Autotoxicity in Alfalfa

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Alfalfa stands thin over time due to numerous biotic and abiotic factors. Often it would be handy for alfalfa producers to improve failed stands by overseeding into existing stands. Mixed results have been reported in the literature when renovating stands and problems have been attributed to autotoxicity and pest pressures.

Autotoxicity is the negative effect of well-established alfalfa plants, either living or recently killed or plowed under, on the germination, emergence and vigor of new alfalfa seedings. Allelopathy is defined as the effect (harmful) of one plant on another through the production of chemical compounds that escape to the environment. Autotoxicity is a form of allelopathy (Volenec, 2004). There is no specific chemical proven to be the primary cause of autotoxicity but phenolics, including coumarin, *o*-coumaric acid, and trans-coumaric acid, give seedling growth responses that are consistent with those of water-soluble extracts of alfalfa that have been reported in the literature (Chon, 2004). Other allelochemicals include alkaloids, phenolics, flavonoids, terpenoids, and glucosinolates. Not knowing which specific chemical or mixture of chemicals makes it difficult to fully understand alfalfa autotoxicity.

Reseeding alfalfa into an existing stand or following alfalfa is not recommended in most states due to autotoxic chemicals leached from leaves, flowers, stems and roots. In a survey of agronomists and forage specialists in over 40 states, autotoxicity ranked as the second most important problem for seeding alfalfa after alfalfa with soil borne diseases ranked above autotoxicity (Jennings, 2001). Many of these same agronomists recommend removing stands for a minimum of one year before seeding alfalfa into that location.

Autotoxic water-soluble chemicals are concentrated more in leaf and flower than root and stem tissues (Chung and Miller, 1995). In addition, stage of alfalfa growth can impact autotoxicity. Hegde and Miller (1992) reported that extracts from forage at the reproductive stage of growth contain more autotoxin than does forage at the vegetative stage of growth. Chon (2004) found that water-soluble extracts from dry leaf tissue did not affect final germination percentage, but increased time to germination by 16%, reduced hypocotyl length by 16%, and reduce root length by 85% at 120 hours compared to the water control. Jennings and Nelson (2002) have shown that germination is reduced due to a slowing and killing of the primary root within the germinating seed. Those tap roots that do survive are smaller and branched which reduces the plants ability to tolerate drought and are less productive. According to Nelson, one of the most significant findings is that alfalfa does not outgrow the initial effects of autotoxicity. Alfalfa appears to have a memory of response and this has been termed by Nelson as "autoconditioning". Even if a producer reseeds and appears to have established a

successful stand, autoconditioning can in most cases lower the productivity from 8 – 29%.

Soil texture plays an important part in autotoxicity responses as sandy soils tend to be more toxic in the short-term but the same autotoxins are leached more quickly through the soil profile. Heavier clay soils tend to bind autotoxins and are leached more slowly. Apparently 50% more water is needed to move extracts through a silty clay loam compared to sandy soils (Undersander, 2007). Tillage also reduces toxin affects by mixing compared to no-till in the second week after killing the previous stand but was still 80 and 60% less yield than the control for Till vs. No-Tillage, respectively. Even after a 4 week delay in seeding, yields were 70% of the control for conventional tillage compared to 45% for no-till showing the effects of the autotoxins

In 2002, researchers noted that alfalfa has a definite "Zone of Influence" meaning the closer to an existing alfalfa plant the more concentrated the autotoxin. These researchers showed that seedlings closer than 10" from the plant either did not germinate or grew very slowly and roots were deformed where-as plants 10" or further were normal and healthy. Even if someone wanted to reseed low stand density fields, new seed being sown would be closer than 10" from existing plants and would therefore grow poorly due to autotoxins. Autotoxins can also persist in soils for extended periods of time. Planting 6 months after removing an old stand has resulted in yield reductions compared to checks ranging from 8 to 58% of the control (Jennings and Nelson, 2002).

Research has been mixed on the effects insecticides and fungicides play in improving stand density or yield when overseeding with some applications being of limited value to the grower. This is in part due to soil type as sandy soils do leach water soluble compounds faster and are generally drier and have less pathogen pressures at seeding.

Sound guidelines have been proposed that should reduce the risk of autotoxicity when trying to decide on re-seeding fields that previously were alfalfa (Volenec, 2004). These are general guidelines and are not specific to all operations.

1. For least risk, wait at least one year before reseeding alfalfa into a field previously in alfalfa.
2. At a minimum, do not reseed alfalfa into a previous alfalfa field until at least two weeks after destroying the previous alfalfa stand using tillage.
3. If you are no-tilling alfalfa after killing the previous alfalfa stand with herbicide, wait three to four weeks before reseeding alfalfa.
4. In all cases, remove alfalfa forage prior to killing the stand in order to reduce the abundance of autotoxic compounds released to the soil from leaves and flowers.
5. Irrigation and rainfall leaches the toxic-causing compounds out of the soil profile and reduces autotoxicity. Reseeding delays should be extended if dry weather occurs while old alfalfa stands are being destroyed.
6. Additional tillage prior to reseeding alfalfa mixes the soil and reduces autotoxicity.

7. Autotoxicity tends to disappear from sandy soils sooner than soils with a clay texture. Therefore, reseeding delays should be extended on clay-containing soils.
8. Reseed a seeding failure promptly before autotoxicity can become a problem.

Individual varietal response to autotoxins as well as the production of the toxins exists in the literature but few varieties are actually reported on this subject. However given variability does exist for the plants ability to respond to the toxin and/or production of the toxin will allow for improvement in toxin response or production by plant breeders. Use of autotoxins is also being researched as a form of weed control but is not yet marketed.

Allelopathy interacts with plant stress, because stressed source plants often release a greater array and concentration of allelochemicals, and stressed target plants may be more susceptible to allelochemicals (Reigosa et al., 2002). Allelochemical production is also thought to be a result of natural environmental selection pressures of the plant to reduce competition from nearby new seedlings during scarce soil moisture (Undersander, 2007).

In summary mixed results exist in the literature for improving existing alfalfa stands by overseeding. Knowing your field soil type and following sound guidelines for reseeding will help you as a producer make the decision on if and when you can seed alfalfa following alfalfa.

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