COMPARISON OF THE ERADICATION PROGRAMS FOR KOCHIA (*KOCHIA SCOPARIA* (L.) SCHRAD.) AND SKELETON WEED (*CHONDRILLA JUNCEA* L.) IN WESTERN AUSTRALIA

J. Dodd
Agriculture Western Australia, Baron-Hay Court, South Perth, Western Australia 6151, Australia

Summary Infestations of kochia (*Kochia scoparia*) and skeleton weed (*Chondrilla juncea*) in Western Australia differ in their origin and subsequent management. Both are targeted for eradication.

Following its introduction to planting sites in 1990 and 1991 and a subsequent brief episode of population increase, known populations of kochia responded to eradication and are now reduced to a fraction of their peak abundance. Eradication appeared feasible until the recent discovery of an extensive infestation originating from unreported plantings. For skeleton weed, despite the activity of a highly organized eradication program since 1974, new infestations—derived, presumably, from both interstate introductions and existing populations—continue to be found at an increasing rate. Nevertheless, eradication is achieved at around 50% of on-farm infestations.

The success of the eradication programs for these weeds strongly reflect the weeds' biology, their history of introduction, and management procedures.

INTRODUCTION

Kochia (*Kochia scoparia* (L.) Schrad.: Chenopodiaceae) is an annual plant that is native to eastern Europe and western Asia. One form of kochia is a serious weed in northern America, as well as Argentina, parts of Europe and temperate Asia (Holm *et al.* 1979, Dodd and Moore 1993).

The weedy form was introduced into Western Australia in mid-1990 for use as a forage plant and as a rehabilitation species for salt-affected agricultural land. When it was observed to be spreading from planting sites in early 1992, its weed potential was investigated. This led to its proclamation by the Agriculture Protection Board of Western Australia (APB) in April 1992 as a Declared Plant to be eradicated, and then to the funding of a major eradication effort in March 1993 (Dodd and Moore 1993).

Skeleton weed (*Chondrilla juncea* L.: Asteraceae) is a herbaceous perennial weed of Eurasian and north African origin that became established in south-eastern Australia early this century (Cullen and Groves 1977) and more recently in the USA and Argentina (Panetta and Dodd 1987a).

Although a long established, widespread weed in south-eastern Australia, skeleton weed was not detected in Western Australia until 1963 (Meadly 1963). Since 1974 it has been the subject of an eradication program, currently costing around $A857 000 a year (APB Annual Report 1994/95), which has significantly limited the weed's impact and rate of spread (Dodd 1987). One of the justifications for continuing to pursue the eradication of skeleton weed is to protect the extensive areas of agricultural land in Western Australia that are prone to invasion because of their climatical suitability for this weed (Panetta and Dodd 1987b).

MATERIALS AND METHODS

Because of the significance of kochia and skeleton weed as weeds and their status as eradication targets in Western Australia, detailed records are kept about the location of infestations and their management. Progress in the eradication programs was documented by summarizing these records.

For kochia, surveys of known infestations have been conducted in spring and summer initially, but more recently in summer only, to supplement frequent routine reporting by Agriculture Protection officers.

The data for skeleton weed are the annual summaries of new infestations found on farms, and of farms released from quarantine as a result of the eradication of the weed.

RESULTS AND DISCUSSION

Kochia The eradication program against kochia began in April 1992, following its declaration as an eradication target. The January 1993 survey revealed the largest number of farms (n=53) and greatest area (2200 ha) infested with kochia. Subsequent summer/autumn surveys have shown a decline in the number of affected farms (Table 1).

The reduction in the number of plants and area of infestation until summer 1996 has not been consistent, but the amounts are nevertheless below those at the January 1993 peak. Only one in eight of the farms known to be infested in January 1993 were still infested in February 1996, and the number of plants found this summer is a fraction of previous years' totals (Table 1).

By February 1996, all indicators showed that the eradication program for kochia at known infestations was progressing to a successful conclusion. This supports the statement (Dodd 1993) that kochia was 'a suitable candidate for eradication because of its recent introduction, its limited but well documented distribution, the high degree of farmer support and the limited longevity of its seeds'.

However, the discovery, in May 1996, of thousands of kochia plants (Table 1) 50 km from the nearest known infested farm led to a reassessment of the success of the eradication program.

The new infestation was along a 2 km long belt of trees that had been planted 12 months previously. The source of this population has been traced to two nearby demonstration plots for saltland revegetation, believed to have been sown in 1991 by the local land conservation group. For reasons not yet known, these plantings were not reported when the kochia incident was being publicised in Western Australia early in the eradication campaign.

The extent of spread around these plantings is still being documented. However, the detection of these new infestations has clearly changed the overall assessment of the success of the eradication program for kochia.

The behaviour of uncontrolled kochia at these sites demonstrates this weed's potential for local increase and for rapid, long distance spread (Forcella 1985). It also clearly indicates that the early imposition of eradication measures at other sites has, indeed, prevented kochia spreading widely from the original plantings.

Table 1. Kochia survey results.

Survey date	Farms infested	Area (ha)	Total plants
Oct. 1992	46	696	many 1000s
Jan. 1993	52	2200	many 1000s
March 1994	24	68	1064
Feb. 1995	8	139	1945
Feb. 1996	6	no data	127
June 1996	8	unknown	many 1000s

Table 2. Analysis of new skeleton weed infestations found on farms in Western Australia.

Stage	Period	Average new finds per year
1	1963–1972	1
2	1973–1981	8
3	1982–1991	23
4	1992–1995	51
5	1995/96 season	99

Skeleton weed Despite the operations of a highly organized and well funded eradication program since 1974 (Dodd 1987), new infestations of skeleton weed continue to be found on farms, along railways and, occasionally, on roadsides in Western Australia.

The skeleton weed eradication program began in earnest in 1973/74 following the discovery of large areas of the weed in Narembeen shire. Since then there has been an increasing trend in the number of new finds of skeleton weed on farms each year. Four or five stages can be identified in the records for new infestations since skeleton weed was first discovered (Table 2).

In the 20 years since the start of the eradication campaign there has been more than a 12-fold increase in the average number of new finds per year (Table 2). During the 1995/96 search season, there was a record total of 99 new skeleton weed infestations found on farms. This took to 596 the cumulative total of properties in Western Australia that have ever had skeleton weed. It remains to be seen whether the 1995/96 total is exceptional or whether it represents the start of a new stage with high annual totals of new finds.

The increasing rate of new finds reflects population growth. This, in turn, is probably due mostly to spread from populations already present in Western Australia. If this is the case, infestations are reproducing and giving rise to new populations before they are found and eradicated.

This is supported by the pattern of spread detected in Western Australia, when the dates of first known infestation are examined on a shire-by-shire basis (Dodd unpublished results). The pattern that emerges is one of spread from the earliest known infested shires, leading to a coalescence of infested shires across most of the wheatbelt.

Despite this, eradication is being achieved at around 50% of individual farms that have been treated and have been in quarantine long enough (three cropping years free of skeleton weed) to confirm elimination of the skeleton weed population.

The value of the skeleton weed eradication program in Western Australia has been questioned, because this weed has not been eliminated from the State in the 33 years since it was first found; instead, it is being found in increasing amounts.

However, the operation of the eradication program has stopped the increase of existing infestations, by preventing them from further reproduction and spread, and has led to the eradication of half the on-farm infestations. Consequently, the area of farmland affected by skeleton weed remains low (<1000 ha) and its economic impact on affected farms has been negligible.

Benefits have accrued from the operation of this eradication program in Western Australia, even though

full eradication has not been achieved on a statewide basis.

Even if all populations of this weed were eradicated in Western Australia, new populations will arise from seeds that enter the State in and on vehicles and produce from other regions of Australia, until biological and other control measures reduce seed production in all forms of the weed to insignificant levels.

COMPARISONS

Although both eradication programs are highly organized and well resourced, there are some important differences between them that may help explain the different outcomes.

The kochia program deals with sites that were known from the start to contain the weed, whereas the skeleton weed program is reactive, dealing only with infestations found during the course of other operations.

Kochia is an annual that lacks vegetative reproduction, whereas skeleton weed is a persistent perennial with potent vegetative reproduction.

The Western Australian populations of kochia were the only ones in Australia, so there was no risk of supplementation from populations elsewhere. However, because of the presence of large populations of skeleton weed in south eastern Australia, there is the continuing likelihood of seeds reaching Western Australia to cause new infestations. Even if all local infestations were eradicated, new populations may establish from seed arriving from interstate.

The eradication treatments for kochia were applied mostly within 12 months of the seed being sown, which minimized seed production and escape. Most skeleton weed infestations contain mature, reproductive plants when found, from which new infestations are likely to have arisen.

ACKNOWLEDGMENTS

The information presented here summarizes the collective efforts of many officers formerly of the Agriculture Protection Board of Western Australia, most of whom are now Agriculture Protection officers within Agriculture Western Australia.

REFERENCES

Cullen, J.M. and Groves, R.H. (1977). The population biology of *Chondrilla juncea* L. in Australia. Proceedings of the Ecological Society of Australia 10, 121-34.

Dodd, J. (1987). An analysis of spread of skeleton weed, *Chondrilla juncea* L., in Western Australia. Proceedings of the 8th Australian Weeds Conference, pp. 286-9.

Dodd, J. and Moore, J.H. (1993). Introduction and status of *Kochia scoparia* in Western Australia. Proceedings of the 10th Australian and 14th Asian-Pacific Weeds Conference 1, 496-500.

Forcella, F. (1985). Spread of kochia in the northwestern United States. *Weeds Today* 16, 4-6.

Holm, L., Pancho, J.V., Herberger, J.P. and Plunknett, D.L. (1979). 'A geographical atlas of world weeds'. (John Wiley and Sons, Toronto).

Meadly, G.R.W. (1963). Skeleton weed. *Journal of Agriculture Western Australia* 4, 700-8.

Panetta, F.D. and Dodd, J. (1987a). The biology of Australian weeds 16. *Chondrilla juncea* L. *Journal of the Australian Institute of Agricultural Science* 53, 83-95.

Panetta, F.D. and Dodd, J. (1987b). Bioclimatic prediction of the potential distribution of skeleton weed (*Chondrilla juncea* L.) in Western Australia. *Journal of the Australian Institute of Agricultural Science* 53, 11-16.