

INTRODUCTION AND STATUS OF *KOCHIA SCOPARIA* IN WESTERN AUSTRALIA

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Summary. Within two years of its introduction for use as a salt tolerant forage plant and for saltland rehabilitation, kochia showed weedy attributes by proliferating at planting sites and spreading to non-saline soils. Assessment of its weed potential indicated that it would cause considerable damage to agriculture in Western Australia and, even more so, in summer-grown crops and summer fallows in south-eastern Australia. Recognition of its weed potential led, first, to its proclamation as a Declared Plant in Western Australia and, ultimately, to it becoming an eradication target, under a program funded jointly by Federal and State bodies.

INTRODUCTION

Kochia, *Kochia scoparia*, is an annual chenopod originating from eastern Europe and western Asia. It is a C₄ plant that is competitive under hot, sunny conditions and it has a high water-use efficiency, enabling it to thrive in summer. Well grown plants are dense, multi-stemmed, spherical bushes that may reach 1.5 m in height and diameter.

A weedy form of this species has become a problem in various parts of the world, including most of Europe, parts of temperate Asia, Canada, USA and Argentina (5, 6, 10), but had not been recorded in Australia. The taxonomy of this form is unclear, but *K. densiflora* or *K. scoparia* subsp. *densiflora* may be applicable (P. Wilson, pers. comm., 1992). An ornamental form, known variously as summer cypress, mock cypress or burning bush, *K. scoparia* var. *trichophylla*, is distinct from the weedy taxon and has been grown in Australia for many years.

Problems associated with kochia are its competitiveness in a wide range of agricultural and horticultural crops, invasion of pastures, allelopathic effects on pasture and crops plants, toxicity to stock, and infestation of roadsides and railway reserves (1, 3). It is also noted for its rapid spread, which results from the 'tumbleweed' nature of dead, seed-laden plants (3). It has developed resistance to sulfonylurea and triazine herbicides as a result of repeated treatment (1, 7, 8).

Despite its well documented weediness, there has been considerable interest in cultivating kochia as a forage plant, on account of its palatability, rapid growth, high productivity and ease of establishment (2, 4). Its ability to flourish in saline soils led to its recognition as a potential forage plant for use in salt-affected soils in Australia. It was introduced into Western Australia in 1990, but by early 1992 it had begun showing weedy behaviour by spreading from planting sites.

This paper reviews the introduction of kochia into Western Australia, its progress during two years of cultivation, and the intervention by the State's Agriculture Protection Board (A.P.B.), the Department of Agriculture and the Australian Quarantine Inspection Service (A.Q.I.S.) aimed at preventing kochia becoming established as a weed in Australia.

METHODS

Abstracts of literature on kochia were obtained from the Commonwealth Agricultural Bureaux (C.A.B.) database for the period 1973-91.

Individuals to whom kochia seed had been sold were traced through sales records supplied by the Perth-based seed merchant who imported the seed in mid 1990. They were contacted by phone in early 1992 to determine the progress of plantings. This led to field surveys in autumn 1992. Further surveys of known plantings were conducted in spring and early summer 1992 to determine the amount of regeneration from seed, the extent of spread within and beyond the planting site and the environmental conditions of the site.

RESULTS AND DISCUSSION

Literature profile. Of the 208 references on this plant in C.A.B. Abstracts for the period 1973-1990, two thirds dealt with its deleterious attributes (Fig. 1). The literature also provided information on the plant's biology.

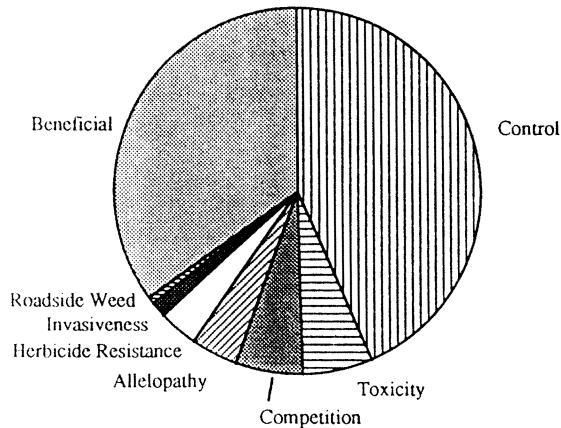


Figure 1. Literature on kochia from C.A.B. abstracts for the period 1973-1990, categorised by topic.

Introduction and ultimate distribution. When the seeds of kochia were imported into Perth from United States in May 1990, there was no reason for A.Q.I.S. to doubt the claims made regarding the usefulness of kochia for rehabilitating salt-affected land. Since the plant was not prohibited under Federal or State legislation, its importation was allowed.

Plantings were made in 1990 on a small number of farms in Western Australia, mainly for the production of commercial quantities of seeds. By late 1991, kochia had been planted at 68 sites throughout the southwest of Western Australia. Almost without exception, the plantings were in salt scalds that the landholders were keen to rehabilitate. The plantings were located throughout

Weed status

the wheatbelt, with two in adjoining pastoral regions. No seeds were distributed beyond Western Australia, apart from two consignments that were sent to Victoria, of which one failed to germinate and the other was not planted.

In most cases, the seed was sown as a component of a mixture, in which the other species were salt-tolerant perennials including saltbush, *Atriplex* spp., acacia, *Acacia saligna*, and the grasses puccinellia, *Puccinellia ciliata*, and tall wheat grass, *Agropyron elongatum*. Several farmers who purchased seed had not planted it, while in other cases the seed failed to germinate or else the planting was destroyed by grazing while plants were immature.

Surveys. Field inspections throughout 1992 showed that kochia was growing actively at 52 sites in all parts of the wheatbelt where it had originally been introduced. The spring 1992 survey revealed that kochia seedlings were present at practically all sites that had contained mature plants the previous autumn. Seedling densities were often high, reaching several thousand seedlings/m². This indicated a high level of seed production within the planting site, since these seedlings were clearly not derived from the original sowings. Most infestations were small (Table 1). The majority were less than 10 ha in extent and, within that size class, most occupied 0.1-5 ha, reflecting the limited size of the original sowings in salt-affected sites.

Table 1. Size distribution of kochia infestations, December 1992

Size class (ha)	Infestations (n)	Size class (ha)	Infestations (n)
0.1 - 10	38	61 - 70	0
11 - 20	4	71 - 80	1
21 - 30	5	81 - 90	0
31 - 40	0	91 - 100	1
41 - 50	2	101 - 110	0
51 - 60	0	111 - 120	1

Seedlings were not restricted to saline soils, but were found on a range of soil types, including non-saline agricultural soils and an alkaline 'kopi' soil of pH 8.8 (9). In most cases, the seedlings were growing within the salt scald, but there were several instances where they occurred in crops (specifically barley and lupins) and pasture adjoining the scald. Others grew in nearby firebreaks, ditches and tracks, and along fences where the parent tumbleweed had stopped. These findings indicated the weed's adaptability and its potential to invade a wide range of soil types and land use.

One limitation of the spring 1992 survey was the small size of seedlings (most were <5 cm tall), which made their detection difficult, especially when they were present at low density. When some sites were examined again in January 1993, after plants had grown substantially, isolated plants could be found some distance away. The most extreme examples of this were at Jerramungup, in the southern wheatbelt, where the sizes of two infestations that were recorded as occupying less than 10 ha each when assessed in spring 1992, were revised to 750 ha in January

Weed status

1993 when large plants were found in adjoining paddocks, in one case up to 3 km from the original planting. These examples also illustrate the plant's ability for rapid spread, following its initial sowing in 1990.

Declared plant status. Within a few weeks of the magnitude of the weed potential of kochia being realised, the A.P.B. gazetted kochia as a Declared Plant (noxious weed) in April 1992, placing it in the P4 (containment) category which required landholders to prevent its spread. This was an interim classification, pending further evaluation of the suitability of placing kochia in the eradication category. Declaration led to various control measures at all known plantings, aimed at preventing dead plants breaking off and spreading from the existing plantings. At that time an intense publicity campaign was undertaken to alert growers to the risks posed by kochia and to invite reports of suspect plants.

The declaration status of kochia was upgraded to P2 (eradication) in December 1992, in response to the widespread germination at planting sites and evidence of spread of the weed. It was also considered to be 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, which appear to lose viability after 18 months (A.H. Cheam, pers. comm., 1993).

Potential distribution. The potential distribution of kochia was predicted by bioclimatic matching, using climatic profiles for locations overseas and in Western Australia where the plant had been recorded. The resulting prediction indicated that most of southern Australia was climatically suitable for kochia, including the major cereal growing regions of all southern mainland States (S. Connell, pers. comm., 1992). Overall, kochia might be an even greater threat to south-eastern Australia than to Western Australia. This is because its prevalence as a weed in a wide range of summer-grown crops in the United States (3) suggests that it would be of particular concern in those parts of south-eastern Australia where crops are grown in summer. It is also highly likely that kochia would flourish in summer fallows, depleting the soil moisture reserves required for subsequent crops.

Eradication program. In view of the perceived threat to Australian agriculture as a whole, and the weed's current restriction to Western Australia, joint Federal (A.Q.I.S.) and State funding for a four-year eradication program for kochia was approved in March 1993. As a result, a vigorous program of herbicide treatment, crash grazing and grubbing was conducted at all known infestations in autumn 1993, with the aim of preventing seed production by destroying all known kochia plants (B. Uren, pers. comm., 1993).

A commitment to monitor known infestation sites, to search adjoining areas for any missed plants and to continue with publicity to help locate any new infestations should guarantee the success of the eradication campaign and protect Western Australia and other parts of Australia from this recent, undesirable introduction.

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Weed status

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