BIOLOGY OF THE WESTERN AUSTRALIAN WEED AFGHAN THISTLE (SOLANUM HOPLOPETALUM)

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Summary: This paper reviews current information on Afghan thistle and summarises the results of recent studies on this W.A. endemic weed.

INTRODUCTION

Afghan thistle is one of the few W.A. native plants that has become a weed of agricultural importance. It occurs widely throughout the south west of the State and is renowned for its spininess and persistence, and because of difficulties associated with its chemical control.

Name: Afghan thistle (*Solanum hoplopetalum* Bitter & Summerh., family: Solanaceae) is also known as prickly potato weed (Paterson 1967). The species was previously referred to as *S. hystrix* R. Br. (Meadly 1965), but this is now recognised to apply to a closely related species in South Australia (Symon 1981, Grieve 1982).

Description: Detailed descriptions are provided by Symon (1981) and Purdie et al. (1982). *S. hoplopetalum* is a low growing clonal perennial herb with erect or sprawling stems 30 to 40cm long, which are produced annually and rarely last more than one year. All parts of the plant are densely covered with pale, straight prickles up to 14mm long. Lobed elliptical leaves up to 12cm long and 5cm wide are borne alternately on the stem on petioles 1.5 to 4.5cm long. Inflorescences bear from 4 to 8 white or pale blue flowers, 2 to 3cm in diameter when fully open The fruit is a spherical berry 1 to 2cm in diameter, which is mostly enclosed by the enlarged prickly calyx and is green when immature, but black or brown and shrivelled when ripe.

The root system consists of extensive brittle, horizontal roots up to 1cm diameter at 15 to 20cm depth, with occasional tap roots. Above-ground shoots arise from buds borne on the root system and on the below-ground parts of stems. Afghan thistle typically forms dense or diffuse patches, a few square metres to a hectare or more in extent, in which the apparently separate shoots arise from a common root system.

History and Distribution: The species is endemic to Western Australia and can be found as a component of natural vegetation in non-agricultural areas inland of the wheatbelt (Symon 1981). Its presence in the agricultural region of the south west of the State is believed to be due partly to the persistence of individual colonies that have survived clearing (Meadly 1965) and partly to the introduction of material after clearing. Its vernacular name alludes to the common belief that it was spread by camel teams, driven by Afghan handlers arriving from the Goldfields and elsewhere. More recently it has spread along railway lines, leading to infestations of the railway reserve and adjacent land. It is not known whether this is due to the transport of fruit, seed or vegetative material. With the exception of those areas receiving the highest rainfall, Afghan thistle is found throughout the agricultural south west, in paddocks, along road shoulders and verges and on railway reserves. Population density is often low, but dense infestations occur in parts of the northern and eastern areas of the central wheatbelt district.

Habitat: *S. hoplopetalum* grows under a range of climatic conditions, from the mediterranean winter-wet climate areas of the agricultural south-west with 300 to 700mm of rain annually, to the semi-arid Goldfields and pastoral areas with low annual rainfall of 200 to 300mm. It is found on a variety of substrates including light sands, sandy loams and heavy clays, but favours the lighter soils (Meadly 1965).

During winter and spring, Afghan thistle is a relatively minor component of the agricultural weed flora when compared to the abundance and biomass of other weeds present; however, it becomes conspicuous in summer after the death of most annual weeds, when it is found with summer weeds such as mulla-mulla (*Ptilotus* sp.), wireweed (*Polygonum aviculare*), paddy melon (*Cucumis myriocarpus*), Afghan melon (*Citrullus vulgaris*), stinkwort (*Dittrichia graveolens*) and mintweed (*Chenopodium cristatum*). It has not been found in remnants of original vegetation in the wheatbelt, but such stands are mostly small and scattered and have not yet been closely examined.

Growth and Morphology: *S. hoplopetalum* has several characteristics that contribute to its survival and spread. Its capacity to survive the effects of agricultural activity can be attributed mainly to its ability to shoot from below-ground adventitious buds, allowing replacement of damaged shoots and regeneration from root fragments. The extensive horizontal roots appear to store starch, while the tap roots have access to soil water stored deep in the profile, ensuring carbohydrate supply when aerial stems have been destroyed and water supply at times of drought. The enlarged prickly calyx that partly encloses the fruit is thought to protect the ripening fruit against excessive water loss and predation by marsupials (Symon 1982).

Above-ground parts die at the start of winter, and plants perennate during the winter months by means of dormant buds on lateral roots and the below-ground parts of stems.

EXPERIMENTAL RESULTS

Physiology and productivity: Measurements of xylem pressure potential (X.P.P.) and stomatal conductance in summer 1983/84 indicate that Afghan thistle does not experience any major degree of water stress even at the height of summer. Xylem pressure potential at dawn varied from -0.5 to -0.2 MPa. Minimum daily X.P.P. usually occurred around midday or early afternoon, and was -1.9 MPa in January and February and -1.1 MPa in March and April. The large stomatal conductances recorded indicated that plants were maintaining high rates of transpiration. The combination of high conductance and X.P.P. values measured over this period may be related to elevated soil water contents that resulted from the unusually large amounts of rainfall in summer 1983/84. The response of Afghan thistle to prolonged summer drought more typical of wheatbelt conditions has not yet been measured.

Biomass increases during spring with the growth of new shoots. Total above-ground dry matter at Toodyay and Northam varied around 75g m^{-2} for January to April 1984. Over this period leaf area index declined from 0.25 at Toodyay and 0.1 at Northam, to 0.1 and 0.05 respectively.

Phenology and Reproduction: Although generally considered a summer weed, most growth takes place in spring during formation of the aerial shoots. These persist through summer but die in early winter, in May or June. Flowering reaches a peak in October to November but becomes infrequent after January. Flower structure varies on the plant since *S. hoplopetalum* is andromonoecious, i.e. a proportion of flowers are male while others are hermaphroditic. The proportions of these two flower types vary regionally and with time (Table 1).

Table 1: Regional and seasonal variation in *S. hoplopetalum* floral morphology.

Location	Date (1984)	Total flowers counted	Hermaphroditic flowers (%)	Male flowers (%)
North Miling	19 Jan.	59	63	37
Northam	24 Jan.	43	33	67
Merredin	25 Jan.	111	62	38
Moorine Rock	25 Jan.	97	67	33
Narembeen	26 Jan.	39	51	49
Toodyay	18 Jan.	11	73	27
Toodyay	15 Feb.	14	50	50
Toodyay	22 March	86	93	7
Toodyay	19 April	78	49	51*
			$\bar{x}$=60	$\bar{x}$=40

* this total includes 5 short-styled hermaphrodites.

Andromonoecy is a feature of a number of *Solanum* species (Symon 1981, 1982) but has not been reported previously in *S. hoplopetalum*.

Individual flowers remain open 2 to 3 days. If pollination occurs, fruit development takes at least 3 months and occupies most of late summer, January to April. Seed content averaged 38 seeds per fruit at Toodyay and 79 seeds per fruit at Northam in 1984: at these sites fruit density was, respectively, 9 fruits and 60 fruits m^{-2} of infestation. Panetta (unpublished) recovered viable seeds at a density of 40 m^{-2} from soil at the Toodyay infestation, which suggests that Afghan thistle does not develop large persistent seed banks.

Germination requires relatively high temperatures. Peirce (unpublished) found maximum germination at alternating 20/30^{o}C temperatures; under this regime 48% of seed had germinated after 6 weeks, 16% were dead and 36% remained dormant. Germination rates are low. Eleven month old seed from 36 sites throughout the wheatbelt and further inland (Peirce unpublished) germinated under a 15/25^{o}C temperature regime, had a cumulative germination percentage that averaged 35% of total seed number (S.D. = 27, range 0 to 79%). The number of days to first germination averaged 26 days (S.D. = 18, range 3 to 78) and the time taken to achieve 50% of the final germination percentage averaged 44 days (S.D. = 23, range 5 to 84). These low germination percentages and rates indicate a high degree of dormancy in *S. hoplopetalum*.

Afghan thistle had not been known to reproduce sexually under field conditions until the discovery of seedlings at Wyalkatchem early in 1984. All propagation of this weed was previously thought to be by vegetative means.

Vegetative reproduction occurs by regeneration from root fragments. Regeneration varies seasonally and according to temperature and root fragment size, but no consistent patterns have been found (Panetta, unpublished).

Importance: Because Afghan thistle is most active in spring and summer it does not compete significantly with cereal crops or winter pastures (Paterson 1967). However, its prickly nature makes it a nuisance to the farmer. Sheep will browse the shoot tips to a limited extent, but it is likely that the plant would be toxic (like most members of the Solanaceae) if consumed in large amounts, although there are no known instances of stock poisoning caused by this plant. A beneficial characteristic of Afghan thistle is its ability to stabilise light sandy soil, thus protecting against wind erosion. Afghan thistle is gazetted as a pest plant in 12 wheatbelt shires, which empowers the local authority to call for its control when growing within its district.

Response to herbicides: The application of broad leaf herbicides at standard rates might kill the shoots but does not affect the below-ground parts: consequently new shoots emerge from the active root system. Effective chemical control can be achieved using picloram, dicamba or glyphosate; however, high rates are required, making their use over broad areas unsuitable because of cost and/or soil residual effects. The search for suitable herbicides for use on Afghan thistle is continuing.

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