

# ALFALFA STAND SURVIVAL IN SEASONS OF MULTIPLE STRESSES

## Agronomy Facts Series: AF-20

The 2003 growing season was a difficult one for alfalfa producers. Not only was hay making very difficult with the frequent rains but potato leafhoppers (PLH) continued to attack the crop time and time again throughout the summer. Some growers with PLH resistant alfalfa cultivars (a cultivated variety) thought that they did not need to worry about the need to spray for PLH. An alfalfa cultivar is a population and each seed and resulting seedling is genetically different. In a PLH resistant cultivar, alfalfa plants will express the full range of expression for this particular trait. Some of the older PLH resistant varieties only had 25 to 45 percent of the plants that express resistance to PLH.

The very newest cultivars exhibit 60 to 80 percent resistant plants. In 2003, researchers working with some of the new so-called 4<sup>th</sup> generation indicated that the resistant cultivars performed very well. They still had a lot of hoppers in the crop and some yellowing was visible, but looked great when compared side-by-side with a nonglandular-haired cultivar. These data confirm previous findings demonstrating that glandular-haired varieties are superior to standard alfalfa under heavy PLH pressure. The consensus among researchers evaluating these cultivars is that the newer cultivars are good but insecticides may still be justified under extreme outbreaks. Unfortunately, economic threshold levels for the new PLH-resistant cultivars are not clear at this time.

### **Starting with basics—for the PLH resistant cultivars, how does resistance work?**

The new PLH resistant alfalfa cultivars have an increased density of something called glandular hairs or trichomes that are specialized hairs with a multicellular tip, that produce sticky, resin-like exudates. In older alfalfa literature, alfalfa plants with high densities of simple hairs on their leaves and stems did show a moderate level of resistance to the PLH. It was thought that the hair density interfered with feeding and egg laying and this physical effect can be called physical entrapment.

Glandular hairs cause problems similar to those caused by simple hairs, but in addition, their exudate creates serious problems for the immature and adult stages of the PLH. The current thinking is that there is a relationship between glandular hairs present on resistant alfalfa and PLH resistance and that it is associated with a compound that is toxic to the PLH. The exact mechanism is still under debate since the sticky exudates may be acting as a “glue”, trapping the small fragile immature stages of PLH or may seal their respiratory system causing suffocation (called biophysical antibiosis), or may be causing them to become disoriented and unable to establish on their host plants.

Reduced survival of adults and nymphs on glandular-haired alfalfa is called antibiosis. Research studies show that survival of nymphs is especially low (immature nymphs are

particularly susceptible to compound or compounds involved in antibiosis response). Studies by Dr. Bill Lamp with the University of Maryland show that there is as much as a 67 percent reduction in PLH egg production or egg-laying on leafhopper resistant alfalfa as compared to susceptible cultivars. This effect is called non-preference in oviposition (egg-laying).

Finally, the last effect researchers have discussed is tolerance. Some research suggests that tolerance is a component of the resistance mechanism. In this case, the data suggest that the PLH population required to cause economic damage on field plots is twice as high on resistant as compared to susceptible cultivars.

**How much effect will 2 or 3 consecutive cycles or injury from PLH have on a stand of hopper resistant and non-resistant alfalfa cultivar?**

If an infestation of PLH leads to the typical leafhopper burn that causes a u- or v-shaped lesion to appear at the apex of the alfalfa leaflet (See Photo 1) and that can cause plant stunting, the effects can impact yield from one or more cuttings. This is typically what happens in a moderate to slight infestation season.



Photo 1. Note typical potato leaf hopper burn on leaflets in the lower left corner of photo (Photo by R. Taylor).



Photo 2. Typical potato leaf hopper nymph (Photo by R. Taylor).

In a severe PLH season as we've experienced this year, PLH burn may occur in multiple harvest cycles and lead to more significant long-term impacts. Several factors may come into play during repeated PLH infestations that lead to burn symptoms. First, the stunting that often accompanies the more visible leaf burn will reduce the photosynthetic capacity of the plant and reduce crop yields.

Secondly, the lack of photosynthetic capacity diminishes the ability of the alfalfa plant to replace the root reserves it needs for the next growth cycle or for winter hardiness.

Third, the stunting that often accompanies leaf burn allows germinating weeds to be more competitive against alfalfa. Competing weeds and especially summer annual grasses such as barnyardgrass, giant foxtail, giant crabgrass sometimes called water grass, and fall panicum can rapidly form a canopy over the stunted alfalfa plants further reducing their ability to manufacture food as well as increase the incidence of diseases due to shading, increased canopy humidity, and reduced plant vigor.

Fourth, the visible stunting the grower sees is compounded by the fact that root growth can also be reduced. Poor root growth results in less nutrient uptake and less available water. These growth limitations then compound the previous problems the plant experiences.

Why are root reserves so critical to alfalfa? Alfalfa stores its energy reserves in the tap root so when the top growth (photosynthetically active leaf area) is removed by grazing or mechanical harvesting there is enough stored energy to regrow the leaf area to the point that the plant can fix from the sun the energy it needs to continue growing. As a healthy plant emerges from winter, the root reserves are almost used up as new tillers, leaves, and stems form but once a critical mass of leaf area is formed the plant can sustain itself on just the sun's energy and can begin to replenish the root storage reserves. The lengthening days and the large amount of leaf area (yield) generated in the spring allow a plant to accumulate a large amount of extra energy in the tap root.

After a harvest is taken, the plant uses a large percentage of the stored energy to make the second flush of growth and so forth through each harvest or grazing cycle. However with each cycle, the plant never quite stores as much energy in the root as was accumulated in the previous cycle. For this reason, producers generally allow the crop to accumulate energy for a longer period just prior to frost and the winter dormant season. The crop must accumulate enough energy reserves to survive the winter months and then support the early flush of growth the following spring until the plant is able to rely on its newly-generated leaf area to support growth.

### **What do all these adverse factors mean for the alfalfa grower?**

On an immediate level, yields can be reduced significantly and crude protein levels of harvested forage will be lower than normal because of the loss of leaf tissue. Often with severe repeated PLH infestations, growers can expect diminished stand survival during periods of drought stress in late summer or during the winter if conditions are harsh. Stand life will be shortened and if the problems are severe enough stands in the year following multiple PLH infestations will be inadequate for maximum economic yield. New stands seeded either the fall

before or this past spring will be at most risk but older stands nearing their expected life expectancy are also at severe risk.

### **What can a grower do to manage PLH?**

First and most critical are new seedings of alfalfa planted either the fall-before or in the spring of the current year. These new seedings must be protected during the first summer's growth. Pay strict attention to PLH thresholds and control PLH immediately when thresholds are passed. Part of the reason for this is to prevent PLH damage from limiting root growth during this important establishment phase and to ensure good root reserve development before the critical winter period.

Growers should also limit the food supply of PLH by making a short, clean cut and harvesting the entire field at one time. Cutting an entire field cleanly at one time will eliminate at least temporarily the presence of PLH nymphs and cause the surviving adults to disperse to other fields. Generally, PLH populations tend to drop dramatically after a cutting and won't begin to rebuild until about 10 to 15 days of regrowth is present in the field. Again, do not depend on averages but continue scouting to be sure PLH populations do not reach the threshold level.

Another option is cutting slightly early and using 4 to 5 cutting cycles rather than 3 to 4 as this will limit the time during which PLH populations can buildup.

Human nature can come into play as well. Growers should avoid revenge sprays and should not spray alfalfa stubble until thresholds are exceeded. You should always plant alfalfa varieties that have good performance records even under heavy PLH pressure. Also, growers should adjust their action PLH thresholds based on crop conditions. In years where weather or other stresses may be unfavorable for rapid alfalfa growth, you should adjust thresholds downward to help protect the health of the stand and increase the frequency with which you monitor PLH levels.

Potato leafhoppers were not the only problem alfalfa producers experience in 2003. Among the other problems were compaction caused by harvest weather delays, mowed hay sitting in the field or windrowed in the field for long periods, baled hay left on the production field, delayed or infrequent harvests, and grassy weed competition.

### **What impact does compaction have on alfalfa stands?**

During this past season, many alfalfa producers, trying to harvest in the few periods when the forecast indicated several consecutive days of dry weather, inadvertently created compaction problems during the harvest process. Often this new stress was compounded with other stresses such as PLH burn/stunting or delayed harvest with removal of already elongating crown buds. Compaction will reduce root growth by increasing the soil's bulk density, reduce soil moisture holding capacity, limit immobile nutrient uptake through reduced root growth, and limit water infiltration and percolation which in wet years can favor root and crown diseases.

In an already stressed stand, compaction can cause rapid stand loss, reduced alfalfa vigor, and lead to weed invasion. Once in place, compaction exists until the next renovation/rotation cycle. A layer of deep compaction is best alleviated by deep fall tillage when the soil has dried out and will fracture better with subsoiling equipment. Meeting these requirements can end up adding an extra half to full-season to the usual rotation cycle out of alfalfa.

### **What are the effects of windrows left for long-periods on an alfalfa stand?**

Most hay producers at one time or another have had the experience of laying fresh cut alfalfa or other hay in a windrow only to have unexpected rain event(s) ruin the quality of the alfalfa cutting. In the 2003 growing season, such events have been frequent and often have resulted in extended periods of time passing before the windrowed hay could be dried, baled, and removed. In addition, regrowth sometimes makes the advisability of old hay removal questionable.

As long as ruined hay is removed in a timely fashion (say within 5 to 7 days of cutting or sooner), the impact on subsequent regrowth is minimal although, in year's where multiple stress events occur, the damage can be cumulative and therefore more than minimal. When windrow removal is delayed by a week or more or does not occur at all, the damage to the alfalfa (and even grass hay stands) stand can be substantial.

First and most obvious, the windrow reduces the amount of sunlight that reaches the crown and crown buds. This causes a reduction in the chlorophyll content of old and new leaves, a corresponding reduction in fixation of the sun's energy, and an increase in the need of the plants underneath the windrow to use up root (alfalfa and red clover) or crown (many grasses) energy reserves. The longer the shading lasts, the greater the decline in root energy reserves until the point is reached when the plant can no longer recover enough to survive. Plant death can occur either as a result of the plant's inability to renew its photosynthetic base (add enough new leaf tissue above the interference of the windrow) or as a result of inadequate root energy reserves to survive the following winter or even next harvest cycle.



Photo 3. Spoiled hay left in windrow in orchardgrass hay field (Photo by R. Taylor).

Secondly, stand loss, reduction in tiller density of regrowth, or reduction in competitive leaf area can allow weed encroachment. The timing of the loss of competitiveness by the existing

alfalfa stand affects whether annual grass or broadleaf weeds invade the stand or their proportions and causes a further decline in stand quality and longevity.

Third, the presence of a layer of organic material above the plant crowns, cools the soil, reduces water loss and increases soil moisture levels, and can provide a food source for saprophytic and possibly pathogenic fungi. Any and all of these effects can potentially increase the loss of stand from disease organisms.

Is it better to bale spoiled hay and remove it or can it be chopped and spread? If the spoiled hay has not been formed into windrows and the yield level is low, chopping and spreading the residue over the field can be a viable alternative. However if the hay is in windrows or the yield was substantial, the probability that at least some areas of the field will be affected adversely by inadequately spread material is too great to risk so the hay should be baled and removed. Keep in mind the risk of fire with baled wet hay.

### **What about leaving hay bales in the field for a period of time after baling hay?**

It should be noted that the above effects occur on a more localized level when baled hay is not immediately removed from a field (Photo 4). The area impacted is small at each harvest; but, if hay removal is delayed time and time again, the total area of a stand that is ultimately impacted increases rapidly with four to five harvest cycles per year and



Photo 4. Large hay bales left on alfalfa field until regrowth is about 12 inches tall (Photo by R. Taylor).

multiple harvest years. Also, the small area involved with a single bale when converted from solid alfalfa (or other planted species) to annual weeds provides seed inoculum that can spread to the remainder of the field whenever another stress such as stunting from potato leaf hopper infestation opens the door for weed encroachment (Photo 5).

Another impact from a delay in removing baled hay from the field is the injury to plants caused by the equipment used to remove the baled hay after substantial regrowth has occurred (Photo 6). Not only can crowns and tillers be injured but if soil moisture has been



Photo 5. Dead spot and potential weed patch under old bale left in field (Photo by R. Taylor).

recharged by rains, there will be the potential for compaction and root injury/restriction. Although these individual effects are rather small, they can add up to significant stress and possible stand loss during adverse growing seasons such as seen during 2003.



Photo 5. Damaged caused to an alfalfa stand when large round bales are removed two to three weeks after harvest (Photo by R. Taylor).

### **How concerned should I be about annual grass encroaching into alfalfa fields and should I take action against the grass?**

Many producers find that as the late-July to August period approaches (usually the third or fourth harvest) many annual grass weeds invade alfalfa fields (Photo 7). A number of questions come to mind including what grasses can be a problem; how much invasion is too much; what effect does the competition have on the alfalfa; and how much time before frost is needed for alfalfa to be able to recover if the grass is controlled?



Photo 7. Annual grass encroachment in alfalfa field by mid-August is not uncommon (Photo by R. Taylor).

First, what grasses can be a problem? In irrigated alfalfa, large crabgrass often called water grass and barnyardgrass (also a major weed in rice culture) can quickly invade fields and rapidly overwhelm alfalfa in competition for light and nutrients. In dryland alfalfa, goosegrass, giant foxtail as well as both small and large crabgrass can be problem grasses. If the seed head emerges and seed set begins, foxtail will die after the next alfalfa harvest and leave the incorrect impression that little damage has been done to the stand.

How much invasion is too much? Often, the problem is not noticed until another factor (water availability or PLH injury) stunts the alfalfa. In such a situation, the fibrous root system of the grass can support rapid top growth allowing the grass to appear as if suddenly above the alfalfa. If harvest timing permits seed set by the grass, the stage is set for a rapid buildup of the weed problem. Certainly, a limited amount of annual grasses can be tolerated by the alfalfa but producers should try to be proactive in eliminating the competitive effects of these weeds before they severely impact stand. More often, the grassy weeds become established in small areas of a field where another stress has reduced alfalfa stands or vigor. These areas then expand gradually until or unless a major stress releases them to invade the remainder of the field. The bottom line is that producers should pay close attention to grassy weed encroachment and work to minimize the problem. The goal should be to control these weeds before they are able to canopy the alfalfa.

What effect does grass weed competition have on alfalfa? The fibrous root system and the ability of many of these grass weeds (the ones using the C-4 carbon fixation pathway—summer annual like corn) to better use available soil moisture and the summer heat means that the grasses can compete successfully against alfalfa for water, nutrients, and sunlight during the mid-summer period.

When annual grass weeds are present, there will be intense competition for available soil moisture and nutrients. Alfalfa needs both to support large yields and on good alfalfa soils without supplemental irrigation water availability often will be a problem in the mid-summer months in the mid-Atlantic region. If the weeds are able to grow above the alfalfa canopy, several problems can occur. Obviously, there will be less sunlight available to the alfalfa. The relative humidity of the lower canopy likely will increase and can lead to an increase in some alfalfa diseases, especially leaf spots and mildews.

How much time before frost is needed for alfalfa to be able to recover if the grass is controlled? Six weeks of competition-free growth should help alfalfa recover enough to survive the winter months although it would be better to control the weeds early enough to allow eight or more weeks before frost.

In summary, given that factors out of the producer's control have caused significant stand losses, what can be done about reinvigorating the stand? If enough plants survive until the fall, producers should make certain that adequate potash ( $K_2O$ ) is available or is applied to help the remaining plants survive the winter months. If possible weeds and especially grassy weeds should be controlled to allow the crop six to eight weeks of competition-free recovery before a hard freeze ceases growth for the season. If in spite of all efforts, the stand this fall or next spring proves inadequate for maximum economic production, the producer should consider the following options:

1. Using no-till, interseed with orchardgrass, ryegrass (annual or tetraploid), or a festulolium (preferably one based on a cross between ryegrass and meadow fescue) to boost yields and thereby extend the stand life by a year or two. Fertilization should be aimed at maximizing grass growth and production.
2. Kill the existing alfalfa and replant as soon as possible. (See the write-up below on autotoxicity.)
3. Rotate out of alfalfa and other legumes for at least a year but preferably two years and then reseed alfalfa.

### **What effect does a late first cutting (full bloom or later) have on alfalfa?**

Although some first cutting alfalfa took place on time for the most part, the first harvest of alfalfa in 2003 occurred when the crop was either at full bloom or later and often after it was starting to die on top.

Late-cutting can have an adverse effect on alfalfa since crown buds that had already begun elongation often are removed. If the crown buds are clipped below the growing point, fewer tillers will be produced in the second cutting and yields will be smaller. If first cut is late enough that most of the crown buds are clipped during harvest, the second harvest will be delayed until new crown buds are activated and complete their growth cycle. The delay between the first and second harvest can be long enough that producers will end the season with one fewer harvests than normal.

### **Why can regrowth between cuttings take as long as 40 to 50 days as happened during the 2003 growing season?**

Regrowth interval in alfalfa during 2003 often was much longer than the usual 28 to 35 days producers try to achieve. In some cases, the delay was caused by the removal of growing crown buds as described above.

Other causes of the long harvest intervals included PLH injury and stunting effects, prolonged periods of cloudy, cool weather that limited dry matter accumulation, disease impacts from the presence of too much moisture even on sandy soils (often with unusually high water tables this season),

### **In rainy growing seasons, what impact do wet soil conditions have on alfalfa root systems?**

Wet soil conditions can have an impact on nitrogen fixation, root growth, nutrient uptake, and disease incidence (see below for a discussion of disease problems associated with wet weather and wet soils).

Wet soil conditions can reduce the amount of oxygen in the soil and this will impede the growth of new roots. For much of the spring and early summer, soils were not only wet but cold and this also limited root development and nodule activity. The cloudy, cool, and often wet weather limited the amount of water that the plants needed to transpire so nutrients that primarily are taken up by the process called mass flow (N, Ca, Mg, S, Cu, B, and Mn) were in short supply to the plant.

Leaching also is a concern in this type of growing season. Nutrients, such as the anions S, B, Mo, and soil supplied N, moved out of the upper soil layers. To maintain electro-balance in the soil, the leaching of these anions was accompanied by an equal equivalence of Ca and Mg resulting in a drop in the soil pH. Producers should monitor Ca, Mg, and pH levels carefully during the next growing season and apply lime as needed.

### **What impacts do wet years have on alfalfa diseases and thus on stand longevity?**

A number of alfalfa diseases become more severe during wet climate cycles. A partial list is given below:

Anthrachnose occurs most often under warm, moist conditions and can reduce yields by as much as 25 percent. The diamond-shaped lesions can enlarge and join to girdle and kill one or more stems on a plant. Girdled stems will appear to wilt suddenly and exhibit a “shepherd’s hook” appearance. Dead stems are often straw-colored to pearly white dead shoots that are scattered across a field. Anthracnose is a major pathogen of crown tissue and will turn the tissue a blue-black color easily identified if the crown is split in to two. The crown symptoms can result in fewer stems per plant and eventual plant death. Resistant cultivars are available and this trait should be a part of your pest management strategy.

Root rots are an important disease of wet soils. One such disease, Aphanomyces root rot, stunts and kills seedlings and causes a chronic root disease in established plants. The disease results in a reduction of root mass, fewer lateral roots, absent or decaying root nodules, and plants are slow to regrow following winter dormancy or harvest.

Another concern is Phytophthora root rot that kills seedlings or established plants in wet or slowly drained soils. The fungus is prevalent in our soils and can cause the disease on

established plants in poorly drained soils and where water stands for 3 days which describes most fields at some point during the 2003 growing season. Plants can die within one week of infection or linger on with reduced root mass and growth rate. Phytophthora root rot is often not identified until the soil dries and apparently healthy plants begin wilting because the damaged tap roots can not supply adequate water. Resistant cultivars are available against both root rots mentioned.

A disease that appears following a cool, rainy period is common and Leptosphaerulina (lepto) leaf spot. Common leaf spot occurs primarily in first and second cuttings and in the fall regrowth. Resistance is available in some cultivars. Lepto leaf spot attacks young regrowth of alfalfa during the spring and fall and resistant cultivars are not available. Yield and quality can be lost through the loss of dead leaves or leaf drop during harvesting and drying operations.

Spring black stem and leaf spot is a fungus disease that can both reduce yield and quality of alfalfa. The disease often begins in early spring as new shoots become infected as they grow through last year's stubble. Dew or rain is needed for the fungal pycnidia to release spores and for infection to occur. First cutting alfalfa is the most damaged but cool, moist periods in the fall can allow the incidence of the disease to increase again. Colonized dead stubble often results in crown infections. Moderate resistance is available in some alfalfa cultivars but early cutting when the disease is prevalent tends to reduce leaf loss.

Another disease of concern during a wet growing season would be Fusarium wilt. This is a vascular disease that causes gradual stand thinning. Plants will die but often over a several month period. Although resistant cultivars are available to control this disease, producers should maintain good soil fertility levels and control pea aphids and PLH that can help spread the disease.

### **Do wet soil conditions impact soil fertility considerations, especially for the following year?**

The amount of rainfall that has occurred since last fall has impacted the fertility status of some alfalfa soils. Well-drained, coarse textured soils where alfalfa is often grown are ideal for leaching losses. These soils also have very little anion exchange capacity so anions such as sulfate, borate, molybdate, and nitrate (the result of soil organic matter mineralization processes) have been leached from the upper soil layers. To maintain the chemical ionic balance in the soil, equivalent quantities of cations such as calcium and magnesium move downward with the negatively charged anions. On its own, potassium also is subject to leaching losses especially on coarse-textured soils.

For producers, this means that additional fertilizer may be needed to make up for not only the usual loss of these nutrients when the crop is harvested and removed but also leaching losses. Producers should carefully monitor their soil fertility levels including soil pH so that inadequate nutrient levels do not cause added stress to the crop.

Even without a wet growing season, soil fertility is critical to maintaining vigorous and healthy alfalfa stands. Alfalfa producers should maintain an aggressive soil fertility program by

soil testing on a regular basis. In addition, producers should consider not only monitoring the fertility in the top eight inches of soil but also monitor that in the deeper soil layers.

Research from Dr. Ed Jones at Delaware State University suggests that a ratio closer to 3:1 rather than the traditional 4:1 ( $K_2O$  to  $P_2O_5$ ) should be used when applying potassium and phosphorus to alfalfa. His research indicated that the four pound potash to one pound phosphate ratio was not adequate to maintain soil phosphate levels and that depletion of P occurred below the surface 6 inches. Potash fertilization of 400 lb  $K_2O$ /acre were inadequate to maintain yield or soil test value but 600 lb  $K_2O$ /acre resulted in the accumulation of potash in the upper 12 inches of soil. To maintain stand and yield potential in alfalfa, adequate phosphate and potash should be applied annually, preferably in two applications—one in early summer and one in late summer or early fall.

### **When and how should you evaluate an alfalfa stand?**

Below are descriptions of two methods that can be used to determine the viability of an alfalfa stand. An alfalfa producer should use not only one of these methods but their feel for the vigor of the particular stand they wish to evaluate.

The first method consists of counting the number of plants per square foot. Current research information suggests that when stand counts fall below 4 to 5 plants per square foot, it's time to either rotate out of pure alfalfa or interseed a grass crop such as orchardgrass, festulolium, tetraploid ryegrass, or annual ryegrass.

The second method derives from research out of Wisconsin by Dr. Dennis Cosgrove that indicates that stem number rather than plant number is a more accurate determination of when to plow down or interseed an alfalfa stand. Cosgrove suggests using a value of 55 or more stems per square foot to indicate that the stand will produce maximum yield. A reduction in stem number per square foot to 40 stems or less will result in a 25 percent yield reduction. At this critical level, alfalfa fields begin to lose profitability and should be rotated to another crop for one or two years.

For uniform fields, 20 to 30 acres in size, count about 20 randomly chosen square foot areas and average the results. Take more counts on non-uniform fields and larger fields.

If you must decide on whether to reseed before growth begins in the spring (and you do not plan to take a first harvest of alfalfa before planting another crop) or after a very hard winter with significant heaving or winter injury, base your decision to reseed on the number of plants per square foot. If a decision to reseed can be made during the growing season or later in the spring, use the stems per square foot threshold.

### **Can you successfully reseed alfalfa into old alfalfa fields without rotating out of alfalfa for a year or two?**

Although there is general agreement that autotoxicity is a problem in old alfalfa fields and often leads to establishment failures or poor establishment of new seedlings, research in some

areas has shown that successful reseedling can be done if a field is tilled and allowed to sit for about three weeks or if the stand is killed with a glyphosate-derived herbicide and reseedling is delayed for two weeks or more. However, experience in Delaware says that there is a potential for stand failure due to insect pressure especially when the existing stand is killed with herbicide. Often, autotoxicity is not considered the problem if the new stand becomes well established. Yield reductions or poor persistence of the established stand are attributed to other factors than autotoxicity.

What most growers do not realize is that autotoxicity is not just a problem that leads to stand failure when alfalfa is planted too soon after a previous alfalfa crop but it also has negative effects that linger in the form of long-term reductions in stand and yield. To complicate matters, not only do autotoxic compounds impact yield and stand but the presence of large populations of soil-borne pathogens that can devastate alfalfa can cause shorter longevity for the stand even if a resistant cultivar is replanted.

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