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STUDIES IN THE DYNAMICS AND CONTROL OF WOODY WEEDS IN SEMI-ARID QUEENSLAND

2. Cassia nemophila and C. artemisioides

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SUMMARY

The population of *Cassia nemophila* and *C. artemisioides* on a water redistribution scheme in the Cheepie district is tending to stabilize after an initial rapid spread and increase in density. Control of these plants through heavy stocking with sheep and by ploughing has not been achieved. Chemical sprays (2,4,5-T and combinations of picloram with 2,4,5-T and 2-4-D) were found to be a reasonably effective means of killing species of *Cassia*, but at higher rates than research elsewhere indicated.

The results are discussed in terms of the ecological implications of improved water relations in this semi-arid environment, and it is suggested that grasses common to more mesic sites could in time replace both species of *Cassia*.

I. INTRODUCTION

The need for research into woody weeds in south-western Queensland and the dynamics and control of one of these plants (*Eremophila gilesii*) were considered in another paper (Burrows 1973). Species of *Cassia* are other plants causing concern in this area (Purcell 1964). They are a particular problem on water redistribution schemes (water-spreaders) (Burrows 1965).

Purcell (1966) found that regrowth of *C. nemophila* on cleared gidyea (*Acacia cambagei*) scrubs could be controlled by knapsack misting with 1% a.i. 2,4,5-T ester in water. Overall high-volume spraying at 0·3% a.i. 2,4,5-T butyl ester in water was also effective. Inconsistent kills were obtained when these same treatments were applied to *C. nemophila* growing on a water-spreader (Burrows unpublished). Yet plant moisture relations are usually enhanced on water-spreaders (Newman 1963, 1966; Burrows, Cull and Ebersohn 1966), and active growth in *Cassia* improves herbicidal action (Purcell 1966).

It is possible that mechanical and biological techniques may be employed to control *Cassia*. Purcell (1966) and Cunningham (1971) have reported that *C. nemophila* is readily eaten by stock. However, opinions vary as to its palatability to cattle. In some regions cattle graze on the leaves and pods, and in South Australia there are areas where the shrub has been thinned out by grazing animals (Chippendale and Jephcott 1963).

C. nemophila and *C. artemisioides* are generally found along the wetter drainage lines of the *Acacia aneura–Eucalyptus* associations in south-western Queensland. Situations used for water-spreaders generally include some portions on which the density of these species is high. This paper reports studies of *Cassia* population changes and control investigations, carried out since 1965, on a water-spreader at "Beechal" in the Cheepie district, 170 km west of Charleville.

II. MATERIALS AND METHODS

Population dynamics.—Sixteen permanently positioned 100 m x 2 m belt transects were laid out on a grid system contained within a 4 ha block. Within this block the *Cassia* were initially thickest in the north-western corner and were expected to spread to the south-eastern corner in time as the general flow of water during spreading is in that direction.

The number and position (within 0·4 m^2) of all *Cassia* plants in the transects were recorded in July 1965, June 1968 and November 1971. For purposes of analysis the transects were divided into segments giving individual 20 m^2 plots. At each reading, frequency and density of *Cassia* plants were recorded, but no distinction was made between *Cassia* species. *C. nemophila* and *C. artemisioides* were the main species present.

Chemical control.—The following chemicals and methods of application were tested in a fully randomized block design, treatments being applied in April 1969:

Basal bark spray

0·5% a.i. 2,4,5-T butyl ester in diesel distillate.
1·0% a.i. 2,4,5-T butyl ester in diesel distillate.
0·5% a.i. 2,4,5-T amine in water.
1·0% a.i. T,4,5-T amine in water.
0·1% a.i. picloram + 0·4% a.i. 2,4,5-T ester in diesel distillate.
0·2% a.i. picloram + 0·8% a.i. 2,4,5-T ester in diesel distillate.
Diesel distillate alone.

High-volume spray

0·5% a.i. 2,4,5-T butyl ester in water.
1·0% a.i. 2,4,5-T butyl ester in water.
0·5% a.i. 2,4,5-T amine in water.
1·0% a.i. 2,4,5-T amine in water.
0·1% a.i. picloram + 0·4% a.i. 2,4-D amine in water.
0·2% a.i. picloram + 0·8% a.i. 2,4-D amine in water.
0·1% a.i. picloram + 0·4% a.i. 2,4,5-T amine in water.
0·2% a.i. picloram + 0·8% a.i. 2,4,5-T amine in water.

A non-ionic surfactant ("Agral 60") was added to all treatments in which water was the carrier. Basal bark sprays thoroughly wet the stems to a height of 20 cm. High-volume sprays wet all the foliage on individual plants treated. The treatments (including a control) were replicated twice on plots containing 35–40 actively growing bushes.

Results were assessed by measuring percentage kill 12 months after application.

Mechanical control.—A 6·5 ha area containing an apparently uniform stand of *Cassia* species was selected for a pasture species evaluation trial in 1964. It was ploughed twice with a Connor Shea "Baby Giant" disc plough, and the trial sown in January 1965. Following poor germination the area was ploughed once more and resown in February 1966. Germination was again poor and the trial was abandoned as such in 1967.

In November 1971 the number of *Cassia* plants present in 200 random 1 m x 0·5 m quadrats within the ploughed section and in the adjacent unploughed border was determined.

Biological control.—Commencing in September 1969 regrowth of *Cassia* in the previously ploughed plot was subjected to stocking intensities of 40 sheep/ha for 2 weeks and 5 sheep/ha for the following 10 weeks.

The effects of the stocking pressure on the *Cassia* were evaluated in permanently marked and photographed plots. Since January 1970 both the treated (initially ploughed and then grazed) and untreated areas have been lightly stocked at <1 bullock/10 ha.

III. RESULTS

Population dynamics.—Changes in frequency and density of *Cassia* since 1965 are shown in Table 1. These involved a rapid increase in both frequency and density to 1968 and no further increase after that.

TABLE 1

CHANGES IN FREQUENCY AND DENSITY OF *Cassia* PLANTS IN PERMANENT QUADRATS AT "BEECHAL"

—	1965 (a)	1968 (b)	1971 (c)
Frequency (%)	41·6	63·3	66·7
	X^2_{a-b} = 15·34 (P < 0·001)		X^2_{b-c} = 0·50 (N.S.)
	X^2_{a-c} = 21·16 (P < 0·001)		
Density* (plants/20 m²)	1·24 ± 0·49	1·47 ± 0·50	1·42 ± 0·51

* Expressed as $\bar{x} \pm t\,S\,\bar{x}$ (P < 0·05).

Chemical control.—A few deaths occurred in the marked control plots over the period of observation, but this has not affected the analysis (Table 2). Good kills were achieved with picloram treatments and reasonable kills were obtained with 2,4,5-T alone formulations.

TABLE 2

CHEMICAL CONTROL OF *Cassia*

Treatment	Percentage Dead at 12 Months	
	Transformed Mean*	Equivalent Mean
1. 0·2% a.i. picloram + 0·8% a.i. 2, 4, 5–T ester in distillate (B.B.) ..	1·4	98·3
2. 0·1% a.i. picloram + 0·4% a.i. 2, 4, 5–T ester in distillate (B.B.) ..	1·4	97·2
3. 0·2% a.i. picloram + 0·8% a.i. 2, 4–D amine in water (H.V.) ..	1·3	94·8
4. 0·1% a.i. picloram + 0·4% a.i. 2, 4–D amine in water (H.V.) ..	1·3	93·1
5. 0·1% a.i. picloram + 0·4% a.i. 2, 4, 5–T amine in water (H.V.) ..	1·3	92·3
6. 0·2% a.i. picloram + 0·8% a.i. 2, 4, 5–T amine in water (H.V.) ..	1·3	91·6
7. 1·0% a.i. 2, 4, 5–T ester in distillate (B.B.)	1·1	81·4
8. 1·0% a.i. 2, 4, 5–T ester in water (H.V.)	1·1	79·4
9. 0·5% a.i. 2, 4, 5–T ester in water (H.V.)	1·0	74·1
10. 0·5% a.i. 2, 4, 5–T amine in water (H.V.)	0·9	66·6
11. 1·0% a.i. 2, 4, 5–T amine in water (H.V.)	0·9	66·2
12. 0·5% a.i. 2, 4, 5–T ester in distillate (B.B.)	0·7	38·7
13. 1·0% a.i. 2, 4, 5–T amine in water (B.B.)	0·6	36·1
14. Diesel distillate (B.B.)	0·5	20·9
15. 0·5% a.i. 2, 4, 5–T amine in water (B.B.)	0·5	19·5
16. Control	0·2	2·3
S.E...	0·1	..
Necessary differences for significance { 5%	0·2	..
Necessary differences for significance { 1%	0·25	..
B.B. = Basal bark application. H.V. = High-volume spray application.	1 to 6 ⩾ 7 to 16 7, 8 ⩾ 9 to 16 9 ⩾ 12 to 16 10, 11 ⩾ 13 to 16 12 ⩾ 16 13 to 15 ⩾ 16	

Mechanical control.—An estimate only is available for the density of *Cassia* present immediately prior to the first ploughing (Table 3). To obtain this it was assumed that the same percentage increase occurred in the unploughed area between 1965 and 1971 as occurred in the north-western quarter of the shrub population study plot. As this area is part of the unploughed treatment, this is a reasonable assumption. In any case the actual density in 1965 is not critical to the deductions made here. There was a substantial increase in the population following ploughing.

TABLE 3

EFFECT OF DISC PLOUGHING ON *Cassia* DENSITY (plants/ha) ON A WATER-SPREADER IN SOUTH-WESTERN QUEENSLAND

——	1965*	1971†
Ploughed area ..	5,900	10,588 ± 3,800
Unploughed area ..	5,900	6,000 ± 2,726

* Estimate only—see text.

† Expressed as $\bar{x} \pm t S \bar{x}$ ($P < 0{\cdot}05$).

Biological control.—The apparent failure of the heavy stocking treatment is shown in Figure 1.

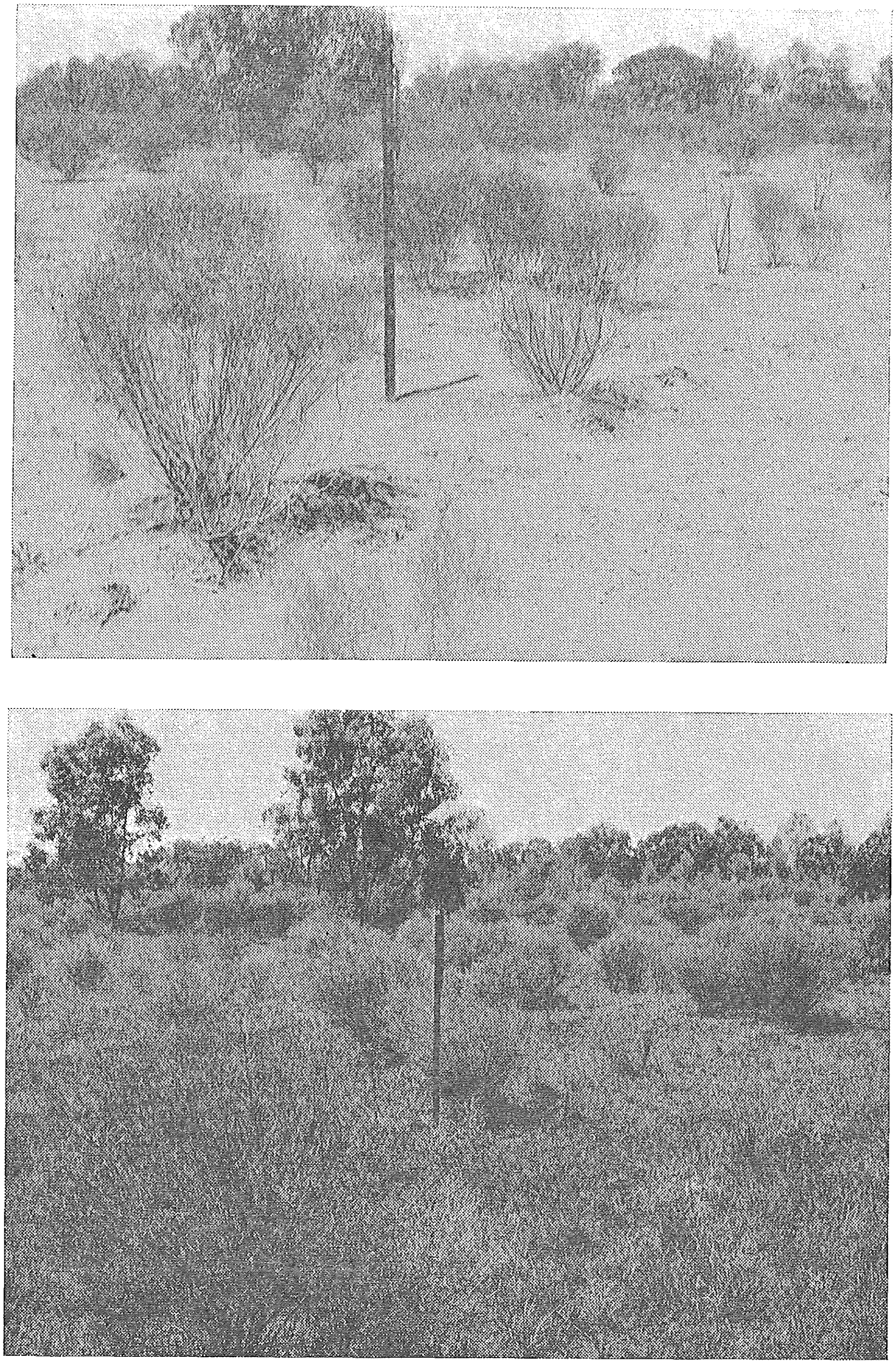

Fig. 1.—Effect of heavy stocking with sheep. Top, sample of *Cassia* area prior to heavy stocking with sheep in 1969. Bottom, same area photographed from the identical position 2 years later.

IV. DISCUSSION

Significant changes were recorded in *Cassia* frequency within the permanent quadrats, while plant density has also shown an increase since 1965 (Table 1). The results suggest that by 1968 *Cassia* had approached the limits of its distribution on this site or that competitive factors since then have prevented further expansion.

It is possible that the initial diversion of water onto the study area in 1962 favoured a rapid build-up in the *Cassia* population, which was more responsive to improved water relations and tolerant of flooding than typical mulga grasses such as *Neurachne mitchelliana, Danthonia bipartita, Digitaria* spp. and *Aristida* spp. However, a light stocking intensity and continued benefit from water-spreading has enabled a more competitive secondary grass succession to develop. Grasses in the genera *Bothriochloa, Dichanthium* and *Themeda* are now particularly noticeable within the *Cassia* stand where once they were absent.

C. nemophila and *C. artemisiodes* have only a short lifespan (Chippendale and Jephcott 1963; Cunningham 1971) and numerous senescent and dead bushes can be seen in the study area. These observations are supported by the apparent decline in *Cassia* density since 1968 (Table 1; control treatment Table 2), and it is possible that *Cassia* regeneration is kept in check by the more aggressive grasses now present. *Cassia* seeds readily on this area, but it is of interest to note that 65% of seeds collected in May 1970 were damaged by insects.

All combinations of picloram tested as basal bark or high-volume sprays were effective in killing *Cassia* (Table 2). Basal bark spraying would have most application on tall bushes $>$ 1 m high. Below this height good foliage cover can be obtained with high-volume sprays while the small multistems of *Cassia* are difficult to treat by the basal bark method.

The other chemicals tested gave varying results. Reasonable kills were obtained with high-volume sprays of 2,4,5-T ester in water, but this treatment was not as effective as that reported for lower concentrations of the same chemical elsewhere (Purcell 1966). The *Cassia* regrowth in cleared gidyea scrubs which Purcell controlled was most likely less mature than that treated in this case.

The regeneration of *Cassia* within the ploughed area (Table 3) suggests that this operation would have to be repeated more often than in the present study if regrowth is to be prevented. Regeneration of *Cassia* is attributed to both root suckers and seed germination in the disturbed seedbed following ploughing.

Biological control of *Cassia* by heavy stocking with sheep was not successful (Figure 1). An insufficient stocking intensity applied for too short a period is probably the main reason for this failure. Chippendale and Jephcott (1963) have noted that *C. nemophila* responds well to grazing or lopping, and the possibility of the grazing treatment having a stimulating effect on the stand cannot be ruled out. There were obviously different levels of palatability within *Cassia,* some bushes being relished by sheep and rapidly defoliated, while others were ignored. There was no evidence of scouring or other deleterious effects in sheep grazing these plants.

The overall results are not encouraging for the control of *Cassia* on this site. Several chemical treatments are effective (Table 2), but the cost of applying these when bush density is 6 000 plants/ha would be high. Likewise mechanical and biological control treatments would need to be applied very intensively if they were to succeed, while the real possibility of these treatments merely stimulating the *Cassia* stand cannot be ignored.

It should be appreciated that water-spreading dramatically changes the ecological potential of a site, whether sown pasture species (Anon. 1964; Cull 1964*b*) are introduced to it or not. As soon as water is first applied, secondary plant succession, favouring plants tolerant of flooding and/or requiring a higher moisture status than that which originally pertained, will develop. If this is understood, control of weed species in this succession can be undertaken when they are first observed and before their density renders this impracticable. There is some evidence that vigorous grasses, typical of more mesic areas, are increasing at "Beechal" and may in time compete successfully with the *Cassia*. However, this is a slow process and the reliability that can be placed on it is doubtful where an additional grazing factor, of unknown effect, is superimposed.

In the meantime, further research into woody weed problems on water-spreaders is indicated if their potential benefits (Cull 1964*a*) are to be realized.

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