



Management of dodder in lucerne for better forage quality

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Forage crops include a wide range of annual and perennial grasses and legumes grown for hay, silage and pasture and are grown throughout the country to support various livestock. Weeds can reduce the quantity and quality of desirable plants in pastures and hayfields. Even some weed species can also be poisonous to livestock. Therefore, weed management is an imperative component of forage crops and pasture management particularly for parasitic weeds. Well-managed pastures require fewer direct actions to manage weeds because healthy, well-established forage plants are more likely to prevent weed invasions. In some situations, however, herbicides are needed for weed control despite a producer's best pasture management efforts. Under some circumstances, the quality of pastures can be substantially improved with a well-planned herbicide programme. Therefore, parasitic weed management requires a combination of cultural, mechanical, biological, and chemical methods starting from field preparation and continues throughout the life of the pasture along with prevention strategies. The weed management techniques are often species-specific, under such circumstances the success of weed management depends on correctly identification of weeds present in the field. In order to make sound management decisions, it is important to know the name of a weed, as well as its lifecycle and reproductive mode and capacity. Accurate information on the biology and lifecycle of the weeds can help growers to apply weed management techniques more effectively, based on the susceptibility of the species to different control methods.

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Introduction : Dodder is an annual total stem (obligate) parasite weed that causes serious problems in Indian land with many plants. In India it is locally known as Amarbel or swarnalata. The parasitic weed *C. campestris* is by far the most important among the dodders, perhaps because of its wide host range. Once introduced, it is almost certain that there will be suitable host plants on which it can thrive and be damaging, whether they are crops or wild species. It also has a wide tolerance of climatic conditions *i.e.* warm temperate to sub-tropical and tropical. It has slender, twining

or threadlike stems that vary from pale green to yellow or bright orange in colour. As the plant do not have any leaves and chlorophyll to live from-they therefore must obtain all of their growth requirements by attaching themselves to other living green plants (host plants). Dodder seeds germinate near the soil surface and send up slender which rotates slowly until it touches the stem or leaf of another plant and begins to wind around it. On a host plant, the dodder stem will immediately form small appendages called hustoria. Soon after attaching to a host plant, the lower end of the dodder withers and break its connection with the ground, while the upper of the stem grows rapidly. Dodder stems that have attached to a host plant have been known to survive for several days after being detached from the host plant. As dodder plants grow, they continually reattach to the host. When other suitable hosts are nearby, dodder shoots spread from host plant to host plant, often forming a dense mat of intertwined stems.

Botanical description : It is a true obligate parasite, spread by seed, in the genus *Cuscuta* in the family Cuscutaceae, the defining characteristic of the mature embryo is the absence of cotyledons. This may be attributable to the fact that the first job of the young stem is to search for a host, not to photosynthesize. Dodder emergence as a rootless, leafless stem (or have small, scale like, triangular leaves), dependent on the food reserve stored in the seed for its immediate survival. Germination of dodder seeds does not require any stimulation from the host crop. Seedlings are yellowish, threadlike, rootless, leafless stems. The bell-shaped flowers are cream colour and usually occur in clusters but occasionally are borne singly. Each ovary bears four ovules but one or more may abort. The fruit is an indehiscent oblong to sub globes capsule bearing a persistent style, enclosed by the corolla. Each flower produces a seed capsule with 4 seeds. Dodder seeds are brown, yellow or grey in colour, slightly pear shaped, have rough coats and vary in size depending on species but generally are about 1-2 mm in diameter (similar in size to clover and Lucerne seeds). A single plant can produce over 2000 seeds, which can remain viable in the soil upto 20 years. Dodder plant die after germination in the absence of

a host plant. The dodder seeds fall in field when they fully matured and accumulate on the ground. They may germinate during the following season if a suitable host plant is growing nearby or may stay dormant until suitable conditions have occurred (Swift, 1996).

Preferred habitat : *C. campestris* is native to temperate North America but has been spread to many tropics and sub-tropic regions. Field dodder grows in a wide range of environmental conditions and on a wide variety of host plants including crops, pastures, vegetable, weeds and some tree species. The seed requires the right combination of soil moisture and warm temperatures to germinate and grow. Germination occurs regardless of light or darkness, at temperatures above 10°C, and optimally at 30°C. Seeds can germinate in spring, summer and autumn, but most germination takes place in late spring. The seed reserves can support growth of the shoot to 5-10 cm, supported by a short stubby root only 1-2 cm long. They germinate readily in moist soil and produce wiry plumules. The plumules try to strike nearby plant roots and stubbles. Then the emerging seedling travel upward in search of a suitable host shoot. A suitable host, such as alfalfa or certain crops, must be found within a few days (5-10) or otherwise its seedling will die. Vegetative spread can be very rapid – up to 5 m in 2 months. A single dodder seedling can grow 2 km or more in length.

Having attached to a host, the seedling then dies below the point of attachment and has no further contact with the soil. It is entirely dependent on the host plant for nutrients and moisture. In dodder the haustoria are modified adventitious roots. Twining stems grow rapidly over the host plant in a tangled mass, extracting nutrients as it grows. Dodder always twines in a counter-clockwise direction. Flowering occurs mostly in spring and early summer, and is closely followed by seed production. Seeds have a hard coat and can remain dormant in the soil for decades. The dodder stems contain carotenoid pigment capable of conducting only limited photosynthesis.

Damage caused by Dodder : Field dodder (*Cuscuta campestris*), the most damaging annual obligate stem parasite causes serious problem in forage legumes like lucerne (*Medicago sativa* L.) and Egyptian clover (*Trifolium alexandrinum* L.). During the seed production of these economic crops, dodder seeds are harvested with the crop seed and being similar in size and density to the crop seeds, it is extremely difficult to separate from the crop seed (Dawson *et al.*, 1994). *Cuscuta* species do contain functional chlorophyll, but numbers of chloroplasts are very low and photosynthesis is only 1-2 per cent of

that in a normal green plant, *i.e.* *C. campestris* is almost totally dependent on the host for growth and survival (Hibberd and Jeschke, 2001). Crop yields can be significantly reduced as it parasitises and shades out the host plants.

- Plants infested with field dodder gradually weaken, their lush growth dwindle and they have very small vegetative and generative yield (Fathoulla and Duhok, 2008).

- Reducing the biological yields of plants parasitized by field dodder. The damage consists mainly of reduced fresh biomass yield and significantly reduction in crop seed production.

- It may reduce seed yield by 60 per cent. For certified seed production of Lucerne, its population should be <0.05 per cent (20 *Cuscuta* seeds/kg lucerne seed) (Cudney *et al.*, 1992) and (Mishra, 2009).

- As the dodder is a powerful sink for metabolites, causing a severe drain on host resources and often completely prevent flowering, normal fruit development and death of the host plant after establishment of contact with the host phloem (Wolswinkel, 1974).

- Hay (fresh biomass of legumes, primarily alfalfa and clover) containing 50-60 per cent dodder fed to livestock caused reduction in body weight of livestock and miscarriages are more frequent along with indigestion occurs.

- Dodder consumption in bulk feed causes diarrhea, vomiting, palpitation and heavy breathing in rabbits and horses. The *C. campestris* can be poisonous to animals if it exceeds 5 per cent of the total roughage (Movsesyan and Azaryan, 1974).

- Some *Cuscuta* species carry viruses such as the cucumber mosaic virus or tobacco rattle virus, thus causing additional difficulties for crop growing and indirectly reducing yields (Marcone *et al.*, 1999).

- It is also a contaminant of hay and threatens the small seeds industry through seed contamination.

Dispersal mechanism : *C. campestris* commonly occurs as a contaminant of crop seed, especially lucerne, red clover and niger seed which have similarly sized seeds. As seeds do not shatter from the capsules, they are harvested with the crop and are then difficult to separate.

Management in Lucerne : Dodder is a difficult weed to eradicate. It grows rapidly and can set seed after only a few weeks of growth. Its seed can survive in the soil for long periods. Preventing entering in new areas and being vigilant in spotting and destroying new outbreaks before they set seed is the best way of control. A long-

term approach is required to manage this weed. Several options are available, depending on the size of the infestation, the crop or pasture infested, and the crop or pasture rotation available, but it is essential to start treatment as soon as possible after an infestation is noticed.

The reserve of viable weed seeds in soil (seed bank) is problematic because they are sources of weed infestations, and they should be managed to deplete them. The goal of weed seed bank management is to lessen the number of weed seeds present in soil, which is essentially tied to long-term population growth rates of annual weed species, to the efficacy of chemical control strategies, and to the success of cultural and mechanical approaches for weed control. Any attempt to deplete weed seedbank can benefit the overall suppression of weeds at a given site; however, seedbank depletion is more likely to produce satisfactory outcomes if it employs multiple tactics. Enhance the vegetative reproduction of desirable species and reduce vegetative reproduction of weed species.

Different measures are available for controlling field dodder, from preventive (pure seeding material, tolerant cultivars, etc.), to mechanical removal (mowing and hand weeding) and herbicide treatments (Marija and Sava, 2015). There are a large number of weed control tools, each of which is effective in specific situations. Always assess the pasture quality and quantity, weed species and weed load before deciding on what action to take. Choose only those control methods that are appropriate in each situation. Also, the choice amongst these shall depend upon their specific selectivity to the host crop in question and are described as below:

Prevention : Preventive is better than control and is one of the most important and fundamental activities in any field dodder control strategy, which focuses primarily on prevention of field infestation by:

- Use of clean crop seed is vital, and seed should be inspected and cleaned if necessary, or obtained from a source known to be reliable.
- Cleaning all nearby field, field margins and waste grounds at recurrent intervals;
- Maintaining irrigation channels dodder-free;
- Spreading well decomposed and rotted manure;
- Crop rotation of at least of 4-5 years is an important preventive measure even though it may be difficult to find an adequate replacement for some crops and so avoid dodder parasitism in that new crop. Cereals crops such as wheat, barley, oats, triticale and cereal rye are less susceptible to dodder, along with *Kharif* grain crops such as maize and sorghum.

- Contaminated hay can introduce dodder to a clean property. Hay containing dodder should be destroyed as mature seed is often present.

- Machinery used for reaping and other intercultural operations in infested areas should be cleaned before moving to other areas.

- Controlling the preferred alternate weed hosts for dodder (Wireweed, Noogoora burr and Bathurst burr) reduces the risk in new infestations and the extent of current infestations.

- All host and dodder plant material must be burnt, preferably on the infested site. Cut the host plant as close as possible to ground level and burn it. Burning can be carried out after cutting and drying.

- Deep ploughing can help reduce the seed burden by burying dodder seed. Most dodder seed will not germinate from a depth of more than 7.5 cm.

- Quarantine with seeds and plant material denied entrance. Strict quarantine regulations with sufficient and effective enforcement and vigilance will be needed.

Mechanical methods :

- Separation of *Cuscuta* seeds from lucerne by equipment comprising felt or velvet covered rollers to which the rough seeds of *Cuscuta* stick while the smoother crop seeds pass over.

- Manual removal and frequent inter-row cultivation before the parasite attaches the host plant are the usual control measures. However, these methods are laborious and often not effective.

- *Cuscuta* can be pulled out and buried.

- The seed of lucerne are to be treated with 5 to 10 per cent solution of common salt for five minutes. The light seeds of *Cuscuta* will float on the surface of water.

- The young seedlings with rudimentary roots are readily destroyed by shallow tillage before or after crop establishment.

- Hand-pulling is suitable only for scattered infestations as the infested crop plants have to be removed with the parasite.

- More extensive infestations in lucerne are also sometimes treated with overall flaming, as the crop is able to recover.

- Grazing by sheep can result in significant suppression of dodder by their grazing habits.

Cultural control :

- Crop rotation is highly effective against parasitic weeds however careful crop selection is essential. Rotation with non-susceptible crops can be helpful. Cereals are virtually immune from attack, and some broad-leaved

crops may also be sufficiently resistant, including soybean, kidney bean, squash, cucumber and cotton.

- Postponement of sowing or replanting is also considered an important cultural measure.

- There are few known resistant varieties of susceptible crop species; the varieties of lucerne viz., 'LLC 6' and 'LLC 7' are moderately tolerant to *Cuscuta* infestation.

- Dense crop canopy is a valuable component because deep shade suppresses the coiling and attachment of *Cuscuta*.

Herbicidal control : A range of soil-acting herbicides are effective in preventing the germination and establishment of *C. campestris*. The herbicides must persist to provide desired degree of suppression for long enough. The selectivity is important parameter along with residual effect in soil is usually required. The following herbicides are recommended for effective control of dodder in lucerne.

- Pendimethalin@ 1 kg a.i./ha (pre-emergence) continues to be the one of the most commonly used herbicides.

- Herbicides for control of established parasites include diquat (@ 6-10 kg/ha 5-10 days after sowing) used for non-selective spot spraying of isolated patches.

- Glyphosate or Paraquat (0.05-1%) spray with a high volume sprayer will kill dodder. Though selectivity is narrow and repeat treatments may be needed.

- Pre-sowing application of diuron @ 2.0 kg/ha or fluchloralin @ 1 kg/ha or EPTC @ 3.0 kg/ha or MCPB @ 0.75 kg/ha after 30 DAS or pronamide @ 1.0 kg/ha just after sowing controls the weeds in lucerne crop.

- Pronamide has been reported particularly useful in killing *Cuscutta* growing on Niger. It is applied at 2kg/ha, about 20 days after sowing of the crop.

Biological control :

- Use of bio-herbicide (mycoherbicide) like Lubao II *Colletotrichum gleosporioides* f. sp. *Cuscutae* for *Cuscuta* sp. (Parker and Riches, 1993).

- Among pathogens, *Alternaria cuscudaceae* is reported to have been used successfully on *C. campestris*.

- The involvement of the agromyzid fly *Melanagromyza cuscudae* and the gall-forming weevils *Smicronyx* spp. controlled dodder effectively.

Integrated weed management programmes : Broad geographic distribution and spectrum of hosts make field dodder, *Cuscuta campestris*, one of the most widespread and most harmful pests among flowering parasitic plants. Different measures are available for controlling field

dodder, from preventive to mechanical to herbicide treatments. The most successful control of field dodder requires a systematic approach ensured through integrated protection, which contributes to a more effective control of parasitic *Cuscuta* plants. Integrated methods involve the all-important use of clean seed; good field hygiene to eradicate scattered infestations before they get out of control; good control of other weeds which might act as reservoirs of infestation; timing of tillage and planting to maximize destruction of parasite seedlings before sowing; and optimum planting arrangement and growing conditions for a good crop canopy to suppress development of the weed.

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