NO.9 THE HARRISIA CACTUS PROBLEM AND POSSIBLE ECOLOGICAL CONTROL

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1. INTRODUCTION

The spiny perennial cactus Harrisia martinii is established in widely scattered localities in Queensland. Known areas include Charters Towers, the Collinsville district, north Rockhampton, Ipswich, Gatton and Goondiwindi. In all except the Collinsville district the infestations are small and should be readily controlled, and thus no further direct reference will be made to them in this paper.

The area immediately south of Collinsville is of chief concern. The cactus was introduced some 40 years ago, apparently as a pot plant and probably of South American origin. Despite active control measures initiated by the Queensland Lands Department in 1951, the cactus has spread rapidly. It is now estimated to infest some 10,000 acres in thick to very dense stands and to occur as scattered plants over nearly 100,000 acres. The plant has been found in the headwaters of the Isaacs and Suttor Rivers and thus further southward spread is likely.

Control measures adopted by the Queensland Lands Department involve repeated spraying with strong concentrations (up to 1 lb/gallon) of arsenic pentoxide or the injection of a similar solution around the plant roots. Both methods are slow and extremely costly, and spraying necessitates removal of all stock from the treated areas. The possibility of biological control has been investigated, but without success up to the present. More recent control measures adopted by both the Lands Department and local graziers involve large scale clearing of all timber on infested areas. The purpose of this paper is to suggest that land clearing, followed by establishment of vigorous improved perennial pasture, may afford an economic means of controlling and preventing the spread of Harrisia cactus.

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2. DESCRIPTION

Harrisia establishes readily from seed and makes most growth during the wet summer months (the Collinsville district average annual rainfall is some 25 inches, 80 per cent of which falls during the months of October to March inclusive). The small seedling immediately produces a swollen tuberous storage root which eventually reaches a depth of 12 to 18 inches. In more friable clay soils and in sandy soils the storage root branches freely in a finger-like fashion. Where a tough clay subsoil is present at shallow depths very little branching occurs. The storage root and its branches are constricted into a number of swollen segments, each of which is capable of developing a phyllo-clade bud. The storage root appears to be of minor importance in absorbing moisture and nutrients from the soil. The functional feeding roots appear to be the lateral roots which radiate from the crown just below ground level and largely exploit the 0-3 inch soil layer.

The established seedling may develop a number of phylloclades at ground level; these largely remain un-branched until they come in contact with the soil. They may then root and a number of vertical phylloclades are produced; ultimately the entire ground surface may be covered with a dense tangled mat of phylloclades 12 to 36 inches in height.

Each phylloclade eventually produces a large number of single white flowers which mature acropetally. A spherical red fruit some 2 inches in diameter and containing large numbers of small black seeds is produced. This is freely eaten by birds. Birds and flood water are the main agents of seed dispersal. No marked variation between individual plants has been observed. Harrisia martinii is possibly self fertilised.

3. DISTRIBUTION

In the Collinsville district, scattered plants of Harrisia cactus are found on all the major soil and vegetation types (Isbell 1954). However, Harrisia obtains maximum plant density in the brigalow (Acacia harpophylla) forests, in which yellowwood (Terminalia oblongata) and bauhinia (Bauhinia hookeri) are prominent associates. Harrisia may also reach dense pro-portions in sandalwood (Eremophila mitchellii) scrubs and shrub woodlands, which usually also contain a discontinuous low shrub stratum of currant bush (Carissa ovata).

In both these communities Harrisia may develop a complete ground cover. The density of the cactus seems correlated with the tree or shrub density. In savannah and

grassland associations, cactus plants are only found at the base of trees or shrubs.

The distribution of Harrisia is largely independent of soil factors per se. Although the most dense and vigorous growth is made on the more fertile clay soils of the brigalow forests, very similar soils supporting grassland or savannah formations have relatively light infestations. Some of the least attractive soils of the region from both a physical and chemical point of view are the solodised soils of the sandalwood communities. Yet these soils almost invariably carry a dense stand of cactus. A feature of note here though is that these soils have dense tough clay subsoils at a shallow depth, the development of the plant storage roots and individual plants are not as vigorous as those on more attractive soils. Experience has shown that control of the cactus by arsenic pentoxide poisoning is more readily accomplished on these soils.

4. SPREAD

Most cases of invasion by introduced weeds are associated with the activities of man such as the clearing of natural vegetation, cultivation, overgrazing, etc. The establishment, development, and spread of Harrisia cactus parallels the spread of prickly pear which in final distribution and maximum development, closely corresponded to the distribution of brigalow in Queensland. The rapidity of spread of these cacti suggests some peculiar adaptability to this brigalow forest environment.

In strong contrast is the general inability of Harrisia to invade grassland. The complexity of the interrelationships and interactions of the numerous physical and biotic environmental factors affecting the spread of Harrisia makes it impossible to explain what are the main factors.

The microclimate of the forest is vastly different from that of the adjacent grassland. Geiger (1950) reviewed the effect of forest cover on radiation, temperature, humidity, wind, and precipitation relationships. The forest cover decreases light intensity, increases humidity and reduces diurnal temperature fluctuations.

The competitive relationships of species are also vastly different in forest and grassland communities. In dense brigalow forests the main low shrub understorey is currant bush and there is a sparse ground cover of salt bushes and other herbs. Grasses are often almost entirely

absent from the ground flora. The bare soil areas in the forests are readily colonised by Harrisia seedlings. In contrast is the intensity of competition for water, nutrients and light in the surface layers of the grassland soil. Another factor of importance is fire. The grasslands are frequently intentionally or accidentally burnt. In the forests the understorey is generally green and sparse and does not carry a fire.

Cacti are quite unique in physiological and morphological characteristics. Daubenmire (1950) states that cacti invariably have shallow root systems which can exploit moisture unavailable to more deeply rooted plants. In some cacti the fine rootlets are drought deciduous, reappearing when moisture is available. The cacti avoid drought by means of their water reserves rather than by being true xerophytes. Daubenmire (1950) reports that Shreve (1916) showed that cacti, in contrast to most plants, close their stomata during the day when transpiration is greatest and open the stomata at night. Because of this their relative transpiration is lowest during the day. The CO_2 used in photosynthesis during the day when stomata are closed is believed to be derived at least in part from organic acids produced in anaerobic respiration (Maximov 1929, reported by Daubenmire 1950). These and other peculiar characteristics of cacti must explain why Harrisia obtains its maximum physiological and ecological development in a forest environment. In direct sunlight and in competition with perennial native grasses, Harrisia, once established, lacks vigour, is red brown in colour instead of bright green, and frequently wilts except during the short wet season.

These considerations suggest that the complete eradication of Harrisia cactus in a given area is unlikely unless accompanied by a change in the microenvironmental factors which predispose these natural communities to invasion. The mechanical clearing of forests, and the prevention of regeneration by sowing highly productive perennial pasture species is an economical and effective way of changing the microenvironment and thus preventing further invasion and spread.

5. CONTROL

If the change in microenvironment with forest clearing and sowing to improved pasture species is sufficient to prevent spread, the main problems then become the eradication of established Harrisia plants and the prevention of scrub regeneration. The most satisfactory means of accomplishing this seems to be a combination of mechanical, chemical and ecological methods.

(a) Mechanical Methods.

Following mechanical clearing, the success of the burn is dependent on the original forest density and climatic conditions at time of burning. An extremely dense undergrowth of green Harrisia can significantly reduce the success of the burn. Regrowth of cactus from underground storage roots will occur after the burn and regrowth is greatest where competition from other species is absent. But an effective burn eliminates most of the accumulated growth of Harrisia and reduces the plant density.

Trials by the Division of Tropical Pastures on a brigalow forest soil at "Havilah" near Collinsville have shown that a single ploughing is highly effective in eliminating the Harrisia plants remaining after a burn. Re-establishment from seedlings or rooted phylloclades rarely occurs in competition with highly productive sown pasture species. Ploughing is also effective in controlling brigalow suckers and other forest regrowth.

(b) Chemical Methods.

Research by the Queensland Lands Department has shown that injecting arsenic pentoxide below ground level at the base of the plant is highly effective. This seems the most satisfactory method of eliminating isolated plants occurring in sparse communities. Some industrial firms have renewed interest in testing hormone spray preparations.

(c) Ecological Methods.

The microenvironmental change following forest clearing, burning and volunteer establishment of native pasture species, has reduced the vigour and density of Harrisia cactus, but has not eliminated it over a three year period. The aerial sowing of more productive introduced pasture species was commenced by landholders during the 1959-60 season. The ecological outcome of competition between Harrisia cactus, introduced pasture species and native species under varying management practices and seasonal conditions is still to be determined. Stocking intensity and frequency and period of pasture burning are important management factors which will affect botanical competition. Shaw (1957), has shown that fire encourages the spread of black spear grass (Heteropogon contortus). This species is an important and undesirable component of native pastures in the Collinsville district.

The ecological method of control is dependent on the development and satisfactory establishment of highly productive, persistent pasture mixtures. There was no experience with improved pasture species in the Collinsville district when the Division of Tropical Pastures commenced pasture experiments at "Havilah" during 1958-9. Previous research in southern brigalow regions and results from two seasons at "Havilah" indicate that strains of Sorghum almum, Cenchrus ciliaris, Phaseolus atropurpureus, Glycine javanica and lucerne are the most suitable pasture species for brigalow soils which have high natural fertility. So far no pasture experiments have been conducted on the less attractive soils of the sandalwood communities.

Results on a cultivated brigalow soil at "Havilah" show a large difference between species in competitive ability to prevent re-establishment and regrowth of Harrisia cactus. This is correlated with the ease of establishment, seedling vigour, initial density and productivity of sown pasture species in the first season. S. almum pasture mixtures are far superior to biloela buffel grass, rhodes grass and green panic.

The most satisfactory method of establishing S. almum pasture mixtures is to sow on cultivated soils. The high productivity of S. almum on fertile soils makes it economical to plough out Harrisia cactus and brigalow suckers and results to date indicate that this is a highly effective method of controlling Harrisia cactus. Under favourable conditions, S. almum produced 5 tons 17 cwt. of dry matter per acre twelve weeks after sowing on a fallowed brigalow soil near Taroom. It can be stocked six weeks after sowing, and can carry two beasts per acre in the first twelve months of grazing (Davies and Edye 1959).

There are many limitations to the use of cultivation and sowing of pasture mixtures as a control measure. Many infested areas are unsuitable for cultivation because of inaccessibility, topography, fertility level, etc. Also property sizes are large (up to 200 sq. miles) and hence management problems become all important. Large scale cultivation of sown pastures will necessitate greatly increased stock numbers and fencing and water improvements to enable proper pasture management. Brigalow sucker regrowth is likely to be a problem in some areas and more than the initial cultivation may be necessary to control regrowth. Suitable pasture species for the less fertile soils of the sandalwood communities have not yet been determined.

A number of graziers with dense infestations of Harrisia are making preparations for the large scale cultivation of cleared brigalow country. S. almum pastures will be sown for grazing or for silage as a drought reserve. Even if more than one cultivation is necessary to control Harrisia cactus or suckers, the potential productivity of S. almum will make this a profitable undertaking.

Chemical control methods should be used in conjunction with ecological methods in areas where Harrisia occurs only as scattered plants under sparse timber cover, or in dense infestations where it is impracticable to cultivate. The easiest and possibly the most effective way of chemically spraying Harrisia is in a pasture community where Harrisia has a physiological and ecological disadvantage. The relative susceptibility of Harrisia, forest regrowth and pasture species to different herbicides, will effect competition between these species under a spraying regime.

6. REFERENCES.

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