

4 Eradicating *Cuscuta* Invasive Killer Weeds for Environmental Sustainability

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Abstract

Cuscuta also referred to as (dodder) belongs to a genus of more than 200 species of obligate aerial parasitic plants in the morning glory family Convolvulaceae. *Cuscuta* is an invasive killer weed which adversely affects fruit set, and yields and it robs all food from another organism's through its parasitic nature. The organism that is being robbed of its food supply is called the host. *Cuscuta* invasive killer weed strangles the host plant and is also implicated in the transmission of certain plant bacterial and viral diseases. It is ferociously troublesome where it is sown as a seed contaminant. It is worth noting that, *Cuscuta* invasive killer weeds is a true vegetal vampire due to its fine stems that stick to its victims hence creating a stranglehold by literally sucking the sap until it kills the plant host. Parasitic plant in particular the *Cuscuta* weeds, have been described as keystone species by environmentalists. The research objective of this study was to eradicate *Cuscuta* invasive killer weeds for environmental sustainability. The researcher embarked on a quest on how to get rid of dodder for the small, medium and large scale crop growers and engaged stakeholders such as KEFRI, KEPHIS, and NEMA in developing environmentally friendly mechanisms to exterminate the *Cuscuta*. Cultural, physical/mechanical biological means of exterminating *Cuscuta* invasive killer weeds are considered environmentally safe and friendly. Farmers are advised to hand uproot scattered *Cuscuta* invasive killer weeds.

Keywords: Dodder, weeds, host, sap, seed

Introduction

Cuscuta (dodder) belongs to a genus of more than 200 species of obligate aerial parasitic plants in the morning glory family known as Convolvulaceae. When *Cuscuta* invasive killer weed robs all food from another organism's body it is called a parasite. The organism that is being robbed of its food supply is called the host. The genus is found throughout the temperate to tropical regions of the world, sub-Saharan Africa subtropical and tropical regions. *Cuscuta* species have a very distinct appearance that is composed mainly of leafless, yellow or orange, hairless twining stems and tendrils, bearing minute scales in the place of leaves. It has very low levels of chlorophyll for example in some of the some species such as *Cuscuta reflexa* can photosynthesize slightly, while others such as *Cuscuta campestris* are almost totally dependent on the host plants for nutrition that is plant sap. If a dodder plant is allowed to grow unchecked, it forms dense mats in and over the host plant. Dodder plants branch and re-branch hence spreading from plant to plant until large areas may be infested. Stem growth of 7.5 cm per day has been recorded in the above *Cuscuta* invasive killer weeds. In addition, single strand of dodder plant spreads to a diameter of 3 meters or more.

In particular, the most important dodder species in Africa include the following *Cuscuta approximate* (alfalfa dodder), *Cuscuta epithymum* (clover dodder), *Cuscuta campestris* (field dodder), *Cuscuta reflexa* (common dodder), *Cuscuta kilimanjari*, *Cuscuta planiflora*, and *Cuscuta somaliensis*.

Dodder weed is characterized by the following morphological features: it has thin, twining stems that are either pale green, yellow or bright orange in color. The weed bears cream coloured bell-shaped blooms containing a seed capsule with 2 to 3 seeds. The rootless seedlings have a limited ability to photosynthesize and rely on the host plant to provide them with energy and sap. A dodder seedling survives 5 to 10 days without a host, but will soon die. As the dodder weed rapidly grows, it continually reattaches itself to its host and sends out more shoots to attach to nearby hosts thus creating a dense mass of intertwined stems. Seeds are generally dispersed by wind, soil, farm tools, dirt clinging to shoes and tires and through infested plant materials that is being transported. Upon germination, the *Cuscuta* invasive killer weeds seedling are dependent upon carbohydrates stored in the seed until they attach to a host. Once attached, *Cuscuta* extracts sap and water from the host plant hence predisposing the host to innumerable diseases and insect invasion. Consequently, this adversely affects fruit set and yield and eventually killing off the host plant.

Dodder weed control and management is a basic essential to most small, medium and large scale farmers. *Cuscuta* species afflicts many crops, ornamental flowers and native plants by virtually decimating them. The researcher embarked on a quest to finding out how to get rid of dodder for the small, medium and large scale crop growers and considered the small scale rural farmers as well. The researcher engaged stakeholders such as KEFRI, KEPHIS, NEMA as well as other relevant semi-autonomous government agencies in the Ministries of Environment & Forestry and Agriculture in developing environmentally friendly mechanisms to exterminate the parasitic annual invasive killer weed, the dodder (*Cuscuta* species).

Statement of the Problem

Dodder derives nutrients such as water and plant sap by penetrating the stem tissues of the host plant with its haustoria which composed of specially modified root-like growths that help in absorbing water, carbohydrates and minerals at the expense of the host plant. *Cuscuta* invasive killer weed strangles the host plant and is also implicated in the transmission of certain plant bacterial and viral diseases. It is ferociously troublesome where it is sown as a seed contaminant on lucerne, clovers, niger seed mostly where broad-leaved crops grown during crop rotation as perennials or biennials such as lucerne, clovers, citrus, sugar beetroot and in horticultural crops where most crops in the rotation are broad-leaved for example vegetables and ornamentals. *Cuscuta* and other varieties of *Cuscuta* species are frequently used as a research tool to enable the small, medium and large scale farmers comprehend the nature of different plants for transmission of diseases from one host to another. However, the use of *Cuscuta* invasive killer weed as a research tool cannot compensate for this plant's overall negative impacts.

Cuscuta invasive killer weeds possess powerful metabolic sink effect hence the damage to infested plant hosts is severe, to the extent of total crop loss. Crop losses have rarely been measured, however there are estimates of 57 percent reduction in lucerne forage production over a 2 year period, and reductions of up to 40 percent in root weight and 3.5 to 4 tons of sugar per hectare in infested sugar beetroot. *Cuscuta* invasive killer weed has occasioned enormous economic loss when crop produce, intended for export, is rejected or has to be cleaned expensively. It is worth noting that, *Cuscuta* invasive killer weeds is a true vegetal vampire due to its fine stems that stick to its victims hence creating a stranglehold by literally sucking the sap until killing the plant host (Pamplona-Roger, 2000). *Cuscuta* invasive killer weeds are parasitic of a wide range of herbaceous plants. *Cuscuta* invasive killer weeds is a serious weed when broad leaved crops are grown together during crop rotation as perennials such as lucerne, clovers, citrus and sugar beetroot. *Cuscuta* invasive killer weeds cause extensive damage by absorbing food material from the host plant. Moreover, *Cuscuta* invasive killer weeds form a dense mat of stems it produces hence entangling the host plant and causing shading of the ground vegetation layer. In particular, *Cuscuta campestris* has been listed as a noxious weed in South Africa which mean it is prohibited plants and must be controlled. *Cuscuta* invasive killer weeds serve no positive economic purpose and possess characteristics that are harmful to humans, animals and the environment. In Hawaii and most Australian States, *Cuscuta* invasive killer weeds have been listed as noxious weeds.

Literature Review

Empirical Studies on *Cuscuta* Killer Invasive Weeds

The parasitic nature of the *Cuscuta* invasive weeds has evolved independently at least 12 times in the angiosperms (Nickrent, 2009). Parasitic plants in particular the *Cuscuta* killer invasive weeds, have been described as keystone species by environmentalists because they impact multiple trophic levels and adversely altered the abiotic environment (Press & Phoenix, 2005).

Dodders are categorized indiscriminately as *Cuscuta* spp and in Canadian legislation they are classified as **noxious weeds**. In British Columbia, *Cuscuta* killer invasive weeds are classified as **restricted weeds** (Costea & Tardif, 2006; Rice, 2009). In the USA, local and widely distributed species are exempted from the state gazzeted noxious weed list (USDA, APHIS, 2006), despite the fact that some of these dodders are invasive weeds.

Similar to other parasitic plants such as *Rhinanthus angustifolius* (Ameloot *et al.*, 2006; Bardgett *et al.*, 2006), *Cuscuta* species play an important role in the ecosystems since they have the capacity to reduce hosts biomass and alter hosts allocation patterns, as well as to significantly modify the structure of plant communities (Pennings & Callaway, 2002).

Parasitic plants are an integral part of the ecosystem since they behave as prudent predators and are adapted to the life cycle of their principal hosts (Jayasinghe *et al.*,

2004). Of all the more than 230,000 species of flowering plants, approximately 3,900 species of parasitic plants have been recorded (Nickrent, 2002). These plants included some of the most bizarre and beautiful species including the world's largest flower (*Rafflesia arnoldii*) that is three feet (one meter) in diameter. When one organism steals all of its food from another organism's body it is called a parasite. The organism that is being robbed of its food supply is called the host.

Eco-Friendly Ways of Eradicating *Cuscuta* Killer Invasive Weeds for Environmental Sustainability

Cultural Methods

Globally, most nations have laws prohibiting importation of dodder seed hence requiring crop seeds to be free of dodder seed contamination especially through enforcement of stringent quarantine and phytosanitary regulations by semi-autonomous government agencies such as KEFRI, KEPHIS, and NEMA. Use of clean crop seed is vital and has been achieved seed inspection and cleaning if necessary. Small, medium and large scale farmers are always advised to obtain from a source known to be reliable. Removal of highly favoured hosts such as *Convolvulus arvensis* from around field edges is also recommended.

KEFRI, KEPHIS, and NEMA have already enforced mechanisms that have significantly controlled the spread of *Cuscuta* invasive killer weeds by collection and deep burying of infested plants. This is done repeatedly throughout the growing season as *Cuscuta* seed germinates from the upper 3 centimeters of the soil. Small, medium and large scale farmers prevent livestock from grazing in infested areas after dodder has germinated, and do not allow livestock that have grazed fields where dodder has germinated to move to other areas.

Small, medium and large scale farmers always carry out hand uprooting for scattered infestations as the infested crop plants have to be removed with the parasite. Scattered infestations have been controlled by burning/heating, using a hand-held flame gun. More extensive infestations in lucerne have been treated with overall flaming, as the crop is able to recover. Close mowing is an alternative means of control in lucerne and clovers. Crop rotation with non-susceptible crops are helpful in containing the spread of *Cuscuta* invasive killer weeds through planting of non-host crops such as grasses and many other monocotyledons. Cereals and broad-leaved crops are virtually immune, hence sufficiently resistant, such as soybean, kidney bean, squash, cucumber and cotton. However, Guar bean (*Cyamopsis psoraloides*) is not immune, but has been known to significantly cause gross deformity and reduces the vigour of the parasite to the extent that it helps to protect a susceptible crop, mung bean (*Vigna radiata*), when they are grown in mixture. There are no known resistant varieties of susceptible crop species. Deep shade suppresses the coiling and attachment of *Cuscuta* hence, encouraging a dense crop canopy is a valuable component of any integrated control programme.

Biological Control

KEFRI, KEPHIS, and NEMA have always encouraged small, medium and large scale farmers to undertake biological control of *Cuscuta* invasive killer weeds that has involved the use of pest predators such as agromyzid fly *Melanagromyza cuscuteae* and the gall-forming weevils *Smicronyx* spp in decimating the dodder plant. Among pathogens, *Alternaria cuscutacidae* was reported to have been used successfully on *Cuscuta campestris* in the former USSR, and a form of *Colletotrichum gloeosporioides* was used for many years in China as a mycoherbicide for control of *Cuscuta chinensis* and *Cuscuta australis* on soybean.

Integrated Control

Integrated methods involves 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 minimum tillage and planting to maximize destruction of parasitic seedlings before sowing as well as optimum planting arrangement such as crop rotation and growing conditions for a good crop canopy to suppress development of the weed.

The precise management measures adopted for any plant invasion depend upon factors such as the terrain, cost and availability of labour, severity of the infestation and the presence of other invasive species. KEFRI, KEPHIS, and NEMA always encourage small, medium and large scale farmers to undertake prevention as the best form of invasive species management. If prevention is effective, it is best to treat the weed infestations when they are small to prevent them from establishing - via early detection and rapid response. Controlling the weed before it seeds reduces future problems. Control is generally best applied to the least infested areas before dense infestations are tackled. Consistent follow-up work is required for sustainable management to stop spread of the *Cuscuta* invasive killer weeds.

Cuscuta can be controlled by planting uncontaminated crop seeds and young seedlings are readily destroyed by shallow tillage before and after crop establishment. Hand uprooting is suitable only for scattered infestations as the infested crop plants have to be removed with the parasite. Scattered infestations are easily controlled by using a hand-held flame gun. More extensive infestations in lucerne are treated with overall flaming hence, the crop is able to recover. Close mowing is an alternative means of control in lucerne and clovers. Crop rotation with non-susceptible crops such as cereals has been helpful.

Small, medium and large scale farmers engage in controlling *Cuscuta* on vegetation along road sides, boundary-strips and waste lands. In addition, practicing crop rotation for a period of not less than three to four years cycle by unsusceptible crops and cultures

is advisable. Due to its spread by people, one of the best methods of control is to sensitize people to desist from carrying the *Cuscuta* invasive killer weeds plant parts and if they do, they should immediately destroy them or to dry them on a surface other than on living plants and then to dispose of them by burning.

Physical/Mechanical Method

The young seedlings with rudimentary roots are readily destroyed by shallow tillage before and after crop establishment. Hand uprooting is suitable only for scattered infestations as the infested crop plants have to be removed with the parasite. Scattered infestations can also be controlled by heat, using a hand-held flame gun. More extensive infestations in lucerne are also sometimes treated with overall flaming, as the crop is able to recover. Close mowing is an alternative means of control in lucerne and clovers. Similarly, grazing by sheep can result in significant suppression (Nicol et al., 2007).

Chemical Method

Chlorpropham was one of the first herbicides to be used in lucerne and other crops, but short soil persistence meant that it rarely provided suppression for long enough. As a result, it has been superseded by other compounds such as propyzamide, chlorthal-dimethyl, trifluralin, pendimethalin, prodiamine, pebulate and ethofumesate have all been used to destroy *Cuscuta* invasive killer weeds in crops such as lucerne, clovers, lespedeza, sugarbeet, onion, chickpea, carrot, tomato, vines, niger seed but selectivity is rarely perfect and integration with cultural methods is usually needed. Currently, Pendimethalin continues to be the one of the most commonly used herbicides (Mishra *et al.*, 2005), also ethofumesate in sugar beetroot.

Research Objective

To eradicate *Cuscuta* invasive killer weeds for environmental sustainability

Methodology

Literature review, and primary data gathered from relevant documents published by individual researchers and other research organizations were the main methods of data collection for this paper. The researcher embarked on a quest on how to get rid of dodder for the small, medium and large scale crop growers and considered the small scale rural farmers as well. The researcher has engaged stakeholders such as KEFRI, KEPHIS, NEMA as well as other relevant semi-autonomous government agencies in the Ministries of Environment & Forestry and Agriculture in developing environmentally friendly mechanisms to exterminate the parasitic annual invasive killer weed, the dodder (*Cuscuta* species).

Moreover, the researcher in collaboration with KEFRI, KEPHIS and NEMA took part in

a sensitization clean up on eradication of *Cuscuta* killer invasive weeds during the World Environment Day in June 2020 at Wote Municipality to ascertain the extent of damage caused by the *Cuscuta* killer invasive weeds. This enabled the researcher to comprehend the negative environmental impacts attributable to *Cuscuta* killer invasive weeds.

Conclusion

Cultural, physical mechanical biological means of exterminating *Cuscuta* invasive killer weeds are considered environmentally safe and friendly.

Recommendations

Collaborative efforts between agencies such as KEFRI, KEPHIS, and NEMA are considered beneficial in terms of disseminating information on eradication of *Cuscuta* invasive killer weeds for environmental sustainability.

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