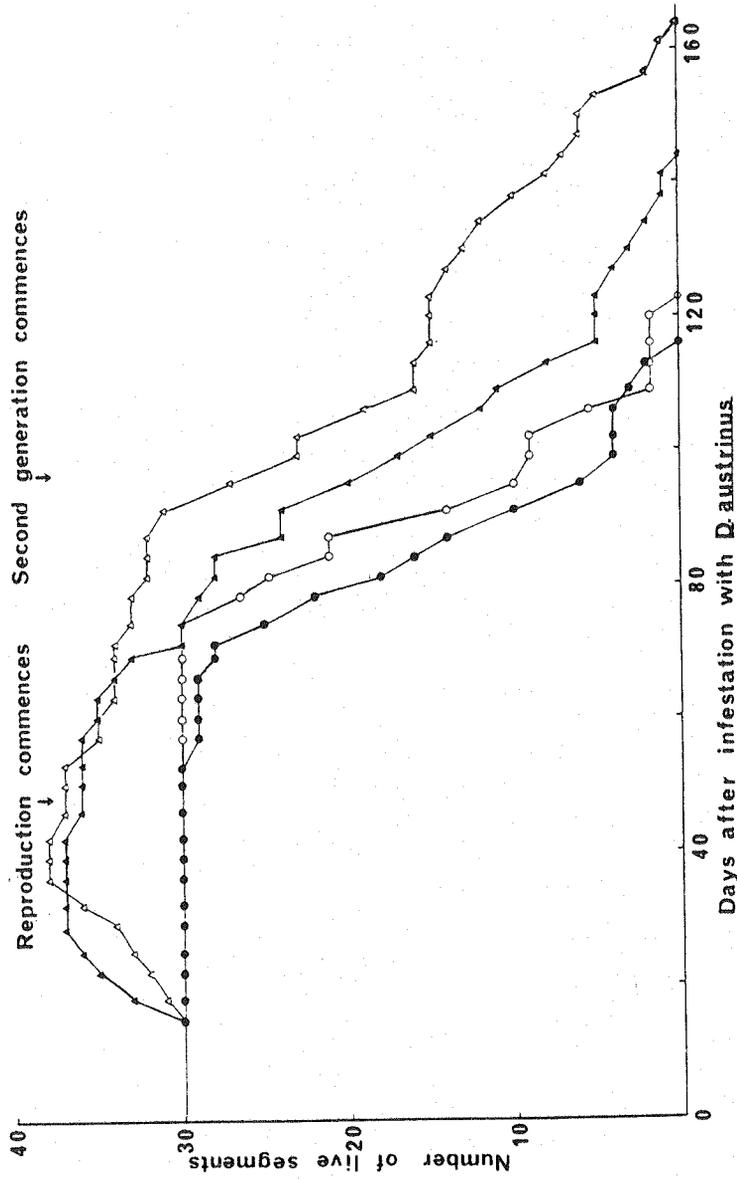


Figure 1. The effect of *D. austrinus* on the number of live cladodes of *O. aenaniaca* where watering regimes are varied:  $\Delta$  every 7 days,  $\blacktriangle$  every 28 days,  $\bullet$  none (plants) and  $\circ$  none (loose cladodes). The number of loose cladodes is increased by a factor of 1.76 so that the initial number of cladodes is the same for all treatments.

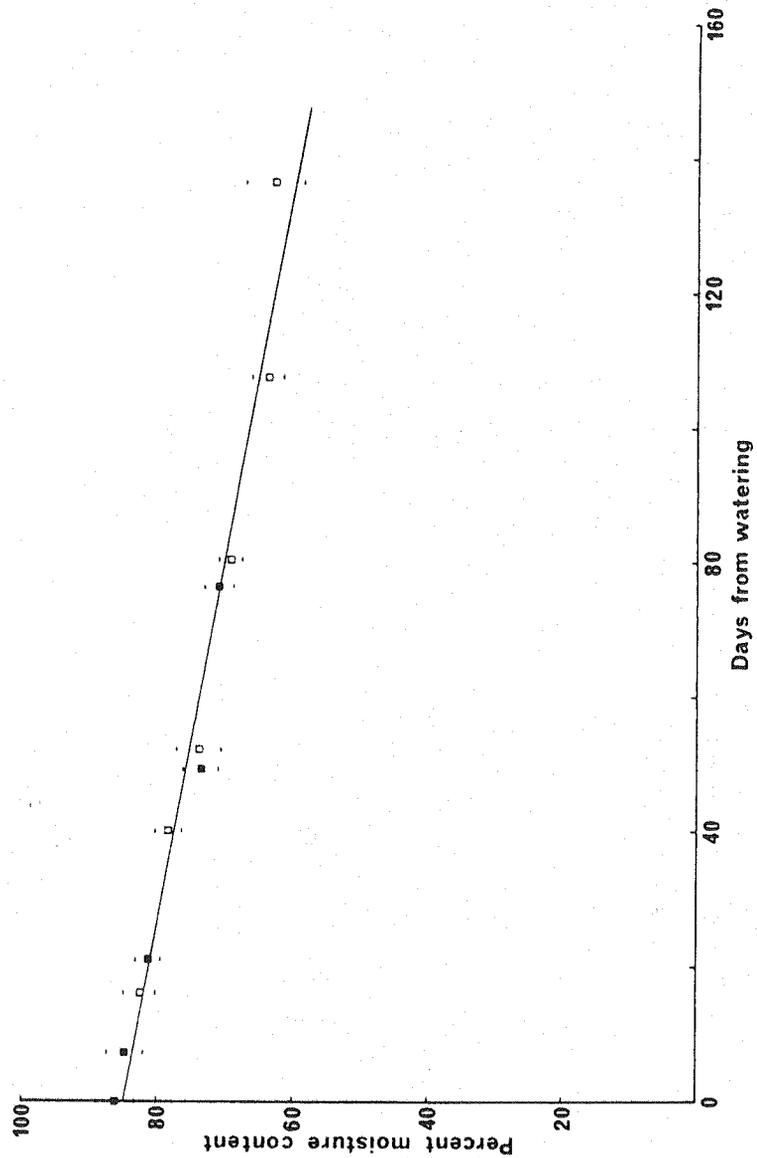


Figure 2. Change in moisture content of cladodes from unwatered insect-free cacti. Results are shown as means  $\pm$  1 s.d.  $\square$  from plants originally watered to excess;  $\blacksquare$  from plants partially dry at the commencement of the experiment (at this time these plants had water contents equivalent to about 16 days without water).

Figure 2 shows how moisture content of unwatered, insect-free plants changes with time. Moisture content is shown as:

$$\text{per cent moisture} = (\text{fresh weight-dry weight})/(\text{fresh weight}) \times 100$$

Levels of plant moisture decreased slowly with time showing that these plants can withstand considerable desiccation. Cladodes from plants watered every seven days had moisture contents averaging 85 per cent while after 28 days without water moisture content averaged 83 per cent. Dead segments were found to have moisture contents averaging 13 per cent.

A number of references (Mann 1969, Moran and Annecke 1979) suggest that dry weather or dry conditions favour biological control of *O. aurantiaca* by *D. austrinus*. Mann (1969) and Zimmerman (in Moran and Annecke 1979) report that rain washes crawlers from plants and that this decreases cochineal populations. This study shows that dry conditions also decrease the ability of the plant to withstand large cochineal populations. Dry conditions such as those prevailing in much of New South Wales during early 1980 support this finding as there were large reductions in the quantity of *O. aurantiaca* where *D. austrinus* was present. *D. austrinus* has generally been thought to be ineffective in cool regions of New South Wales such as the Turon River Valley (Anon. 1967). However, during early 1980 *D. austrinus* caused extensive damage to cactus in this area; probably as a result of the abnormally dry conditions. This damage occurred despite the lower number of *D. austrinus* generations per year in this area compared with other infested areas in New South Wales (unpubl. data).

*D. austrinus* is apparently more effective in dry conditions than in wet conditions because of decreased ability of the host to withstand infestations, as well as less physical damage to insects as a result of rain. Control of *O. aurantiaca* by *D. austrinus* is therefore greater in drought years than at other times. Under dry conditions *D. austrinus* can also be expected to control *O. aurantiaca* in areas generally less suited to biological control by this insect.

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