

University/Pioneer Research¹ Update: Managing Autotoxicity in Alfalfa by Tom Doerge, Agronomy Research Manager

Key Findings of CMRA¹ Research Project

- Plant bioassays using water soluble extracts of alfalfa tissues have successfully demonstrated the effects of the autotoxic chemical(s) on the germination and subsequent growth of alfalfa seedlings.
- Although there are no effective soil tests to determine the level of the autotoxin in a field.
- There are few, if any circumstances when interseeding of alfalfa into an existing stand is recommended.
- Plants do not outgrow the initial effects of autotoxicity.
- To avoid autotoxicity problems, an alfalfa-free interval of at least 12 months prior to reseeding is recommended. Reseeding after an alfalfa-free interval of less than 12 months will jeopardize both plant density and productivity for the life of the stand.

Introduction

Autotoxicity is a negative effect of well-established alfalfa plants on the germination, emergence and vigor of new alfalfa seedlings. Both living or recently killed or plowed-under alfalfa plants may produce these negative autotoxic effects. Consequently, reseeding of alfalfa into an existing or recently killed stand must be delayed to be successful.

A survey of extension agronomists from 20 universities in the U.S. reveals a wide range of recommendations for when to reseed alfalfa after killing the old alfalfa stand. Agronomists in 13 states (including Missouri) recommend a rotation interval of at least 12 months. However, some agronomists recommend intervals from 0 to 6 months, and a few recommend periods longer than 12 months. No geographic pattern was apparent with these recommendations.

The variation among state recommendations suggests that environmental conditions and production practices may affect the autotoxicity response. Activity of the autotoxic chemical(s) could be impacted, causing field response times to differ. Understanding these factors affecting autotoxicity will help to develop management recommendations that are



Well-established alfalfa plants (above) exert a negative effect on germination, emergence and vigor of new alfalfa seedlings.

transferable to a wide range of soils and environments. This *Crop Insights* includes the findings of a completed Crop Management Research Network project that provides new information on how to best manage autotoxicity in alfalfa.

Primary Research Objectives

The primary objectives of this study by Dr. Jerry Nelson, University of Missouri were: 1) to determine the utility of plant and soil bioassays for evaluating autotoxicity in alfalfa, and 2) to develop crop and soil management recommendations to minimize or avoid crop losses due to this problem.

Study Description

An integrated series of field and laboratory studies was conducted with soils that had been used for alfalfa production for a number of years. Several parallel field experiments were also conducted to understand competitive aspects of alfalfa seedling development, especially as related to seedling density and time of emergence of seedlings (both reduced by autotoxicity). Collectively, the results of these experiments provided strong insights and conclusions into management of autotoxicity in alfalfa.

Results

Does autotoxicity actually occur when planting alfalfa after alfalfa?

Data from field experiments show clearly that in Missouri, as in many other states, alfalfa stand establishment from spring seedings is reduced unless the previous stand has been killed for a period of at least 12 months. Unique field experiments proved that autotoxicity did occur when seeding alfalfa after alfalfa, and when interseeding alfalfa into an established stand. The responses were not due to insects or diseases.

Are plant bioassays effective for studying autotoxicity in new seedlings of alfalfa ?

Yes. Water extracts of alfalfa plant tissue contain sufficient concentration of the autotoxic chemical(s) to inhibit seed germination and the growth of alfalfa seedlings.

How does autotoxicity affect seed germination and the growth of the new seedlings?

Bioassays with water-soluble extracts from alfalfa leaves demonstrated that of the growth processes studied, root growth is the most sensitive, with some effect on germination and shoot growth, and the least effect on hypocotyl growth. The reduced germination at higher concentrations of the autotoxin appears to be due to a slowing and likely killing of the primary root within the germinating seed. Surviving but impaired roots will have reduced capacity for mineral uptake, nitrogen fixation and drought tolerance.

Do current alfalfa varieties differ in autotoxin production?

No, all of the varieties tested produced the autotoxin in similar amounts.

Are there differences in tolerance of various alfalfa varieties to the autotoxin?

Apparently not. An alfalfa variety trial was planted in paired sub-plots with alfalfa-free intervals of 0 and 12 months. All of the varieties tested were equally damaged when the preceding alfalfa stand was killed immediately prior to seeding. Likewise, all varieties were equally successful when one year had elapsed prior to re-planting.

Can varieties be developed with tolerance to the autotoxin?

Laboratory bioassays with 20 sources of alfalfa germplasm showed that genetic differences in tolerance to the autotoxin do exist. The most sensitive growth process was root elongation. However, in this study none of the varieties



Controlled field studies evaluated the spatial effects of previous alfalfa plants on growth of new seedlings.

tested offered both tolerance of the autotoxin and acceptable root growth rates.

Do soils differ in their response to autotoxicity?

Yes, they do. The autotoxic chemical has a positive charge and is adsorbed on the surface of soil particles. Thus, sandy soils tend to be more toxic in the short-term as more toxin stays in the soil solution. However, the autotoxin is also leached relatively easily so it is dissipated more quickly. In clay soils the autotoxin attaches more strongly to the soil particles, causing the concentration in the soil solution to be lower, and the autotoxin to leach more slowly. Thus, with the same amount of rainfall, the delay before reseeded could be shorter for sandy than clayey soils. Sandy fields leached by irrigation after killing the old plants should allow for earlier replanting.

Are there soil tests for the autotoxic compound(s)?

Currently there is no soil test to determine the level of the autotoxin in the soil.

Can I interseed alfalfa into a thin stand to thicken it?

No, not unless the old alfalfa stand is very, very thin. A stand density of just one alfalfa plant per 2.8 sq. ft. will decrease yields following interseeding by nearly 30% compared to seeding in an area with no alfalfa plants. If a legume is needed, it would be better to thicken the stand with red clover since it is tolerant of the alfalfa autotoxin.

Would it help to cut or graze the established plants when reseeded to thicken a stand?

No, in fact, it may even aggravate the problem. Stress such as repeated clipping of the established plants actually leads to greater production of autotoxic chemicals by alfalfa.

Do plants grow out of the initial effects of autotoxicity?

It appears they do not. Numerous studies have shown that long-term yields of alfalfa affected by autotoxicity were 8 to 29% lower than the control. Thus, the true cost of autotoxicity is much greater than just that of a potential seeding failure. Stands may appear adequate, but autotoxicity effects will lower production for an extended time. Plants affected by autotoxicity had a less-pronounced taproot and more extensive branching. Branch-rooted plants may be less productive, especially in drought-prone environments.

Additional Information on Autotoxicity

- **Alfalfa Autotoxicity**
Ontario Ministry of Agriculture and Food
<http://www.gov.on.ca/OMAFRA/english/crops/field/autotox.htm>
- **Understanding Autotoxicity in Alfalfa**
University of Arkansas Cooperative Extension
http://www.uwex.edu/ces/forage/wfc/proceedings2001/understanding_autotoxicity_in_alfalfa.htm

- **Autotoxicity During Re-establishment of Alfalfa: Is it a Serious Concern?** University of Minnesota
<http://www.agro.agri.umn.edu/forages/topic/alfalfa/autotox1.html>
- **Autotoxicity**
University of Minnesota
<http://forages.orst.edu/IS/AIS/enfpmain.cfm?PageID=252>
- **Seeding Alfalfa Fields Back into Alfalfa**
University of Wisconsin
<http://www.uwex.edu/ces/crops/uwforage/AlfalfaTox-FOF.htm>
- **Alfalfa Autotoxicity Spreadsheet**
University of Wisconsin
http://www.uwex.edu/ces/crops/uwforage/Autotoxicity_risk.xls

¹The Pioneer Crop Management Research Awards (**CMRA**) Program provides funds for agronomic and precision farming studies by university and USDA cooperators throughout North America. The awards normally extend for three years and address crop management information needs of Pioneer agronomists, sales professionals and customers.