Factors affecting the distribution of rubber-vine (*Cryptostegia grandiflora*) in north Queensland

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SUMMARY

A survey was conducted to determine the environmental factors most closely related to rubber-vine distribution. Both soil type and foliage cover from woody plants less than 2 m tall have direct, independent effects on rubber-vine distribution. A pot trial using a soil sample from each soil type recognized in the survey showed that the establishment of seeds sown on the soil surface was closely parallel to the observed frequency of rubber-vine on the soil types in the survey area. The clay content of the soils was the factor most closely related to the percentage establishment for each soil. Placing leaf litter on the soil surface in the pots improved plant establishment on all soils. A separate study showed that fire could be an effective controlling agent in some situations.

INTRODUCTION

Rubber-vine (*Cryptostegia grandiflora* R.Br.), a woody climber native to Madagascar, was first reported in Queensland in 1875 (Hill, 1875), and its weedy nature noted in 1917(White, 1917). Caltabiano (1973) suggested that the total area of infestation in Queensland would be approximately 200,000 ha with an estimated 120,000 ha north of Bowen. This plant reduces productivity and increases costs on grazing properties through increased difficulties in mustering, reduction in the amount of pasture available, and cattle deaths due to poisoning. The extent of infestation was reported to be still increasing in all areas (Caltabiano, 1973), but little information is available on the rate of spread. The plant was declared noxious for the whole of Queensland under the Stock Routes and Rural Lands Protection Acts in 1955.

This study was conducted to determine what environmental factors are controlling the distribution of rubber-vine in north Queensland. This information was used to predict the potential spread and to assess the future weed status of the plant. Management practices which could be used to control the plant were also evaluated.

MATERIALS AND METHODS

An area of 380 km^2 surrounding but not including Charters Towers, 105 km south-west of Townsville, was used for the study. Rubber-vine has been present at Charters Towers since early this century. The area was divided into land systems, and sampling sites were located in each land system at points spread over the whole area. Data were collected from 20 contiguous quadrats each 20 m square located along a transect at each sampling site. Some quadrats on each transect contained rubber-vine but in others the plant was absent. The data collected were the same as that proposed by Walker, Ross and Beeston

(1973), but the soils information was reduced to assigning each quadrat to one of eight soil types and taking soil samples for analysis from several quadrats for each soil type. The data consists of land form, vegetation, soil physical and chemical characteristics, and land management. Pattern analysis techniques were used on each section of the data to group sites with similar characteristics. These groups were then studied for their relationship to rubber-vine distribution. The factors which placed sites in similar groups to the rubber-vine - distribution were then studied in more detail.

The effect of fire on rubber-vine was studied at a site 40 km south-west of Charters Towers. Part of the area was very lightly grazed and was burnt in October 1974 and October 1975. The rest of the area was grazed normally and was unburnt. Recordings were taken from six plots on the mid slope and six plots on alluvial soils along a watercourse under each fire regime.

The top 10 cm of soil from the soil types recognized in the field study were used in a pot trial to study establishment of rubber-vine on each soil. Seeds were sown on the surface and at 1 cm depth. Possible mechanisms by which the shrub layer may affect rubber-vine distribution were studied in pot trials using shading and leaf litter with seeds sown on the surface.

RESULTS

The factors which showed some relationship to rubber-vine distribution from the pattern analysis groupings of the 668 quadrats were tested for relationships with rubber-vine density. Significant ($P<0.01$) interactions were obtained between rubber-vine density and : soil type, extent of bare ground, percentage of quadrat eroded, amount of foliage cover from woody plants less than 2 m tall, and presence of *Eremophila mitchellii*, *Carissa lanceolata* and *Eucalyptus brownii* (Table 1). These factors are all interrelated and the technique of multiple predictive analysis (Macnaughton-Smith, 1965; Williams et al, 1971) was used to determine which factors were having direct, independent effects on rubber-vine density. Soil type and shrub cover were the only factors to have direct and independent effects on rubber-vine density. The analysis indicated that the density of rubber-vine was a function of these two factors only. The other factors were significantly related to rubber-vine distribution because they were also a function of the two major factors.

Significant ($P<0.01$) reductions in rubber-vine numbers occurred with both fires on the slope but only in the first fire on the watercourse (Table 2). Significant increases in rubber-vine numbers occurred between the first and last recordings on the unburnt plots.

The percentage of quadrats in which rubber-vine was recorded in the field for each soil type is shown with the establishment percentages from the pot trial in Table 3. A close parallel occurs between field occurrence and the establishment from seed sown on the surface. Buried seed gave high establishment figures on all soils. Leaf litter on the soil surface increased the establishment on all soils with the only significant difference between soils being the much lower establishment on soil 4. Shading alone gave establishment on each soil between that for bare soil and that with litter.

Table 1. Number of sites in each rubber-vine density class for environmental factors recorded in the field survey

Rubber-vine density (plants/400 m^2)	No. of sites											
	Soil type								Bare ground+		Extent of erosion+	
	1	2	3	4	5	6	7	8	<50%	>50%	<30%	>30%
0	51	188	29	3	2	48	15	1	303	34	296	41
1- 5	32	41	38	19	1	3	1	5	105	35	105	35
6- 30	9	11	29	30	0	3	4	19	73	32	84	21
31-500	2	4	31	7	3	2	0	15	47	17	48	16
> 500	0	0	8	0	7	0	0	7	17	5	18	4

	Shrub foliage cover (%)				*Eremophila mitchellii*		*Carissa lanceolata*		*Eucalyptus brownii*	
	<2.5	2.5-10	10-25	>25	Present	Absent	Present	Absent	Present	Absent
0	209	104	19	5	20	317	187	150	44	293
1- 5	44	44	30	22	42	98	99	41	36	104
6- 30	27	16	23	39	40	65	85	20	53	52
31-500	18	18	12	16	25	39	52	12	38	26
> 500	9	7	6	0	12	10	13	9	8	14

+ Expressed as percentage of 400 m^2 quadrat

Table 2. Effect of fire on the number of living rubber-vine plants over two years

Treatment	Live rubber-vine plants (no./50m^2)		
	September 1974	September 1975	September 1976
Burnt, mid-slope	11.3	4.5	2.8
Burnt, alluvial	48.2	39.2	37.5
Unburnt, mid-slope	9.8	10.3	16.4
Unburnt, alluvial	41.6	54.7	68.4

Table 3. Percentage frequency of rubber-vine in field survey and establishment in pots for seven soils

Soil type	Field frequency (% occurrence)	Establishment+			
		Buried seed	Seed on the surface	Surface seed with litter	Surface seed with shading
1	48	97	75	97	84
2	24	100	28	97	38
3	78	97	47	91	64
4	93	100	50	69	58
5	92	84	56	97	72
6	14	91	9	97	38
7	25	100	22	88	64

+ Expressed as a percentage of the seeds planted

The soil characteristics (Table 4) show a variation in clay content which parallels the establishment recorded with surface sown seed. Clay content influences most other soil properties which show a similar variation. The effect of clay content on the water relationships in the different soils would be the factor most likely to affect plant establishment.

DISCUSSION

The good relationship between establishment of rubber-vine in pots and the field distribution of the plant suggests that the factors which affect seedling establishment are the ones that determine field distribution. Within the study area the fire factor is less significant than in many other areas with rubber-vine, as past mismanagement has caused extensive erosion and denudation which has

Table 4. Physical and chemical characteristics of the surface layer of seven soils used in the pot trials

Soil type	pH 1:5 H_2O	Available P ppm	C.E.C. m.e. per 100g	Total N %	Sand %	Silt %	Clay %	Water+ content g/100 g	Unconfined compressive strength (kg/cm^2) ‡	Northcote classification
1	7.7	55	51	0.12	43	14	43	28.4	0.32	Ug 5.1
2	6.6	17	6	0.04	77	11	12	13.2	0.49	Dr 2.1
3	6.5	7	6	0.04	81	12	7	12.4	0.37	Dy 3.43
4	6.6	8	10	0.05	71	10	19	13.5	0.65	Db 2.33
5	7.1	18	25	0.07	61	10	29	21.7	0.49	Db 1.13
6	6.6	11	6	0.03	82	10	8	11.3	0.39	Db 1.12
7	6.4	6	4	0.03	88	4	8	9.4	0.48	Dy 3.42

+ measured at field capacity

‡ measured with a pocket penetrometer at field capacity

reduced the frequency of fires. The few dead mature rubber-vine plants recorded during the survey had all died following a fire. Soil type 1 contains most of the areas in the survey area where fires are frequent. Fires would reduce the observed frequency of the plant in the field below that expected from the pot trials.

Over the whole area of rubber-vine distribution, fire is a major controlling factor on the plant. Tothill (1971) found that fire was of limited effectiveness in controlling woody regrowth but this referred to native species which had evolved in the presence of fire. Within the areas which are free from fire, the soil type and shrub cover affect the establishment and final distribution. The mechanism by which these factors affect establishment appears to be through the availability of water to the seed. Soils with more clay and consequently higher water content at field capacity give better establishment. Leaf litter and shading reduce the rate of water loss, but the better establishment would also be due in part to the more rapid germination under dark conditions.

The present distribution along watercourses with some spread to the slopes (Caltabiano, 1973) reflects these controlling factors. The area along watercourses is seldom burnt and the alluvial soil, because of the better water availability, gives good establishment, particularly if the seed is buried. With the present trend towards greater utilization of the pasture and reduction in the frequency of fires, the movement of rubber-vine onto the slopes can be expected to continue. The spread will be slower than along watercourses and will initially be limited to those soils where the seeds germinate most successfully.

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