Biology and management of red dodder – a new threat to the grains industry

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Summary Seed dormancy release, host species preference, the effect of parasitisation on pods or burrs of host plant species, the effect of crop sowing time and control of red dodder (*Cuscuta planiflora*) by selective herbicides were investigated in a series of experiments under laboratory and glasshouse conditions in 2005 at Northam, WA. About 88% of untreated seeds of red dodder were dormant but soaking seeds in concentrated sulphuric acid for 10 minutes improved seed germination from 12 to 45%. Treated seeds of red dodder germinated over a range of temperature regimes. This weed species successfully parasitised lupin, lentil, chickpea, field pea, faba bean, sub-clover and canola plants in order of decreasing preference. Parasitisation reduced pods or burrs per plant by 20% in lentil, 50% in faba bean, 60% in lupin, 75% in chickpea, and 100% in sub-clover. Pre-sowing herbicides such as trifluralin, simazine, Kerb®, diuron, Spinnaker® and Lexone® controlled 90 to 100% of red dodder plants. Post-emergent herbicides such as atrazine, Spray.Seed® (paraquat + diquat), Lexone® and Sniper® controlled 83 to 100% of red dodder plants. Delay in sowing time of crops by two to four weeks effectively reduced red dodder plants.

Keywords Red dodder, dormancy, host preference, parasitic effect, herbicide control, time of sowing.

INTRODUCTION

Red dodder (*Cuscuta planiflora* Ten.) is widely distributed in the Mediterranean and central Asia but it has been introduced in many other countries (Parker and Riches 1993). It is known to attack lucerne and clovers (Al-Menoufi and Hassan 1976) and some species of dodder are mildly toxic to animals (Movesian and Azaria 1971). Cooke and Black (1987) reviewed the biology and control of *Cuscuta campestris* Yuncker and other *Cuscuta* spp. including *Cuscuta planiflora* which was referred to as red dodder. That review highlighted the lack of information available on red dodder.

Red dodder was found in a canola crop in the Northern Agricultural region of WA in 2001; the first record of parasitisation of canola. The presence of dodder has the potential to contaminate produce and may exclude this produce from markets which have zero tolerance for dodder seed.

Very little information is available on the biology and management of this parasitic weed under WA wheatbelt conditions. The aims of this study were to investigate red dodder seed dormancy release, the preference of red dodder for host plant species, the effect of parasitisation on the pods or burrs of host plant species, the effect of crop sowing time on red dodder and its control by selective herbicides.

MATERIALS AND METHODS

A series of experiments were conducted in a completely randomised design with 50 seeds per Petri dish or pot replicated three to five times under laboratory or glasshouse conditions at Northam in 2005. An untreated control was maintained in each experiment.

Release of red dodder seed dormancy Seeds were treated with concentrated sulphuric acid for 10 minutes and then allowed to germinate at three temperature regimes (5/15, 10/20, and 15/30°C night/day) with or without prior chilling. Germination of seeds was recorded either daily or every alternate day for 3–6 weeks. Data were averaged over the temperature regimes.

Host preference for red dodder plants Treated seeds of red dodder were sown with seven species of crops and pastures in 10 L pots with three replications. An untreated set of three pots species was maintained without red dodder seeds. The crop and pasture species are canola (*Brassica napus* L.), chickpea (*Cicer arietinun* L.), faba bean (*Vicia faba* L.), field pea (*Pisum sativum* L.), lentil (*Lens culinaris* Medik.), lupin (*Lupinus angustifolius* L.), and sub-clover (*Trifolium subterraneum* L.). Emergence and survival of dodder plants were recorded for up to seven weeks after sowing. Preference was determined by the extent of parasitisation and survival of red dodder on different species.

Red dodder effect on the pods or burrs Treated seeds of red dodder were sown on the surface of pots and covered with a thin layer of sandy soil. In the pots where natural parasitisation did not occur, artificial parasitisation was performed by wrapping an 8 cm long fragment of red dodder shoot around the stem

of the target host plant. Pods produced by host crop plants both in the absence and presence of red dodder were counted.

Time of sowing effect on red dodder Treated red dodder seeds were sown in pots four times at weekly intervals. Emergence and survival of red dodder plants were recorded for each time of sowing (TOS) up to 31 days after sowing.

Red dodder control by herbicides Selected pre-sowing herbicides recommended for each host species were sprayed on the surface of pots and covered with a thin layer of sandy soil. Emergence and mortality of red dodder plants were recorded for seven weeks after sowing. Selected post-emergence herbicides recommended for each host plant species were sprayed at the label rate and at the recommended growth stage of each host plant species. Density and mortality of red dodder plants were recorded four weeks after spraying.

RESULTS

Release of red dodder seed dormancy Temperature regimes did not affect germination of treated red dodder seed under growth cabinet conditions. So, data were averaged over temperature regimes. About 88% of collected seeds of red dodder were dormant. Soaking seeds in concentrated sulphuric acid for 10 minutes (followed by rinsing with distilled water) increased germination from 12% to 45% (Figure 1). Chilling after acid treatment reduced the germination of red dodder compared to the acid + no-chilling treatment while chilling without acid treatment did not affect its germination.

Host preference for red dodder plants Germination of treated red dodder seeds sown with various host crop and pasture species started five days after sowing (DAS) in lupin and seven DAS in other plant species (Figure 2). Regardless of species, the highest number of surviving red dodder plants (5 to 30 pot^{-1}) was found from 8 to 22 DAS (except in canola) after which the number of surviving red dodder plants gradually decreased. The number of surviving red dodder plants at 44 DAS was reduced to 3 to 6 plants pot^{-1} regardless of species.

The number of surviving red dodder plants did not vary greatly at 44 DAS. However, based on the highest observed number of surviving red dodder plants the host species may be ranked in the order of decreasing preference by red dodder as lupin >lentil >chickpea >field pea >faba bean >sub-clover >canola (data for field pea and sub-clover not shown). Parasitisation of red dodder in canola started later with fewer surviving red dodder plants than other crops, although the number of final surviving plants was similar to those in lupin.

Red dodder effect on the pods or burrs The production of pods or burrs was greatly affected by red dodder in all host species (Figure 3) except in canola (data not shown) where the number of the surviving red dodder plants between five and 36 days after sowing dodder was also less than in the other species (Figure 2). The presence of red dodder reduced pods or burrs per plant by 20% in lentil, 50% in faba bean, 60% in lupin, 75% in chickpea, and 100% in sub-clover (Figure 3).

Time of sowing effect on red dodder The time of sowing experiment showed that delaying the sowing time of lupins by two to four weeks can substantially

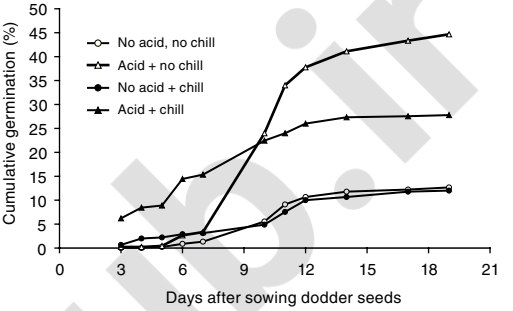

Figure 1. Effect of concentrated sulphuric acid and chilling treatments on the germination of red dodder seed under laboratory conditions, averaged over temperature regimes.

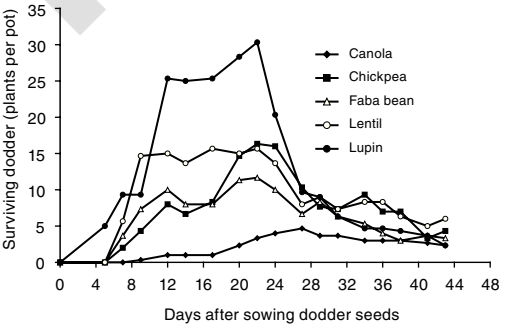

Figure 2. Emergence and survival of red dodder plants in association with various host crop plants under glasshouse conditions.

reduce the number of surviving red dodder plants (Figure 4).

Red dodder control by herbicides Pre-sowing herbicides controlled 91 to 100% of red dodder plants (Table 1). No emergence of red dodder plants was observed in pots sprayed with Kerb® while a few plants emerged in the pots sprayed with trifluralin. Red dodder emerged normally and then slowly died in all other pre-sowing herbicide treatments.

Among the post-emergent herbicides sprayed at the recommended stages of each of host plant species, atrazine and Spray.Seed® controlled 100% of red dodder plants, Lexone® and Sniper® each controlled 83%, and Broadstrike® and Lontrel® each controlled 50% (Table 1). Efficacy of other herbicides such as Eclipse®, Brodal® and Raptor® was less than 40%.

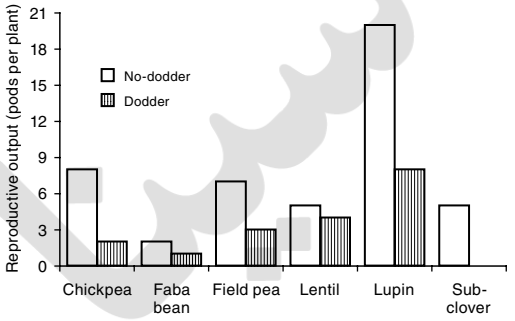

Figure 3. Effect of red dodder parasitisation on the production of pods or burrs by various crops under glasshouse conditions.

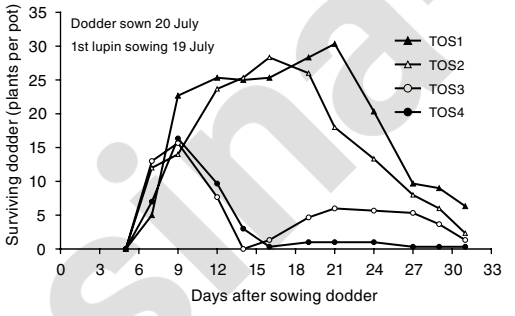

Figure 4. Effect of time of sowing of lupin crop seeds on the survival of red dodder plants under glasshouse conditions.

DISCUSSION

The proportion of hard seeds in red dodder was 88%. Hutchinson and Ashton (1980) reported that the proportion of hard seeds in *Cuscuta campestris* was up to 95% in the USA. Acid treatment greatly improved the germination percentage of red dodder although chilling after acid treatment reduced its germination. Lower temperature is known to reduce germination of small-seeded dodder (Allred and Tingey 1964). Red dodder seeds germinated well across all the three temperature regimes used in this study suggesting that red dodder may germinate in crop at any time during the season. Unlike *Striga* and *Orobanche*, the seeds of *Cuscuta* spp. have no specialised temperature requirements for germination (Parker and Riches 1993). Red dodder successfully infested all crop and pasture species tested (canola, chickpea, faba bean, field pea, lentil, lupin and sub-clover) and reduced their pod or burr production by 20 to 100%, even though lucerne and clovers were the only species previously recorded as red dodder hosts (Al-Menoufi and Hassan 1976).

Pre-emergent herbicides such as simazine, diuron, Kerb®, Lexone®, Spinnaker®, and trifluralin controlled red dodder by 91 to 100%. Post-emergent herbicides

Table 1. Effect of different pre-sowing and post-emergent herbicides on the control of red dodder plants in crop and pasture plants.

Pre-emergent herbicides	Dodder control (%)	Post-emergent herbicides	Dodder control (%)
Diuron	91	Atrazine	100
Kerb® (propyzamide)	100	Broadstrike® (flumetsulam)	50
Lexone® (metribuzin)	97	Brodal® (diflufenican)	33
Simazine	100	Eclipse® (metosulam)	33
Spinnaker® (imazethapyr)	93	Lexone® + Brodal®	83
Trifluralin	100	Lexone®	83
LSD (P = 0.05)	18	Lontrel® (clopyralid)	50
		Raptor® (imazamox)	39
		Sniper® (picolinafen)	83
		Spray.Seed® (paraquat and diquat)	100
		LSD (P = 0.05)	20

such as Lexone®, Sniper® and Spray.Seed® controlled red dodder by 83 to 100%. Dodder plants are completely dependent on their own roots for minerals and water uptake for the first eight days of their life cycle (Sitkin 1976). This may cause them to be more susceptible to pre-sowing rather than post-emergence herbicides. However, Parker and Riches (1993) reported that both contact and translocated post-emergence herbicides are important for the selective control of dodder in crops and pastures.

Delaying crop sowing by two to four weeks effectively reduced the density of red dodder. Since a dodder plant must contact a suitable host plant within eight days, a delay in the sowing time of the crop by at least two weeks should kill the older plants of red dodder. A knockdown herbicide should be applied to kill young plants of red dodder along with other existing weeds before sowing crops. This may reduce the density of dodder plants but new dodder plants may emerge in the crop from residual seed bank.

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