Managing *Aceria malherbae* Gall Mites for Control of Field Bindweed

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INTRODUCTION

Field bindweed (*Convolvulus arvensis* L.) originated in the Mediterranean area and the Middle East but is now found in temperate areas throughout the world. It was introduced into North America in the early 1700s and became one of the most widespread and difficult-to-manage weeds on the continent (Boldt and Sobhian, 1993). Field bindweed is a persistent competitor, robbing nutrients and moisture from desirable crops and producing long vine-like stems that clog harvesting equipment (Boldt and Sobhian, 1993). This species produces seed that can survive in the soil for 30 years or longer before germinating (Boldt and Sobhian, 1993; Rosenthal, 1983). Field bindweed also develops an extensive root system, reaching depths of 20 to 30 feet (Boldt and Sobhian, 1993), coupled with lateral roots and rhizomes that help it spread and make it difficult to eradicate chemically or mechanically (Rosenthal, 1983; Boldt and Sobhian, 1993). Mechanical removal or grazing by sheep is temporarily effective. However, field bindweed plants recover quickly (Boldt and Sobhian, 1993) by storing carbohydrates used for recovery and regrowth in their root systems (Boydston and Williams, 2004).

Figure 1. **Adult *Aceria malherbae* gall mite (400× magnification).** (Photo by USDA Agricultural Research Service, Bugwood.org.)

During the 1970s, researchers collected potential agents for biological control in southern Europe. Ten of 155 organisms collected showed value as potential management tools for field bindweed. The most promising of these biocontrol agents for low-humidity areas, such as the semi-arid U.S. Southwest, was the bindweed gall mite, *Aceria malherbae* Nuzzaci (Acari: Eriophyidae) (Rosenthal, 1983). The USDA Animal and Plant Health and Inspection Service (APHIS) determined through quarantine and testing that the mite can

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Figure 2. **Classic damage by *Aceria malherbae* gall mites to field bindweed when unmanaged. Note the folding of the leaves (a) and the curving of the mid-vein (b).**

survive only on field bindweed and hollyhock bindweed (*C. althaeoides*) as hosts. Species tested from genera closely related to *Convolvulus* (*Calystegia* and *Ipomoea* [including species formerly in *Quamoclit*]) were found to not be hosts to the mite. Therefore, it was released in 1989 and is well established at Bushland, Texas (Boldt and Sobhian, 1993; G.J. Michels, personal communication). Since 2000, the mite has been successfully established in several areas throughout New Mexico (Lauriault et al., 2002). Additionally, it has been established in Missouri near the Mississippi River (Lauriault et al., 2013), despite previous unsuccessful attempts to establish it in central Oklahoma where it was thought that high humidity inhibited the mite (G.J. Michels, personal communication).

Once established, mite populations persist; however, mite survival under flood irrigation is questionable, especially if water is allowed to stand for long periods. A clear demarcation of gall mite damage symptoms on bindweed has been observed, with severe symptoms above and no symptoms below the high-water mark in a barditch (Leonard Lauriault, personal observation). Additionally, the mite is generally slow to spread on its own (Boydston and Williams, 2004). The mite can crawl only about one foot (G.J. Michels, personal communication), and it is unlikely to spread readily by wind or running water because the plant protects it from such external forces when the leaves fold symptomatically. Human intervention is necessary to spread the mite rapidly throughout large areas of bindweed and to infest new areas, although unintentional dispersal of mites does occur (Joran Viers and others, personal observation).

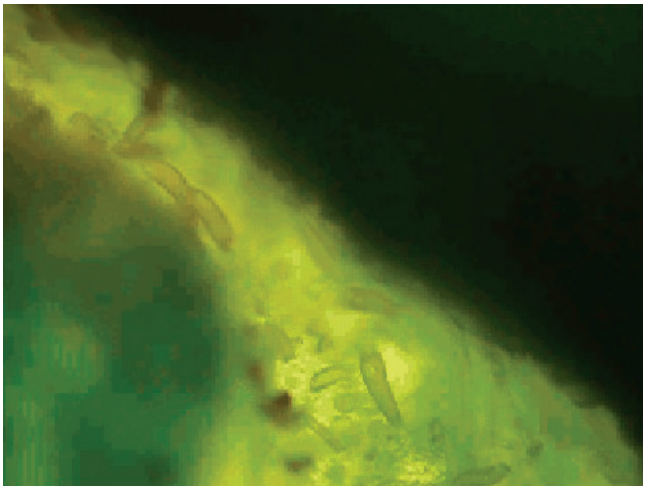

Figure 3. Aceria malherbae **gall mites in the mid-vein of a field bindweed leaf (400× magnification). The large, round, translucent objects in the center and elsewhere are eggs. To view a video of mites feeding, visit https://youtu.be/-BdfJ75aVVI.**

ABOUT THE BINDWEED GALL MITE

Description

When bindweed is actively growing, all growth stages of the mite can be found on leaves, especially along the leaf's mid-vein. Adult bindweed gall mites (Figure 1) are microscopic (about 0.007 in. long; viewable with 40× magnification), with a yellow-white, elongated, segmented body and two pairs of legs adjacent to the head (Boldt and Sobhian, 1993). Eggs are large, round, and translucent, while nymphs resemble adults (Rees et al., 1996). Greater magnification (400×) makes it easier to distinguish between adults and nymphs.

Life cycle

Multiple generations with two nymph stages are produced each year (Rees et al., 1996). The mite's life cycle is synchronized to the seasonal growth of field bindweed, which is a warm-season perennial. As a result, mites are more active on the plant in spring, early summer, and fall when field bindweed is actively growing than in mid- to late summer when growth is reduced. Lower mite populations in mid- to late summer might be related to heat and drought stress effects on bindweed, although it is possible that populations are also reduced by predatory thrips that are active on bindweed leaves during that time (Smith et al., 2010).

During winter or other periods when bindweed growth is reduced or ceases, mite nymphs and adults migrate below ground where they feed on subterranean buds (Rees et al., 1996). These buds are precursors to

***Figure 4*. Stages of damage to field bindweed caused by *Aceria malherbae* gall mites. All stems show some level of damage. Longer stems (a) are outgrowing the effects of the mite. Moderately damaged plants (b) have heavily distorted stems near the center, but stems at the perimeter outgrow mite feeding. Severe damage (c) is indicated by a mass of gnarled leaves, in this case only about an inch in diameter. This is a nutrient sink that limits transport of carbohydrates to the root system or for flower production.**

stems or lateral roots that grow once bindweed dormancy is broken, at which time the mites emerge and begin feeding on the aboveground tissue (Rosenthal, 1983).

Damage symptoms

Mite damage can inhibit leaf formation, stem elongation, and flowering by field bindweed. Classic symptoms of mite damage can be observed when bindweed leaves fold, curl, and fuse along the mid-vein where mites feed (Boldt and Sobhian, 1993; Figures 2 and 3). Additionally, affected leaves thicken and develop a rough surface, along with a yellowish to golden brown grainy or mealy appearance. Stem buds that have been damaged will not properly elongate, but will form a mass of galled leaves that act as a nutrient sink, which limits the transport of carbohydrates throughout the plant (Figure 4). If infestations are severe enough, transfer of carbohydrates to the root system and formation of flower buds can be inhibited (Rosenthal, 1983). Root buds that have been fed on during dormant periods either do not grow at all or produce severely stunted roots or stems once active growth initiates (Figure 5).

***Figure 5*. The effect of moderate damage by *Aceria malherbae* gall mites to the root system of field bindweed. The plant on the right (uninfested) has a strong lateral root approximately an inch below the soil surface. The plant on the left (moderately damaged) has no such lateral root. Often when uninfested plants are pulled, the stems snap at or just above the soil surface. When damaged plants are pulled, the root will snap at approximately an inch below the surface.**

CURRENT RECOMMENDATIONS FOR USING THE BINDWEED GALL MITE TO MANAGE FIELD BINDWEED

Getting started

Establishing a convenient source of mites (an insectary) for distribution to other areas is the first step in managing field bindweed with bindweed gall mites. Spring and fall, when bindweed is actively growing at the destination and the insectary location, are the best times to establish insectaries or to spread mites from an insectary to another area. The insectary site should be as large as possible (20 to 50 feet in diameter) in a location easily accessible for management and collection for mite distribution elsewhere. While mites have been observed to

Figure 6. **White- (left) and purple-flowered (right) field bindweed.**

establish more easily on white-flowered field bindweed, they can also colonize purple-flowered biotypes (G.J. Michels, personal communication; Figure 6).

Getting infested stems

Stems from mite-infested bindweed plants can be collected using a lawnmower with a bagger attachment or by hand. If collecting by hand, select plants with longer stems (>6 inches) because this will make infesting new sites easier. If the material will not be used immediately, it should be placed in a bag, preferably paper, and kept cool. Don't seal the bag because the mites could die from lack of oxygen, increased heat, and/or humidity inside the bag.

Keep mite-infested bindweed in a cooler with ice or ice packs until you are ready to distribute. Insulate the mites from the ice with a layer of crumpled newspaper or other suitable material. Generally, as long as mite-infested bindweed is kept fresh (moist) and cool, mites can survive two to three days, although some have survived for up to three months in chopped bindweed refrigerated in a paper bag (G.J. Michels, personal communication). Ideally, take collected mites straight from the insectary and disperse them in the bindweed-infested area.

Establishing an insectary (or spreading the mites to larger areas)

To release the mites, separate infested stems into pieces longer than 6 inches. Begin at the center of the bindweed patch and start infesting healthy stems from several plants by twisting them together around a single piece of infested stem. Continue this procedure at regular intervals while walking in a spiral outward from the center of the bindweed patch as well as around the perimeter (Figure 7). If chopped bindweed is used, simply scatter the material over the area. When the infested material dries, the mites crawl onto living stems and establish colonies in about 10 days. Because of their size, the mites' ability to crawl from infested material to healthy bindweed stems is extremely limited, and close contact between the two plant materials is essential for successful transfer of the mites to their new host.

After mites are released into a new area, wait two weeks to rotary mow the bindweed. The first time, begin mowing in a circular pattern from the outer edge of the bindweed area and work your way inward toward the center. As you work your way in, discharge the mowed material toward the outside of the bindweed area to scatter the clippings over the already-mowed portion, or in a way that the clippings will come into contact with other bindweed plants, to help spread the mites. Repeat mowing every two weeks, changing the mowing pattern each time but still trying to keep discarded clippings in contact with other bindweed plants. Grazing is also very effective for spreading mites throughout pastures, although the mechanisms are not well understood. Be sure to manage the pasture to maintain intact leaves of the bindweed as well as the desirable pasture species. NMSU Extension Circular 586, *Irrigated Pasture Management in New Mexico* (http://aces.nmsu.edu/pubs/_circulars/CR586.pdf), provides more information about management to maintain desirable species in pastures.

This procedure should establish a healthy insectary with a high mite population ready to distribute mites to other areas in the following fall or spring. Additionally, once uniformly infested, the insectary should be

managed less intensively to maintain mite populations and to provide sufficient plant material to transfer the mites. Consequently, promoting bindweed growth becomes the goal. Over time, the original insectary might become too thin or inconvenient to harvest stems or plant parts, and a new insectary might need to be established using the same steps previously discussed. Visit https://youtu.be/Qe7UMCes9fo to view an instructional video on how to establish an insectary.

Spreading the mites to larger areas

The same methods used to establish an insectary can be used to transfer mites to other larger bindweed areas. However, mite establishment by hand may be more difficult because the release sites may be larger or farther apart. Harvesting stems with a mower or flail chopper and spreading them from a truck bed or with a manure spreader are possible strategies. Another suggestion is to swath bindweed, bale it green, and immediately spread with a hydroseeder or some other blower with a chopper attachment. Make sure to spread the infested material before it begins to heat, which will damage the mite populations. Also, because chopped bindweed could contain seed or root components that can produce new plants, be careful to only spread chopped bindweed on existing areas of bindweed to prevent any unintentional propagation of this invasive plant in previously uninvaded areas.

MANAGING MITE-INFESTED FIELD BINDWEED

The effectiveness of field bindweed control with the bindweed gall mite depends on the property manager's commitment more than any other factor. Although some control can be achieved with minimal input, some degree of management is required for the mites to have any significant effect on bindweed infestations. Left on their own, mite damage can affect the health and appearance of the bindweed, but not its ability to produce viable seed and to negatively impact the surrounding desirable vegetation, including turf, ornamentals, and crops, unless an abiotic stress also occurs. To effectively control field bindweed, a long-term, intensive management plan should be developed using several techniques.

Enhancing the effects of the mite for managing field bindweed

Bindweed mite feeding can be coupled with other environmental stresses and management interventions to enhance the effects of mite damage on the weed. In early spring, field bindweed appears to outgrow the effects of the mite as a result of ideal climatic conditions that promote healthy growth and vigor of the plant. Consequently, mite feeding damage is less apparent, stems seem to grow longer more quickly, and healthy,

Figure 7. **Distribution pattern (top) and stem twisting technique (bottom) for releasing *Aceria malherbae* gall mites into field bindweed.**

photosynthesizing leaves are not as greatly affected by the mite. During this time, frequent defoliation (approximately every two weeks, or more frequently if bindweed growth permits) through mowing or grazing will remove many of the leaves, help to spread mites to other plants, and encourage mites to concentrate their feeding efforts on the remaining leaves. For forages harvested as hay (annual or perennial), mites at the bottom of the swath may move onto uninfested plants. As with mowing, the swathing pattern should be changed with each mowing to help the mites spread. Grazing is also very effective for defoliation in pastures, although care should be taken if bindweed is flowering or has produced fruit to avoid spreading seeds to any other pastures those animals will be grazing.

Mite feeding on roots in winter weakens the plant and reduces competition with desirable plants in the spring. During summer, bindweed growth is reduced due to drought and heat, so mites likely concentrate feeding on the remaining green leaf area, then migrate back to the root system. In the laboratory, sublethal applications of 2,4-DB and glyphosate used in combination with mite feeding reduced bindweed stem and root growth more than mites alone or either of the herbicides (Boydston and Williams, 2004). Sublethal doses of the herbicides had little effect on mite populations because live mites were present on the bindweed three weeks

after the applications (Boydston and Williams, 2004). Additionally, burning down topgrowth with herbicides in spring, summer, and/or autumn might simulate dormant-season effects at a time when bindweed would normally be actively growing and replenishing root carbohydrate reserves for regrowth. After such simulated "dormant" periods, regrowth consumes much of the carbohydrates stored in the root system, further weakening the plant. Implementing an integrated pest management strategy through the combination of herbicides, mite infestation, drought, and frequent defoliation can help weaken perennial plants and prevent new plants from developing a strong root system.

At New Mexico State University's Agricultural Science Center at Tucumcari, NM, mite damage was observed on regrowth of field bindweed that had been treated with labeled rates of 0.5 lb active ingredient (a.i.) 2,4-D and 0.25 lb a.i. triclopyr/acre in a mixture, 1.4 lb a.i. 2,4-D and 0.25 lb a.i. dicamba/acre in a mixture, 10 gal 2.5% glyphosate/acre, and 0.25 lb a.i. paraquat dichloride/acre, all of which burned down the field bindweed topgrowth. When making any herbicide applications, make sure that all herbicides are used only according to their labels.

While field bindweed was not as great a problem in tilled cropping systems in southern Europe as it was in unmanaged land and perennial cropping systems, it seems the opposite is true in the U.S., although it may be that the presence of bindweed in unmanaged areas is more accepted in the U.S. Control of field bindweed in European crop fields may be due to multiple tillage practices during each fallow period (McClay and De Clerck-Floate, 2002). One western hemisphere producer acknowledged that he used deep tillage (moldboard plowing) each year and did not have a problem with field bindweed. It is possible that the moldboard plowing gave the crop time to establish and compete in the disturbed rootzone before the bindweed could reemerge; the crop could then shade out newly emerged weeds once the canopy was closed. This may also explain why well-established and well-managed alfalfa can effectively outcompete field bindweed.

Annual cropping systems

The greatest concern about using the bindweed gall mite in annual cropping systems is tillage, especially shallow tillage. Mites can survive and reestablish colonies after tillage practices, although tillage severely damages the host bindweed on which mite populations rely. Mites in annual cropping systems can be aggressively spread and have their effects enhanced to manage the bindweed using methods similar to those previously described. However, this might be difficult in an intensive row-cropping system because options such as mowing or defoliation might interfere with the crop's life cycle or decrease production.

Should a producer desire to use the mites in annual cropping programs, they should establish the mites after the annual crop and bindweed have emerged and allow the bindweed to grow along with the crop. When harvesting, use a stalk shredder to chop and spread mite-infested stems throughout the field. Again, as with mowing, the combine driving pattern should be changed with each harvest, if possible, to help the mites spread.

If spring, summer, or autumn fallow periods are part of the cropping system, use mowing or grazing to spread the mite and defoliate the bindweed in combination with drought and/or labeled herbicides to induce plant "dormancy" during the fallow period. Before plowing fields with established mite populations, use a burndown herbicide. Wait 14 days after the bindweed is "dormant" to allow the mites to migrate to the root system and colonize there before beginning tillage. When the soil is worked, the mites should move with the belowground plant parts they have colonized, and any plant that is vegetatively propagated as a result should be infested.

Tillage is discouraged in many of New Mexico's field crops since they are grown on marginal, highly erodible lands. Additionally, frequent tillage needed to minimize competition by field bindweed would be detrimental to overall soil health and structure. Consequently, the use of labeled herbicides over multiple years in some crops, particularly sorghum-wheat-fallow rotations used in eastern New Mexico, may establish a bindweed-free rootzone in which the crop can compete (Marsalis et al., 2008). The herbicides listed previously in this circular are known to be mite-friendly. When using herbicides, it is essential to include precautionary practices that delay the development of herbicide resistance in weed populations. For guidance on herbicide resistance management strategies, please see NMSU Extension Guide A-616, *Herbicide Resistance: Development and Management* (http://aces.nmsu.edu/pubs/_a/A616.pdf).

Another consideration with tillage is the potential movement of vegetative plant structures (i.e., rhizomes) within and between different fields allowing further infestations in these areas. Consequently, if tillage is used, it should be done from the outside of the bindweed area toward the center, and equipment should be thoroughly cleaned before moving from field to field or to non-bindweed-infested areas in the same field.

In fields specific to forage or grazing practices, limiting tillage only to areas already infested with bindweed may have multiple benefits while minimizing the spread of bindweed. The belowground plant parts of field bindweed have a fairly high nutritive value, and tillage

practices that expose them to the soil surface may make them a valuable source of energy for grazing livestock (Schutte and Lauriault, 2015). Crop producers in the Southwestern U.S. have utilized tillage to bring Johnsongrass (*Sorghum halepense* [L.] Pers.) rhizomes to the soil surface where they can be consumed by foraging ruminant livestock (L.F. Perkins, personal communication). This tactic might also be helpful for reducing field bindweed populations because it builds on previous studies indicating that livestock and wildlife graze effectively on exposed field bindweed plant organs (Allen, 1968; Stahler, 1948), including roots and rhizomes (Taylor and Smith, 2005). These foraging practices are based on the understanding that root system destruction is essential for limiting spatial and temporal spread of field bindweed (Weaver and Riley, 1982). Roots of mite-infested field bindweed plants were smaller in diameter than roots on uninfested plants, but the nutritive value between the two were similar (Schutte and Lauriault, 2015).

CONCLUSION

Field bindweed is a perennial weed that spreads by a massive root and underground stem system. Bindweed also reproduces by seed and, even with effective control measures of existing plants, the bindweed will be a problem as long as seed remains viable in the soil (30 years or longer). High seed and root production make field bindweed control difficult, if not impossible, with a single management practice (e.g., chemical control). However, an integrated pest management program that combines the bindweed gall mite with additional management practices that stress the bindweed can reduce growth and reproduction of the weed, greatly reducing its competition with desirable plants.

Information about where and how to acquire the mites is available by emailing tucumcar@nmsu.edu or calling 575-461-1620. If you decide to try the mites, we would like you to complete the survey at the end of this publication to help us learn more about the adaptation of the mite and your successes and challenges. The survey is also available online (http://tucumcarisc.nmsu.edu/bindweed-mite-user-surve.html). Please print the survey in this publication and fill in dates and other information as those occur. Then complete the online form six months AFTER you release the mites. Thank you.

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Bindweed Gall Mite Use Survey

Please fill in dates and other information as those events occur; then, six months AFTER applying bindweed gall mites, complete this survey online at http://tucumcarisc.nmsu.edu/bindweed-mite-user-surve.html. Your responses will help New Mexico State University researchers more rapidly understand the best management practices necessary to control bindweed and provide YOU with clear and cost-effective management instructions. Thank you.

1. When you complete this survey, you are providing valuable information for researchers working on bindweed eradication. Because additional observation information may be needed from you, please provide your contact information below.

   Name: _____

   Company: _____

   Address 1: _____

   Address 2: _____

   City/Town: _____

   State: _____

   Zip: _____

   Phone: _____

   Email address: _____

2. Please identify the location where you received your bindweed gall mites.

3. Please indicate, as closely as you can, the date you picked up your bindweed gall mites.

4. Did you receive training on mite usage?
   ___ Yes ___ No

5. How did you transport your mites?

6. AFTER seeing the effects of bindweed gall mites at the insectary and AFTER reading NMSU Extension Circular 600, *Managing* Aceria malherbae *Gall Mites for Control of Field Bindweed*, but BEFORE releasing your mites, did you notice any signs of gall mite infestation in your patch?
   ___ Yes ___ No
   If "yes," go to Question 7. If "no," go to Question 10.

7. If you answered "yes" to Question 6, how UNIFORM were the signs of mite infestation?
   _____ Across the entire field
   _____ In different parts of the field
   _____ In one part of the field

8. How HEAVY was the mite damage in that patch?
   ___ Severe
   ___ Moderate
   ___ Light

9. How had you managed that patch in the past? Please list any pesticide products used and/or frequency of mowing or grazing.
   ___ Mowing (please describe): _____

   ___ Grazing (please describe): _____

   ___ Spraying (please describe): _____

   ___ Other (please describe): _____

10. When you released your gall mites, did you:
   ___ Release your mites into the field you originally planned to release them in?
   ___ Release your mites into a different field because you found your first field already infested with gall mites?
   ___ Other, please explain: _____

11. How soon after obtaining your gall mites did you release them?
   ___ Same day
   ___ Next day
   ___ Third day
   ___ Other, please specify: _____

12. How did you release your mites?
   ___ Opened the ice chest and let them fly out
   ___ Walked or drove around the field and scattered out pieces of infested bindweed
   ___ Twisted infested vines around my vines
   ___ Poured them out in the middle of the field
   ___ Other, please specify: _____

13. After six months, do you feel you got a uniform establishment of gall mites?
   ___ Yes ___ No ___ Not sure
   If "yes" or "no," go to Question 15. If "not sure," go to Question 14.

14. If you answered "not sure" in Question 13, would you like an NMSU Extension Specialist to visit your site? (Please request this ONLY if you are really "not sure.")
___ Yes ___ No

15. Have you done anything to enhance the effect(s) of the gall mites?
___ Yes ___ No
If "yes," please explain: _____

16. As a result of your experiences with the gall mites, do you plan to use mites as an eradication method for bindweed in other areas?
___ Yes ___ No
If "no," please explain: _____

17. Would you recommend to others the use of gall mites to eradicate bindweed?
___ Yes ___ No
If "no," please explain: _____

18. Is there anything else you want to tell NMSU Extension Specialists about your mite application efforts?
___Yes ___No
If "yes," please explain: _____

19. After completing this survey, would you like to continue to participate in this study?
___ Yes ___ No

The pesticide recommendations in this publication are provided only as a guide. The authors and New Mexico State University assume no liability resulting from their use. Please be aware that pesticide labels and registration can change at any time; by law, it is the applicator's responsibility to use pesticides ONLY according to the directions on the current label. Use pesticides selectively and carefully and follow recommended procedures for the safe storage and disposal of surplus pesticides and containers.

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