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1. Nitrogen contributions from legume crops: Amounts and availability

Most legumes have the potential to fix significant quantities of nitrogen (N), which may be made available in the soil for use by future crops. How much N can be expected to become available, and when?

There are many factors involved, including:

- The species of legume
- Soil moisture, temperature, and pH conditions
- The growth and productivity of the legume crop
- Whether the legume is a pure stand, or intermingled with a grass crop
- Whether the legume crop is harvested, grazed, left standing, or tilled under
- The extent of legume nodulation

First, how does nodulation work? In a nutshell, rhizobia bacteria form nodules on the roots of legumes. The bacteria convert free N from the air in the soil into plant available NH_3-N, which the legume plants utilize to make protein and other necessary N-containing compounds within both the roots and above-ground plant parts.

Most of the N that is fixed within legumes is found in leaves, stems, and seeds; with some found in the roots. Perennial legumes may have extensive root systems. Alfalfa, for example, can produce up to a ton per acre of root mass after a year’s growth. Annual legumes typically have less root growth than perennials – roughly about half as much in most situations.

Very little of the N fixed will be present in the soil while the plants are actively growing. It is virtually all retained in the roots and shoots of the plants growing in the field. For example, soil samples taken throughout the year in a field of alfalfa will show little or no change in soil nitrate levels as long as the alfalfa stand is alive. However, large amounts of N may be stored in the roots and crowns as storage proteins during vegetative growth to support re-growth after cutting, or in the spring.

The N that accumulates in the above and below-ground tissues will be released for use by subsequent plants if the legume plant parts remain in the field to decay over time. If the plants are grazed, at least part of the N is recycled back into the soil as animal waste.

If the legume crop is harvested, most of the N that is fixed will be removed from the soil system, except for what remains in the roots and remaining crop residue. In this situation, annual legumes such as soybeans, peas or most fall or spring seeded cover crops may contribute very little N to the soil system. Perennial legumes like established alfalfa, clovers or vetch can have significant amounts of N stored in their roots and crowns, and can contribute N to subsequent crops even if they are harvested immediately prior to termination..

A soybean crop that is harvested for seed or hay will typically take more N from the soil than is fixed by the rhizobia bacteria, especially when yields are average to good. The N credit given to crops that follow soybeans is based on the fact that the C:N ratio in the remaining stems and roots of soybeans is much lower than in wheat, corn, or sorghum residue. Less soil N is needed by soil microbes to decompose soybean residue than the other crops, so more of the soil N is available sooner to subsequent crops.

With alfalfa, about 55-60 lbs N/ton of dry matter is removed per acre. An average to good alfalfa stand (3-5 plants per square foot) can fix about 100 to 250 lbs of N per acre in a growing season. So alfalfa removes about as much N in the hay as it fixes every year. The contribution to soil N will come from the decomposing root system and any remaining forage/residue in the field after the crop is destroyed.

For the N fixed by the rhizobia bacteria in legumes in an ungrazed system to become available to grasses and other subsequent plants, the legume leaves, stems, seeds, roots, and nodules must be decomposed and N mineralized into plant-available forms. For this reason, the amount of N available from legume crops, and the timing of that availability, is highly variable and depends on the factors listed above.

In general, most of the N from a legume crop will not be available to subsequent crops until there have been about two months in which soil temperatures are above 50 degrees. It takes at least that long for soil microbes to mineralize the N from legume plant parts, and that assumes the soil is well aerated, not excessively dry, and has a pH level somewhere in the range of 5.5 to 7.5. So summer crops such as corn or sorghum planted immediately after a spring-killed alfalfa or clover crop may still require some N starter fertilizer to support early season growth, until the release from the legume N gets started. Killing an alfalfa stand in the fall will “jumpstart” the process, and make the legume N available more quickly to subsequent summer crops. This also explains why N recommendations don’t give much N credit to wheat crops planted immediately after killing a forage legume.

What about legumes used as cover crops? Will a cool-season legume crop planted in the fall contribute N to the crop that immediately follows? Yes, if the legume cover crop is allowed to grow long enough in the spring for significant N fixation to occur, and there is enough time for mineralization of the fixed N. But in many cases, fall-seeded legume cover crops are destroyed too early for significant N fixation benefit.

To understand why, it is important to remember that N fixation doesn’t occur until available soil N has been used and depleted. Why? Because uptake of available N from soil requires less energy on the part of the plants than the N fixation process. The primary source of N for early growth of legumes is soil N. Net additions from fixation only occur after soil N has been depleted.

In the case of cool-season legumes such as vetch and winter peas, significant net N fixation benefits from fall-seeded cover crops likely won't occur until after they begin to flower in the late spring. So the N contributions listed in the table will not actually occur until well after normal corn planting dates in most of Kansas. To take advantage of the N fixation capacity of legume cover crops consider using later-planted summer crops, such as sorghum, to give the legume time to maximize N fixation.

The following chart lists some general ranges of N contribution from legumes.

Legume	Growing Environment	N Contribution (lbs N/acre)*
Soybeans (seed harvested or forage removed)	Average yields	0-40
Forage soybeans (used as a cover crop, not hayed)	Average	80-90
Alfalfa (after stand is destroyed)	Excellent stand (5 plants/sq ft)	60-120
	Good stand (3 plants/sq ft)	40-80
	Fair stand (2 plants/sq ft)	20-40
	Poor stand (1 or less plants/sq ft)	0
Red clover	Excellent stand	40-80
	Good stand	20-40
	Poor stand	0
Sweet clover	Excellent stand	55-110
	Good stand	30-60
	Poor stand	0
Cowpea	Good stand	50-95
	Poor stand	15-30
Australian winter pea	Good stand	50-95
	Poor stand	15-30
Hairy vetch	Average	80-90
Annual lespedeza	Average	0-50
White clover	Average	10-20

* The nitrogen contribution is greatest for crops that follow legumes after several months of warm soil conditions, and least for crops that immediately follow legumes with no intervening period of warm soil conditions.

Sources:
K-State publication MF-2586 "Soil Test Interpretations and Fertilizer Recommendations"
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Cornell University "Managing Legume N Fixation by Planting Species Mixtures"
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2. Wheat response to foliar application of copper and zinc

In recent years, there has been speculation that a large number of wheat acres in Kansas are suffering from copper and zinc deficiencies. Copper deficiency can cause wheat leaves to die back at the tip and curl. A few of the factors associated with copper deficiency include very high levels of soil organic matter, poorly-drained soils, high soil pH, and high phosphorus levels.

Symptoms of zinc deficiency are brown lesions on the leaves. Zinc deficiency can occur in highly calcareous soils with high pH, soils with high phosphorus levels, or on coarse-textured soils with low organic matter levels.

To begin to get some idea of whether there might be copper and zinc deficiency on wheat in northwest Kansas; four typical production fields in 2007 and three fields in 2008 were randomly selected. Soils were tested for copper (Cu) and zinc (Zn) levels, and foliar applications of copper and zinc were applied to the wheat in the spring prior to jointing.

Treatments consisted of:
1) 1 lb/a of copper
2) 1 lb/a of zinc
3) Untreated check.

The liquid formulation for the copper product was 7.5% copper in 10.5 lbs/gal, while the zinc was 9% zinc in 11 lbs/gal. Treatments where applied on March 22 to all sites in 2007 and March 26 in 2008.

Soil test levels for each micronutrient were not high or exceedingly low with the exception of Site 1 for zinc in 2008 (Table 1). These soil tests are likely representative of soils in northwest Kansas.

Yield results were combined across sites for each year. Copper and zinc applications had no effect on grain yields (Table 2). Therefore, wheat fields having copper and zinc soil test levels of 0.2 to 1.3 ppm will likely not benefit from supplemental foliar applications of these nutrients.

Table 1. Wheat variety, copper, and zinc levels at each site.

Year	Sites	Variety	Copper	Zinc
2007			----------ppm-------------	
	Site 1	Danby	1	1.3
	Site 2	Jagalene	1	1
	Site 3	Wesley	1	0.7
	Site 4	Jagalene	0.7	0.8
2008				
	Site 1	Jagalene	0.6	0.2
	Site 2	Ike	1	1.2
	Site 3	TAM 111	1.2	0.6

Table 2. Wheat response to copper and zinc.

	2007	2008
	--------------------bu/a--------------------	
Copper	65	40
Zinc	63	42
Untreated	63	42
LSD (0.05)	NS	NS

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3. Topdressing wheat with N: Timing, application methods, source, and rates

The time is now for topdressing the winter wheat crop. The nitrogen (N) in topdress applications should be moved into the root zone with precipitation well before jointing begins in order to be most efficiently utilized by wheat. Ideally, the N should be available to the wheat when head differentiation occurs and head size is being determined, which can be about two weeks before jointing.

If sufficient precipitation is not received to move the applied N into the root zone, wheat plants may be unable to utilize it when they need it most. Since about one-third of total N utilized by wheat is in the plant by jointing, it is best to apply topdress N early – preferably before the end of February – in order to maximize the probability of receiving enough moisture to move the N into the root zone.

The four main factors involved in good N management when topdressing wheat are timing, source, application method, and rate.

* Timing. The most important factor in getting a good return on topdress N is usually timing. It is critical to get the N on early enough to have the maximum potential impact on yield. While some producers often wait until spring just prior to jointing, this can be too late in some years. For well-drained medium-fine textured soils that dominate our wheat acres, the odds of losing much of the N that is topdress-applied in the fall or winter is low since we typically don’t get enough precipitation over the winter to cause significant denitrification or leaching. For these soils, topdressing should begin anytime now, and usually the earlier the better.

For wheat grown on sandier soils, earlier is not necessarily better for N applications. On these soils, there is a greater chance that N applied in the fall or early winter could leach completely out of the root zone if precipitation is unusually heavy during the winter. Waiting until closer to spring green-up to make topdress N applications on sandier soils will help manage this risk.

On poorly drained and/or shallow clay pan soils, N applied in the fall or early winter would have a significant risk of denitrification N loss. Waiting until closer to spring green-up to make topdress N applications on these soils will help minimize the potential for this N loss.

Nitrogen should not be applied to the soil surface when the ground is deeply frozen. This will help prevent runoff losses.

* Application method. Most topdressing is broadcast applied. In high-residue situations, this can result in some immobilization of N, especially where liquid UAN is used. If no herbicides are applied with the N, producers can get some benefit from applying the N in a dribble band on 15-18-inch centers. This can help avoid immobilization and maybe provide for a little more consistent crop response. The ideal application method would be to subsurface place the N into the soil.

* Source. The typical sources of N used for topdressing wheat are UAN solution and dry urea. Numerous trials by K-State over the years have shown that both are equally effective. In no-till situations, there may be some slight advantage to applying dry urea since it falls to the soil surface and may be less affected by immobilization than broadcast liquid UAN, which tends to get hung up on surface residues. Dribble (surface band) UAN applications would avoid much of this tie-up on surface crop residues as well. But if producers plan to tank-mix with a herbicide, they'll have to use liquid UAN and broadcast it.

* Rate. Producers should have started the season with a certain N recommendation in hand, ideally based on a profile N soil test done before the crop is planted and before any N has been applied. If some N has already been applied to the wheat crop, it is too late to use the profile N soil test since it is not reliable in measuring recently applied N.

If the wheat was grazed this fall and winter, producers should add an additional 30-40 lbs N/acre for every 100 lbs of beef weight gain removed from the field. For heavy grazing, it may be necessary to make an additional N application in late winter to compensate for N removed by grazing, depending on how much N was applied earlier.

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4. Onsite wastewater treatment system additives

A wide variety of products are advertised as septic tank or onsite wastewater treatment system additives. Limited third-party research studies have been conducted. This research has found no benefit in septic tank function to using any type of septic system additives. In fact, some additives potentially could be detrimental to the function or components of the septic system or to groundwater quality.

In order to better understand the possible negative effects of a biological or a chemical additive, the functions of the system components must be understood.

Components of an Onsite Wastewater Treatment System

The onsite wastewater treatment system is composed of a septic tank and dispersal field. In the septic tank, three layers develop. The bottom layer is the solids (sludge), which settle out in the tank. The middle layer is the partially clarified water, or effluent. The upper layer is comprised of floating scum, including fats, oils, and greases. These materials are lighter than water and float to the surface. Only the effluent from the middle layer should enter the soil absorption field because solids and scum eventually plug the soil pores and lead to slower rates of absorption and potential system failure. Products that may interfere with component function should not be added to the septic system.

Biological Additives

Microbes are an important part of the treatment system because they degrade organic materials and reduce the amount of solids in the tank. Therefore, many biological additives are marketed for the purpose of accelerating this process. One research study, however, found that the use of a biological additive causes excessive decomposition of solids, which leads to overabundant gas production in the sludge layer. As a result, solids can become re-suspended in the tank and transported into the soil absorption system, causing deposits in the pipelines, clogged soil pores, and reduced soil absorption rates. Therefore, additives that cause the septic tank layers to mix should be avoided.

Research has shown biological additives make no significant difference in the microbe population or diversity in a septic tank. Additives are not necessary for “restarting” microbe populations after the tank is pumped, or after the use of harsh chemical products in the home (such as drain cleaners, heavy duty cleaning products, or disinfectants). In a matter of a few days, microbe populations will become naturally re-established after the use of these products.

Chemical Additives

The hazards of chemical additives are potentially more serious than biological additives. Hydrogen peroxide was once thought to have the ability to rehabilitate soil absorption systems by removing organic material that was clogging the soil. However, subsequent studies found that hydrogen peroxide actually destroys soil structure and, thus, shortens the life span of soil absorption fields.

In addition to being dangerous to handle, some chemical additives may contain chemicals that are corrosive to metal and damaging to concrete. Some chemical additives may temporarily kill or sterilize the microbial population of the septic tank, allowing untreated effluent to pass through the tank and into the soil absorption system. Although tree roots cause damage to soil absorption systems and sewer lines, chemicals designed to control tree roots should never be added to the system. Because solvent chemicals are not degraded as they pass through the soil, a solvent-containing additive passes through the septic system and contaminates groundwater.

Conclusions and Recommendations

A properly functioning and well-maintained septic system does not need septic tank additives at any time. In spite of claims and testimonials, research has not proven that additives improve a poorly functioning system. In fact, caution should be taken in using these products to avoid damage to the components or interference with the system function. Rather than spending money on additives, a wiser decision would be to have the septic tank pumped by a professional every 3 to 5 years.

Additional Tips

Avoid using garbage disposals in homes that use onsite wastewater systems, and avoid flushing anything other than toilet paper. Items that are labeled as flushable, such as baby wipes and cat litter, may cause solids to build up in the tank and thus require more frequent pumping of the tank. Also note that certain medications may hinder microbial decomposition, which would also lead to more frequent septic tank pumping. If you can’t remember the last time your tank was pumped (or it has been more than five years), consider calling a local onsite wastewater professional for maintenance and to have your septic tank pumped. Nearly every county in Kansas requires inspection of onsite wastewater treatment systems when property is transferred.

For more information, see *Onsite Wastewater Treatment System Additives,* MF-2877, Kansas State University, February 2009.

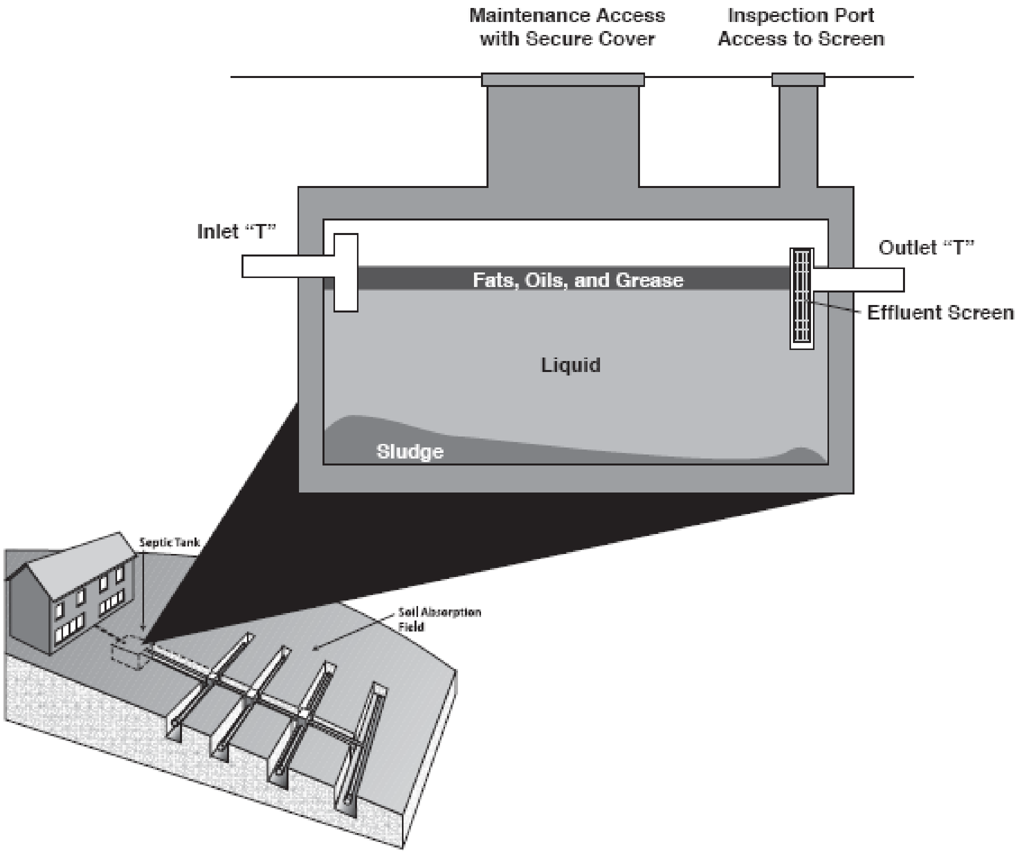

Figure 1. *An important component of most onsite wastewater treatment systems is the septic tank. Notice that waste separates into three distinct layers in a properly functioning septic tank.*

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These e-Updates are a regular weekly item from K-State Extension Agronomy and Steve Watson, Agronomy e-Update Editor. All of the Research and Extension faculty in Agronomy will be involved as sources from time to time. If you have any questions or suggestions for topics you'd like to have us address in this weekly update, contact Steve Watson, 785-532-7105 swatson@ksu.edu, or Jim Shroyer, Research and Extension Crop Production Specialist and State Extension Agronomy Leader 785-532-0397 jshroyer@ksu.edu