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ALFALFA INSIGHTS

VIRENXIA'S NEWSLETTER ON ALFALFA, THE QUEEN OF FORAGES

BIOTIC STRESS MANAGEMENT

REDUCING PEST, DISEASE, AND WEED IMPACT FOR GREATER PRODUCTIVITY

Biotic stress is a stress that is caused in plants due to the damage caused by other living organisms, including fungi, bacteria, viruses, parasites, weeds, insects, and other native or cultivated plants.
A yield loss as high as 30-40% is possible due to biotic stress.

In Alfalfa, product quality is lowered due to the loss of leaf tissue, leaving only stems. Damage to regrowth buds also may occur when plants first come out of dormancy and after the first cutting.

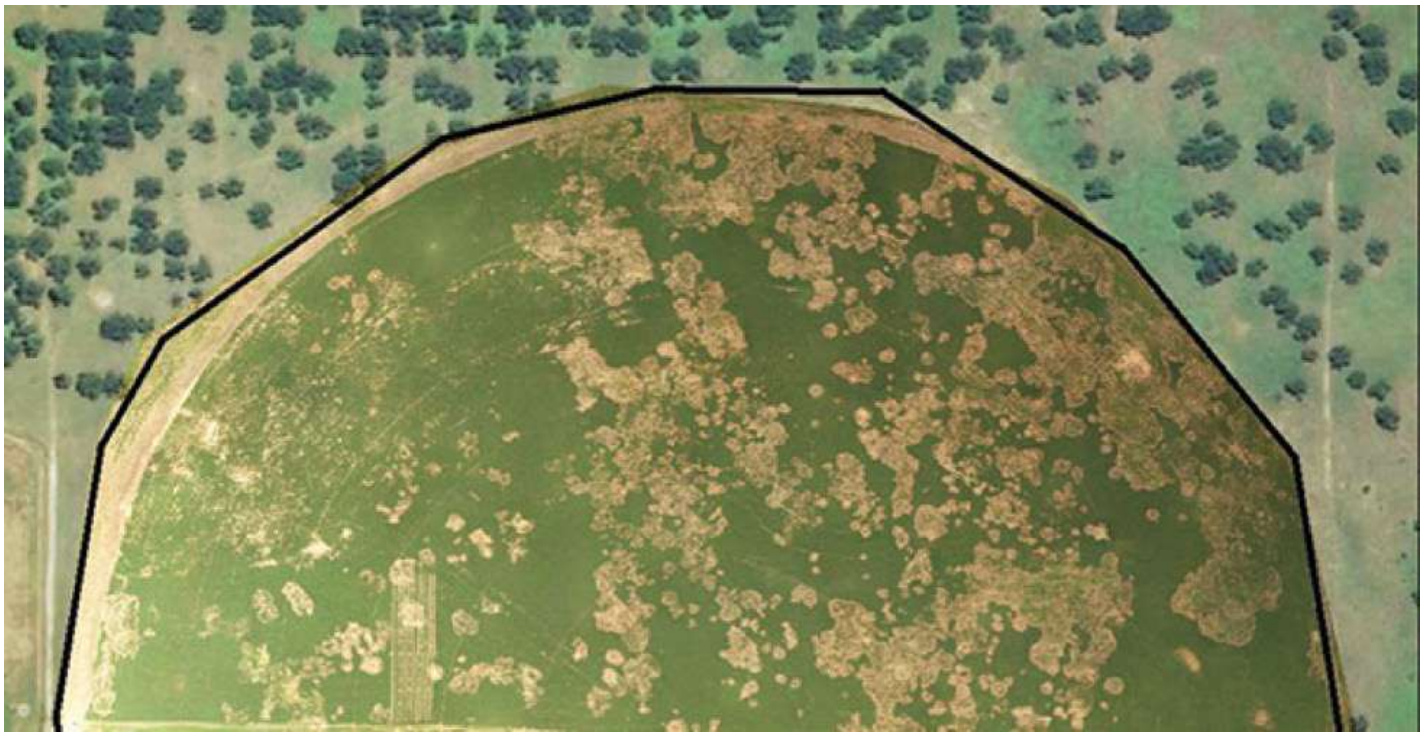
This issue will review some important types of Biotic stress in Alfalfa production and deliver solutions to overcome them for greater quality and productivity.

ALFALFA ROOT ROT DISEASE

DRONES TO THE RESCUE!

Alfalfa growers would not be happy to see a field riddled with large diseased areas as in the aerial picture below. But, who would have ever imagined that a military surveillance tool - an unmanned aerial vehicle, more commonly known as a drone - could also provide disease surveillancein agricultural fields?

Alfalfa stands can become infected with a soil-borne fungal pathogen called *Phymatotrichopsis omnivora*. The fungus causes Phymatotrichopsis root rot, commonly referred to as cotton root rot. More than 2,000 dicotyledonous plants are susceptible to this fungal disease including important agronomic crops such as cotton, alfalfa and pecans. In alfalfa, the fungus attacks roots, causing vascular discoloration and lesions, which in turn results in the formation of numerous diseased areas that are circular to irregular in shape.



Phymatotrichopsis root rot infests a three-year-old, 60-acre stand of alfalfa. This aerial image was acquired using a drone at the Noble Foundation's Red River Research and Demonstration Farm near Burneyville, Okla.

The field in the picture shows the disease progression on a three-year-old alfalfa stand. The stand remained in production for an additional year, but the disease pressure increased and the stand was removed at the end of the growing season.

The questions that growers keep asking are:
· How can I reduce the disease spread?
· When is the stand no longer profitable and ready for replanting?

Researchers at The Samuel Roberts Noble Foundation in Ardmore, Okla., and with USDA's Southern Plains Range Research Station are working to provide answers to these questions. We are currently testing the feasibility of using drones as a monitoring tool for identifying the disease and tracking its progression at several Noble Foundation research farms in southern Oklahoma.

Drones can be equipped with a small digital camera and flown over hundreds of acres in just a few hours. **The images are transferred to a computer and processed using image analysis software. The image analysis software will stitch and georeference the images into a complete picture of the flown area.**

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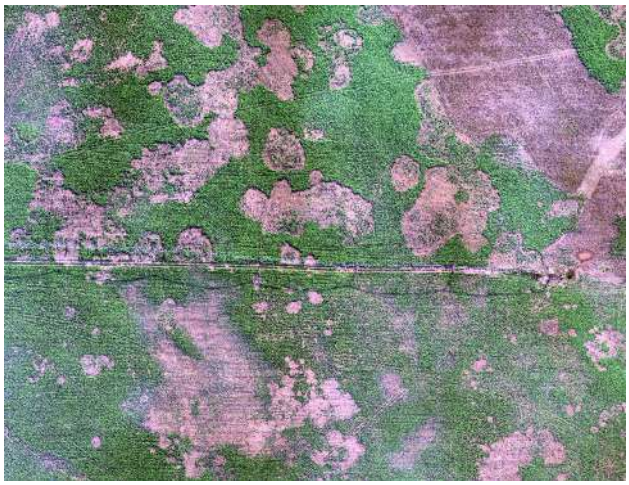

Aerial view of alfalfa root rot

Currently, it's possible to acquire images with pixels that cover just a few square inches on the ground. Drones are especially useful for these applications by making it easy and relatively inexpensive to repeatedly monitor diseased zones in the field,which allows us to see how these areas change over time.

Alfalfa root rot sample

Source: Chakradhar Mattupalli,
Noble Foundation postdoctoral fellow, (USDA-ARS)

BEET ARMYWORM IN ALFALFA

STRATEGIES FOR SUSTAINABLE CONTROL

Spodoptera exiqua

- **Beet armyworm has wide range of host plants that include:** alfalfa, asparagus, bean, beet, broccoli, cabbage, cauliflower, celery, chickpea, corn, cotton, cowpea, eggplant, lettuce, onion, pea, peanut, pepper, potato, radish, safflower, sorghum, soybean, spinach, sugarbeet, sweet potato, tobacco, tomato, and turnip.
- Weeds that serve as hosts include: lambsquarter, mullein, nettleleaf goosefoot, parthenium, pigweed, purslane, Russian thistle and tidestromia.

Broad-spectrum insecticide use can increase Beet Armyworm survival rates.

Damage on leaves

- In general, control measures are more effective on smaller larva than more advanced stages of development.
- Adults are strong fliers. Beet armyworm migrate from over-wintering sites as summer progresses.
- Mass migratory infestations can occur when preferred hosts are no longer available due to lack of moisture and other environmental conditions.

Damage

- **Armyworms skeletonize foliage, leaving veins largely intact.** First- and second-instar larvae tend to feed in clusters around the egg mass from which they hatch. This frequently causes a tattered appearance to the terminals. This whitish appearance caused by the feeding is known as "whitecaps" and can be seen across a field. As the larvae mature and move to more stems, the areas of "whitecaps" tend to coalesce and the entire field takes on a tattered look.
- **Broad-spectrum insecticide use can reduce natural controls and increase Beet Armyworm survival rates.**
- Sex pheromone is used for mating recognition.

Life Cycle (20-45 days)

Egg mass

Larvae hatching from eggs

Army worm

- Eggs: (2-3 Days) Laid in groups of 50-150. Usually found on the undersides of leaves and terminals. Taper to a peak when viewed from the side. White to green in color. White scales are deposited on top of cluster by the female moth that give the egg mass a cottony appearance.
- Larva: (11-25 Days) 5 instars. Variable coloration – light to dark green or pink with a white or dark stripe running the length of both sides of the body. Identifying characteristics include a smooth body with no hairs and large dark spots on both sides of the body just behind the head. Young larva feed in groups around the area of the egg hatch and may produce webbing as they feed. Mature larva feed singly.
- Pupa: (6-7 Days) 15-20 mm. Light brown. Pupal case consists of soil, sand or other ground debris loosely held together by oral secretions.
- Adult: (9-10 Days) 25-30 mm. Mottled brown or gray. Can deposit 300-600 eggs/female. Mating can occur shortly after emergence from pupa. Eggs begin to be deposited 2-3 days after fertilization and can continue for 3-7 days. Mainly nocturnal.

Adult moth

Over-wintering Strategy

Pupal stage is susceptible to cold temperatures. Over-wintering is usually only accomplished in the warm climates in the upper 6 cm of soil. If temperatures allow, can continue to generate populations year round.

Sampling

Traps baited with synthetic sex pheromone can be used to monitor adult populations.
Traps should be checked 1-2 times per week and lure changed as recommended by the supplier. Inspect undersides of leaves and terminals for cottony egg masses. Randomly inspect plants for skeletonized leaves and other feeding damage. Sweep nets can also be used to detect larval infestations. Infestation along edges of fields may be more severe than more central locations.

Management

Populations of armyworms are frequently controlled by natural enemies and are more or less cyclic, occurring in large numbers only every few years. Early harvest, border cutting, and biological control are important components of a management program that will prevent damage from armyworms.

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Biological Control

Natural enemies can provide good control of armyworms in many fields.

Predators include bigeyed bugs, spiders, minute pirate bugs, damsel bugs, assassin bugs, and lacewings.

The parasitic wasp, *Hyposoter exiguae*, is the most important of at least 10 parasites attacking this pest.

Viral diseases of armyworms are also important natural control agents under certain conditions of temperature and humidity. Diseased caterpillars first appear yellowish and limp. After death they hang from plants as shapeless forms oozing the disintegrated body contents. NPV (Nuclear Polyhydrosis Virus) is commercially available for use to control armyworms.

Assassin bug is a natural predator of worms

Cultural Control

- Border-strip harvesting is a useful method for preserving natural enemies because it helps retain parasite larvae in the field. Early cutting will give satisfactory control if the infestation appears late in the cutting cycle.
- Plant Sunflower or Castor on borders as oviposition trap crops, adult moths prefer to lay eggs on these plants, clip off the egg masses and destroy to reduce the population.
- Maintain good fertility and mineral balance in plants. Identify macro- and micronutrient deficiencies by performing plant tissue and soil analysis. Adjust for deficiencies with foliar and soil applied applications of appropriate fertilizers.
- Destroy vegetative materials and crop residue immediately after harvest.

Organically Acceptable Methods

Biological and cultural controls, as well as sprays of *Bacillus thuringiensis*, Spinosad and Neem formulations are acceptable for use on an organically certified crop.

Commonly used products:

- Cold Processed 100% Neem Oil
- Cold Processed 100% Pongamia seed oil
- Biorepel (Garlic Oil)
- Bt: Agree; Xentari; Dipel; Javelin
- Entrust (Botanical)
- Neemix 4.5 (Botanical)
- Spinosad (Bio-pesticide)

Source: John L. Capinera, University of Florida

BEFRIENDING BATS

ATTRACT BATS AS NATURAL PEST CONTROL

Bats consume hundreds of insect pests each hour on nocturnal feeding flights.

Bats are beneficial allies of gardeners and farmers, **consuming hundreds of insect pests each hour on nocturnal feeding flights above yards, gardens and fields.**

"There is abundant evidence now, with more studies coming out, demonstrating bats are important for agriculture," says Gary McCracken, a professor of ecology and evolutionary biology at the University of Tennessee, and one of the world's leading experts on bats. His research has shed new light on insect mobility and the role bats play in decreasing their numbers.

"In the U.S. and Canada, huge numbers of pest insects are migratory. They won't survive harsh winters, and depend on seasonal migration. They take advantage of wind jets at thousands of feet above the ground to go south in the winter and north in the summer - trillions of migrating insects. And there are millions of bats feeding on them every night," McCracken says.

Estimates indicate bats reduce crop insect damage and related pesticide use in the United States by at least $3.7 billion annually.

Nothing to Fear

Widely shared, yet inaccurate myths about their habits and behaviors have made bats one of the most misunderstood and maligned creatures on the planet. **In truth, the small winged mammals prefer to have as little human contact as possible.**

Most of the 40-plus bat species native to the U.S. and Canada **feed on insects, including mosquitoes.** A few bats' dining preferences make them **important pollinators in desert climates**, where they feed on insects attracted to night-blooming plants. Only three bat species out of the more than 1,300 species worldwide make meals from small amounts of animal blood, and none of those three inhabit areas north of Latin America.

While all bats can see, most don't locate insect prey by sight. **They use echolocation instead, emitting high-frequency sounds inaudible to humans to locate their meals.**

Be Bat-Friendly

Loss of habitat is one of the greatest threats to bats. A fungal disease commonly known as white nose syndrome (WNS) also is decimating their populations, and human persecution takes its toll, too. "Many bats live in caves or wooded areas where they roost in foliage and tree hollows," McCracken says. "But increasingly, they are taking up habitation near humans."

Another way of looking at the situation is that we are moving closer to them and their dwindling habitat. Nonetheless, there is no reason to kill bats roosting in attics or in outbuildings, McCracken adds. If they must be evicted, put up a bat habitat nearby before shooing them out.

And, he advises, **"If a bat is in your living space, you should have it removed or remove and release it, but don't touch it with your bare hands."**

Source: Gary McCracken, Professor of Ecology and Evolutionary Biology, University of Tennessee

Use of bat houses in agriculture

DODDER *(Cuscuta campestris)*

A PARASITIC WEED IN ALFALFA

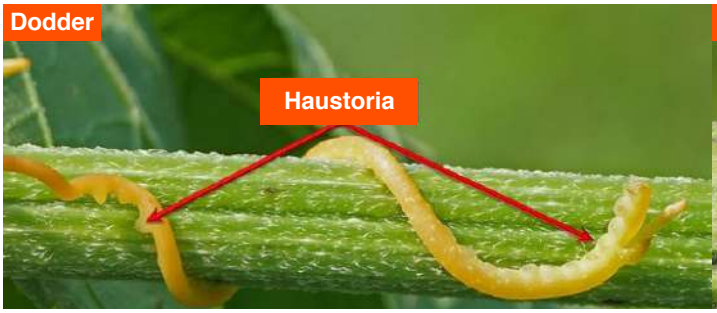
Dodder is an annual total stem (obligate) parasite weed that causes serious problems in many plants. The parasitic weed *C. campestris* is by far the most important among the dodders, perhaps because of its wide host range. Once introduced, it is almost certain that there will be suitable host plants 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).**

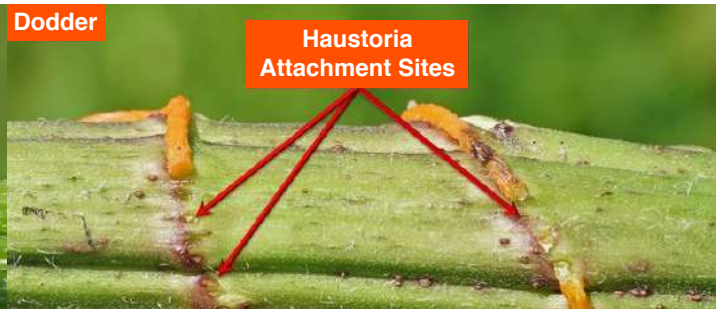
Dodder seeds germinate near the soil surface and send up slender which rotates slowly until it touches the stem or leaf of another plant and begins to wind around it. On a host plant, the dodder stem will immediately form small appendages called haustoria. Soon after attaching to a host plant, the lower 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.

Damage caused by Dodder

Field dodder (*Cuscuta campestris*), **the most damaging annual obligate stem parasite causes serious problem in forage legumes like alfalfa** (*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 dwindles and they have very small vegetative and generative yield (Fathoulla and Duhoky, 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 alfalfa, its population should be <0.05 per cent (20 Cuscuta seeds/kg alfalfa 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.

Management in Alfalfa

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.

The best way of control is to prevent it from entering in new areas and being vigilant in spotting and destroying new outbreaks before they set seed.

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 rotten 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. Cereal 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 reduces the risk in new infestations and the extent of current infestations.
- **All host and dodder plant material must e 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 and enforcement and vigilance will be needed.

Mechanical Methods

- Separation of Cuscuta seeds from alfalfa 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 alfalfa 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 alfalfa 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.
- Dense crop canopy is a valuable component because deep shade suppresses the coiling and attachment of Cuscuta.

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 cuscutacidae is reported to have been used successfully on *C. campestris*.

Integrated Weed Management

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 biological 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.

Source: Management of Dodder in Lucerne for Better Forage Quality,
Anirudh Choudhary, Lokesh Kumar Jain, Phool Chand Meena and Hanuman Prasad Parewa,
College of Agriculture, Sumerpur, PALI (RAJASTHAN) INDIA

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