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Managing Tall Fescue Toxins with Legumes

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Most folks involved with the forage-livestock industry have a love-hate relationship with tall fescue. On one hand, it is one of the most persistent cool-season forage grasses in Virginia. On the other hand, animals regularly get sick if they consume too much of it. About 90% of tall fescue pastures are endophyte-infected in Virginia, and this toxic fescue probably costs the livestock producers millions of lost revenue every year. The toxicity actually comes from endemic fungus, Neotyphodium noenophialum, that grows inside the fescue plant. This mutualistic fungus produces chemicals (alkaloids) that negatively affect livestock in many ways, often producing a malady termed fescue toxicosis. Alkaloid chemicals make fescue aversive to animals so they eat less. Reproductive problems and increased heat stress are also common symptoms. Even though alkaloids are problematic for livestock, the same chemicals increase the survival of tall fescue plants by making them highly resistant to drought, grazing pressure, disease and insect pests.

Toxic tall fescue can be managed to reduce animal health problems, but it is not easy. Alternative forages are available to replace toxic tall fescue, but pasture renovation is very expensive and often unsuccessful. Some recent research studies point to some new ways to deal with tall fescue. It has long been known that some legumes contain chemicals called condensed tannins. Probably the most familiar legumes here in Virginia are birdsfoot trefoil, Sericea lespedeza, and crown vetch. When consumed by animals, condensed tannins in legumes can bind to proteins like the alkaloids that make tall fescue toxic. In fact, recent evidence suggests that condensed tannins may help detoxify alkaloid toxins, make forage more palatable and help reduce heat stress in cattle. In addition to possible fescue detoxification, tannin-containing legumes also are well known to help prevent bloat and reduce parasite loads in animals. Condensed tannins may even help boost animal immune responses.

So if tannin-containing legumes have all these great benefits, why don’t we see them everywhere? Well, there are several reasons. For one thing, legumes like birdsfoot trefoil and Sericea lespedeza are not easy to manage. Establishing these legumes in pasture is difficult, and managing them once established can be tricky. It is also good to remember that while condensed tannins can be beneficial in modest concentrations, if levels get too high, they can be toxic to animals as well. Complicating matters even more is that fact that condensed tannins are quite variable in their chemical structure. The specific forms, or polymers, of condensed tannins that produce beneficial effects in animals are still not well understood. Nevertheless, if these legumes can help offset the negative effects of the alkaloids in tall fescue, livestock producers could have a “natural” and cost effective avenue for coping with fescue toxicosis. More work needs to be done though, and my research group is beginning work at the Shenandoah Valley AREC at Steeles Tavern to explore questions about tannin containing legumes in pasture.
situations. In the next few years, we hope to shed some light on these interesting legumes and the potential for dealing with fescue toxicity.

Global Positioning Systems, Geographical Information Systems and Precision Agriculture

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Efficiency in agriculture has always been of the utmost importance. Managing inputs has always dictated the financial success of a farm. Precision agriculture is of great interest to farmers, environmentalists, politicians and policy makers, as well as the general public.

The University of Kentucky defines precision agriculture (PA) as “a set of technologies that have helped propel agriculture into the computerized information-based world, and is designed to help farmers get greater control over the management of farm operations” (Gandonou, 2005). By exploring this definition through papers and publications and learning what technologies are currently being used, it is possible to theorize the next step in PA technology.

One difference between precision agriculture and traditional farming is that fields in PA are broken down into “management zones” (Grisso et al., 2014a). Precision agriculture management zones are created based on various factors, such as soil pH, previous yields, pest infestations, etc. Each of these zones have targeted applications and seeding rates in an attempt to maximize their economic value, unlike traditional agriculture which takes a field average and a whole field approach to yield goals.

Virginia Tech claims that PA relies on three points: information, technology and management. With modern technology, farmers can access a breadth of accurate information within a very short time span. This includes information gained from their fields and information available online. Finding, analyzing and, ultimately, using this data is crucial to success (Grisso et al., 2014a).

There are numerous technologies available to aid in a PA operation. Global positioning systems, sensors to monitor soil properties and growing conditions, geographic information systems, variable-rate applicators, and even PCs are all valuable in gathering, organizing and using data (Grisso et al., 2014).

A USDA Economic Research Service study from 2011 showed that 40-45 of corn and soybean acreage was analyzed with a yield monitor (Schimmelpfennig and Ebel, 2014). A yield monitor, usually used in conjunction with a global positioning system (GPS), is a device that provides information on grain flow, grain moisture content, area covered and location (Grisso et al., 2014b). However, despite this wealth of information being collected, that same study also
found that farmers were not using their yield monitors alongside variable-rate input applicators or detailed GPS maps. Variable-rate input applicators can be set to increase or decrease planting rates based on yield success from previous years.

There are two basic types of variable-rate applicators: map based and sensor based. Map based relies on a map created using GPS coordinates and changes the rate of application based on where the planter is located within the field. Sensor based takes input from sensors placed throughout the field that monitor the soil quality and plant health and adjusts the rate accordingly (Grisso et al., 2014a).

GPS is a navigation system created by the United States Department of Defense (DoD). The first satellite was launched into space in 1978 as an experiment, and another ten were launched into space in 1985. Currently, a series of 31 satellites constantly orbit the earth. This is to meet the DoD commitment to have 24 operational satellites in orbit at all times. Based on their spacing and orbital speeds, 9 to 12 of the satellites can be used to triangulate and accurately track any position on Earth at any time (GPS.gov, 2014). These satellites have been maintained and controlled by the United States Air Force since their launching. A master control site, an alternate master control site, 12 command and control antennas and 16 monitoring sites, placed all over the world, track and maneuver the satellites to ensure that they function as planned.

Triangulation uses the properties of triangles to calculate position in three dimensions. By using the time it takes for a GPS receiver to relate it's position to the various satellites, each satellite can calculate the position of the receiver. Four satellites are necessary to determine the position of a receiver (Trimble, 2014). The other satellites that connect to a receiver make the calculations more accurate and can narrow down the location to within a distance of 7.8 meters in a worst case scenario (GPS.gov, 2014b).

The first of these satellites were launched in 1978. These Block I satellites have been slowly phased out since 1985. The Block II satellites we currently have in space are going to start being phased out starting this year. (GPS.gov, 2014c).

A Geographic Information System (GIS) is an excellent way to compile information. By using GIS, one can combine multiple layers of information into a map capable of explaining many problems with a given field. University of Colorado suggests that an exhaustive GIS must include “1. data input, from maps, aerial photos, satellites, surveys, and other source, 2. data storage, retrieval, and query, 3. data transformation, analysis, and modeling, including spatial statistics, 4. data reporting, such as maps, reports, and plans” (Foote and Lynch, 2014). By incorporating all these things, it is possible to diagnose field problems even when travel to fields is not possible. This type of diagnosis should be backed up with field visits to gather more data, but for preliminary theories, it is a very useful tool.

The United States Department of Agriculture Natural Resources Conservation Service (USDA-NRCS) has compiled the Web Soil Survey (WSS). After the user defines an Area of Interest (AOI), the WSS will provide the user with the soil series' in the area, will calculate the acreage of the area, and will even provide the percentage of each soil series in the AOI.
(Delaware Soil Survey, 2014). Delaware, for example, has had 1.3 million acres of soil surveyed throughout the state. (Delaware Soil Survey, 2014).

Variable-rate applicators (VRAs) optimize field inputs. Optimization allows farmers to increase their economic yields. Variable-rate applicators are often controlled through both electronic and mechanical means. The electronic components read the inputs from various sensors and send messages to the parts that control the mechanics of applicator (Grisso et al., 2014c). Seeders and seed drills have their speeds controlled in this manner, increasing seeding rates at traditionally poorly producing areas of the field (Grisso et al., 2014c). Weed control VRA can adjust tank mixtures or even the sprayer nozzles themselves. Electronic boom control can help prevent overlaps in spraying patterns (Grisso et al., 2014c).

Variable-rate irrigation is quite common, especially center-pivot irrigation. There are 150,000 center-pivot irrigation systems in the United States (Anonymous, 2014). They water around 21 million acres of farmland, and if water management can be improved on this acreage, it would greatly aid in protecting our limited water resources. These systems are quite expensive, but government grants have provided farmer's assistance, possibly getting the cost down to around $34 per acre (Anonymous, 2014).

Despite the numerous economic and environmental advantages that PA can provide, the amount of time and technology (money) required to make it a success can be major drawbacks. Drawbacks which must be considered when calculating the economic gains of a field include 1. data collection apparatuses must be kept calibrated, or else the data they provide will become useless; 2. data must be analyzed and stored effectively; 3. another layer of bookkeeping, on top what can be an already crushing amount when running a business, is not always welcomed.

If intensive field management becomes prohibitive based on cost, traditional agricultural methods should be use instead. Consulting with County Extension agents, Extension specialists or ag consultants is an important step to consider. Agriculture is, after all, a business, and intelligent business decisions should always be the end goal of any operation.

Precision agriculture will continue to grow and change in the future as we continue to innovate. Comparing agriculture from 100 years ago to agriculture today shows that in a relatively short time-span, massive change can take place by accepting new research and ideas, and an industry can be made exponentially more efficient and cost-effective as a result. The next 100 years should prove to be an exciting prospect for agriculture.

References


Meeting the nutritional demands of a growing global population has been a problem from the time when man began to walk upright. By the year 2050, the current world population of 7.2 billion will increase by 33.3%, and grow 51.4% to 10.9 billion by 2100 (United Nations, 2013).

The primary issue facing this prolific spike in human expansion is; how do we as a people meet the production level of food stocks necessary to sustain this increase? The key factors in the ability of a community to feed itself are: the availability of arable land, accessible water, and population pressures (Sadik, 1991). Add climate change into this equation and the factors become even more variable. With the increase of global temperature, more arable land will
become arid and more extreme weather patterns will cause more droughts and flooding. While it is more transparent how these two factors will influence food production, the issue of population pressures is not as easily explained. Not only is an increased population present to feed, but an intensifying awareness and criticism of how food is produced and processed is prevalent. The two other factors alongside an increasing human population driving the rise in demand for crop production are the growing affluence of a global middle class’s consumption of meat and dairy, and the use of biofuels (Ray, 2013). A competitive use of agronomic crops has been created by this causing an increase in food costs globally.

The primary focus here will be to increase crop production on existing available crop land to meet the looming food production needs. Two options have been historically used to increase food production. The first is to increase the land available to grow crops. For centuries, man would create more cropland by clearing the existing native cover. This practice destroyed natural ecosystems, degraded biodiversity, and was responsible for drastic releases of carbon stored in forests and soils. With 25% of the earth’s surface regarded as suitable for agricultural production and only half of that arable land being cultivated, the second option widely used today should be put into use on a global scale. To intensify crop production on existing land, high-yielding crops and varieties must be developed and constantly improved. Also, optimum growing conditions must be available through adequate water and nutrients, the reduction of nutrient and water losses, and the control of weeds, insects, and diseases. The soil must also be protected from erosion, compaction, nutrient depletion, and acidification. To try to minimize the effects on climate change, this must be done while accomplishing a reduction in greenhouse gas emissions (Hillel and Rosenzweig, 2013).

During the first half of the twentieth century, Malthusians were vocal on the subject of population control. Webster defines Malthusians as those who relate to the theory of Thomas Malthus that population tends to increase more rapidly than food supply, with inevitably disastrous results unless the increase in population can be controlled. Malthusians of the day were conservationists like Edward East who made his name as a corn geneticist and later preached on a platform of soil fertility conservation as the means to increase food production. Another follower of Malthus was the father of wildlife conservation, Aldo Leopold. He took the idea of human population growth and studied other animal populations. He saw that all lands have a carrying capacity for the life in which they can sustain (Robertson, 2012).

The United Nations Population Division (UNPD) was established in 1946. The main purpose of the division is to monitor global population trends and changes in demographics. The findings of the UNPD are published biennially. In its latest report, the UNPD released the possible population growth through the end of the twenty-first century. A three part variant system is used to determine population growth according to a given population’s fertility rate. The medium variant is the average with high assuming an additional half of a child per woman and the low assuming a half of a child less per woman. The projected global population for 2050 ranges between 8.3 billion in the low variant and 10.9 billion in the high variant, with 9.6 billion the medium variant. Likewise, the low range for the year 2100 is 6 billion, medium 10.9 billion, and the high average being 16.6 billion (United Nations, 2013). With population growths of these magnitudes, it is difficult to foresee feeding the world’s population in the next eighty years with the land and the technology available to feed the current 7.2 billion residents of the planet.
Looking at the potential population increases through 2100, the majority of the increases will occur in developing countries due in part to increasing fertility levels, higher life expectancies, and changes in methodology.

What does all of this mean for agriculture? Global agriculture production needs to double by 2050. The obvious reason for this is the rising population. A shift in dietary habits due to an increasing middle class throughout many developing countries is increasing its protein intake creates a need (Ranganathan, 2013). Also, the escalating production of bio-fuels will aid to the reduction of cropland available for food production.

A study by researchers at the University of Minnesota published in 2013 tracked the global production of corn, wheat, soybeans, and rice. Two-thirds of the earth’s caloric intake comes from these four crops. Two and a half million agricultural statistics where compiled and examined over 13,500 global political units. This research showed the worldwide annual increases in the four crops. Corn yield is currently increasing by 1.6%, soybeans by 1.3%, rice by 1.0%, and wheat by 0.9% per year. While this is progress, in order to meet the nutritional requirements of the world population of 2050, the annual yield increases need to be at a rate of 2.4% or better annually (Ray, 2013).

How will agronomists and farmers be able to grow sufficient food to reach the needs of the population boom by 2050? What has been done historically? Japan was the first country to achieve a steady increase in grain yields in the 1880’s. During the past 6 decades, crop yields have consistently improved. In this period, yield increases replaced the expansion of land available for crop production. Technology allowed the planet’s farmers to increase grain production twofold from 1950 to 1973. Technological advances in fertilization, irrigation, and crop genetics along with economic incentives attributed to this 100% increase. According to Lester Brown (2012), the average world grain yield was 1.1 tons per hectare in 1950, booming to an average world grain yield of 3.3 tons per hectare in 2011. During this 60 year period of time, China and the United States have quadrupled grain yields. The high fertility soils of the Midwest United States accounts for 40% of the planet’s corn and 35% of the world’s soybean production. For example, Iowa produces more grain than Canada and more soybeans than China.

Since the use of a static amount of land over the last 60 years, the productivity of that land has risen. In the span of 6 decades, 93% of grain harvest has come from increasing yields and only 7% from expanding cropping area. Now yields are hitting plateaus. Whether it is rice in Japan and Korea or wheat in the United Kingdom, Germany, and France, yields have stagnated in recent years. Irrigation and fertilization removed constraints on yields. Now photosynthesis, photo period, and climate are the next limitations to overcome (Brown, 2012).

With the stalemate between grain production constraints and static yields mentioned above, climate change could be the straw that broke the camel’s back. Researchers at the Stanford Woods Institute for the Environment have found that for each degree Celsius increase in global temperature, yields will suffer a 4.9% decline (Seaman, 2014). Severe weather, droughts, wildfires, cyclones, and floods may become more frequent. We can expect yields to begin dropping around 2030 with major drops after 2050. In order to make the 2.4% annual yield
increases mentioned above to meet the needs of the population by 2050, new strategies need to be developed and adopted to reduce yield loss.

All over the globe we are seeing losses in production due to environmental issues. Aquifers are being depleted at greater than recharge rates in Saudi Arabia and other Middle Eastern countries. In four decades, Saudi Arabia has gone from zero importing of wheat to 100% importation of wheat. California has lost one million acres of irrigated cropland, from nine million in 1997 down to eight million in 2007. Massive areas of rangeland and cropland in China and Africa have been depleted by over grazing and unsustainable cropping practices. Severe wind and water erosion in addition to this has caused much of this land to be lost to desertification. Dust storms from China are known to shut down areas of South Korea (Brown, 2012).

The future of meeting the nutritional requirements of an exploding population consists of two opposing views. The pessimistic view is one that agricultural resources are incapable of meeting the demands ahead of it. This neo-Malthusian view does not discriminate. It includes wealthy, developed countries at risk of not being able to survive an expected long-term food crisis. It is not supported by facts and is the accepted view of opinion formers and policymakers. The competing optimistic view pleads that the world has adequate reserves of under-utilized cropland and technological advances in crop genetics and land management can increase yields. The optimist uses science and husbandry to increase inputs. All of these changes in food production will need to be made to cope with the challenges of rising energy costs and climate change (Gardner, 2013).

Every day we see issues apart from climate change and expanding population effect the production of our food. Governmental regulations are being passed every year stating how our food can be produced and processed. GMO-free (Genetically Modified Organisms) are selling points for many consumers, as are, hormone free, free range, grass fed, and organic food movements. Science is available to show that some health benefits are present when changing to one of the diets above; food cannot be produced using the above methods at a volume to keep pace with the growing population. Lawsuits are being brought upon by environmental groups to stop agricultural practices they do not agree with.

A most recent case in Maryland: the Waterkeeper Alliance v. Alan and Kristen Hudson and Perdue Farms, Inc., where treated municipal sewage sludge from the resort town of Ocean City, Maryland was being stockpiled for land application on the Hudson farm and was mistaken for poultry litter during a fly over of the property by the Assateague Coastkeeper. The Hudsons were taken to court for violations of the Clean Water Act in a case that took more than three years. The Waterkeepers with deep pockets(Robert F. Kennedy, Jr. is their President and they hold annual star studded fundraisers in Aspen, Colorado) were represented by the University of Maryland Environmental Law Clinic, while the Hudsons nearly lost their farm in a practice becoming known as “Bankruptcy by Litigation”. The judge ruled in favor of the Hudsons and Perdue. The Waterkeepers can appeal the decision. Cases like this one will become normal practice as the use of litigation versus mediation increases.
A local issue currently with global implications is occurring in Delaware. The Harim Company from South Korea purchased Seafood-based poultry integrator Allen Family Foods, Inc. in 2012. The now Allen Harim Foods, LLC is looking to purchase the former Vlasic pickle plant in Millsboro and convert and upgrade the facilities to a new, state of the art poultry processing facility capable of processing two million chickens per week. What started as a NIMBY (Not In My Back Yard) issue has gained legs as an environmental movement lead by the group called, Protecting Our Indian River, who filed a lawsuit against Allen Harim and the Sussex County Board of Adjustment to halt the project (Allen, 2014). This project has had no objections from the Delaware Department of Natural Resources and Environmental Control and has gained support from the Delaware Department of Agriculture. An op-ed article by Barry Goldman (2014), he poses the question of: clean water or more chickens? Pick one. He does not feel that the need for increasing food production for Delaware and South Korea, where much of the poultry will be exported to, outweighs the need to for clean bays and rivers. Nowhere in Mr. Goldman’s article does he mention the residential development which has taken place around Delaware’s Inland Bays over the past three decades and the effects of tremendous amount of storm water and wastewater added into the Inland Bays watershed.

A new phosphorus management tool (PMT) proposed as regulation in Maryland could put Maryland farmers at a competitive disadvantage with other farmers in the region. A study has shown that poultry litter as a nutrient source would not be able to be applied to 80% of soils in Somerset, Wicomico, and Worcester counties on the lower eastern shore of Maryland under the PMT. Poultry litter which is an inexpensive source of nitrogen, phosphorus, potassium, and organic matter, is used in the place of expensive commercial fertilizers on crops such as corn and sorghum. If the PMT is passed, these farming operations will have to change how they operate in regards to nutrient application. And if the farmer grows chickens as well as corn, he or she will now need to find an outlet for the litter he or she produces.

Many factors have been discussed here in regards to feeding an every expanding population. This has not even scratched the surface. The important questions are still unanswered. Will we be able to produce ample food stocks on the currently available land? Will advancements in crop genetics, improved fertilizer efficiency, and improved water use efficiency stay ahead of the booming population? Can we maintain increases in food production in the midst of climate change, energy shortages, and urban pressures?

In November of each year, some of the brightest minds in the agronomic field meet for four days in Ocean City, Maryland for the Mid-Atlantic Crop School. In those four short days, you can see that these scholars are up to the task along with their colleagues from all corners of the globe. So, if the primary issue facing the prolific spike in human expansion is; how do we as a people meet the production level of food stocks necessary to sustain this increase? This question has no easy answer, but we have the correct system and people in place to meet this challenge head on.
References


Driving across the state over the past week, I’ve seen a number of fields with yellowing areas of soybeans. There are a number of reasons for the yellowing to be occurring as we move towards fall so I thought it would be valuable to review them.

In a few fields, early planted and early maturing varieties have already begun the process of maturation where the leaves begin to yellow and drop (Photo 1). This is a natural process and can to some degree be identified through examining the plants for their stage of maturity. For maturation to be the cause of general yellowing, plants should be fully in the R6 stage where the seed fully fills the seed pod located on the upper four nodes on the main stem. This is an ideal time to aerially fly on cover crop seed since the leaves that fall will cover the seed and hold moisture allowing the cover crop seed to imbibe water and germinate.

A second reason for yellowing soybeans was discussed in a recent article in Weekly Crop Update on potassium (K) deficiency (Photo 2). In general, K deficiency can be identified in several ways. Tissue and soil testing are obviously the best way to confirm K deficiency although symptomology is reasonably characteristic in K deficient situations. The symptoms begin on the oldest leaves and move up the plant as the deficiency worsens. Mild symptoms are characterized by yellowing around the outside margin of the leaflets whereas severe symptoms include necrosis or browning of the outside margin with yellowing moving closer to the center of the leaflet. Potassium deficiencies have been seen in both the eastern and western portions of New Castle County, in the western portion of Kent County, and as spots in sandy, irrigated fields in Sussex County this year.
Drought is another explanation for soybean yellowing (Photo 3). In this case, drought conditions can cause the nodules of soybeans to stop functioning and even die and fall off the root system. The nitrogen (N) fixing bacteria are very sensitive to drought conditions. Part of this is that drought causes the plants to close stomates to reduce water loss and this stops the uptake of carbon dioxide and the creation of products of photosynthesis (sugars). Without sugars as a source of energy to keep the N-fixing bacteria functioning, the plant soon runs out of N for building proteins and turns yellow.

Another deficiency symptom often seen in Delaware is manganese (Mn) deficiency which causes the newest leaves to turn yellow although the veins generally remain green (Photo 4). West of Dover, some fields are so low in native Mn that the leaves at the top of the plants appear almost white in color. This differs from K deficiency in that the new leaves are the ones first affected and that the symptom is interveinal chlorosis rather than the marginal necrosis of K deficiency.

During dry weather and in fields with high levels of soybean cyst nematode (SCN), symptoms similar to K deficiency can appear although plants will be much shorter than where the nematode is not as severe. Generally, the symptoms of marginal chlorosis and some marginal necrosis or burning are similar to K deficiency except that they symptoms usually appear on the new growth and not first on the oldest leaves. A nematode soil test can be a good means of confirming SCN as the causal agent. When checking for SCN, you should take the soil sample around the margins of the affected area and not near the center where growth is very limited or non-existent.

Although it is past the time in full-season soybean to apply glyphosate, there still may be some double-cropped fields that are being sprayed with glyphosate to control late-emerging weeds (Photo 5). On occasion, we have seen what some people call ‘yellow flash’ where the upper leaves in a soybean canopy turn yellow for a few days following application with one of the glyphosate compounds or even with glufosinate (Liberty). The exact mechanism
for the problem is not known but may involve interference with Mn uptake and utilization by the soybean plant.

Another possible reason for yellowing spots in a soybean field is the presence of a wet area from too much rainfall or irrigation. In this case if saturated conditions remain for too long, the plant roots will die, the nodules will die and slough off the plants, and the area will turn generally chlorotic or yellow losing many of the leaves originally present. Although you can frequently identify that wet soil is the problem just by the moisture level, you also can dig roots and see that they have died due to anoxia.

Another mid- to late-season reason for soybean yellowing is an infestation of spider mites invading from field edges or grassy spots (Photo 6). Although the actual symptoms might be more accurately labelled as stippling of the upper leaflets the overall appearance as one drives by a field is of yellowing in small areas especially along field edges. Mite injury is typically seen in dryland soybeans during long periods of dry weather. If one examines the leaves carefully, you can see the mite webs especially on the underside of the leaflets and see that the yellowing comes from mite injury to the leaf cells.

Diseases can lead to yellowing in soybean crops as well. An example is sudden death syndrome in soybeans where chlorotic to necrotic lesions appear on the upper leaves and often follow the leaf veins giving the leaves an interveinal appearance (Photo 7). The actual agent is a species of fusarium, a fungus, that infects the plant early in the growing season but produces symptoms after soybeans reach R4 (full pod) or R5 (beginning seed). Usually in addition to the leaf symptoms, many plants die prematurely with few pods remaining on the stems. If the root system or lower stem is examined, a bluish cast can sometimes be identified but for certainty a sample should be sent to your local plant clinic for culturing.

One cause I had not previously considered but discovered looking through my photo files for photos to illustrate some of the above examples is where more than one cultivar but of a different maturity group is planted in the same field. The most extreme case is where the seed of the two
cultivars was mixed together giving the field a very spotty appearance. When the two cultivars are kept separate, a straight line division will be apparent (Photo 8).

I’m sure I haven’t thought of all the possible causes of soybean yellowing, I hope I’ve covered a few of those you might encounter as well as given you some idea of how to confirm the cause of some of the problems. If you can think of other possible causes, feel free to email those to me so we can add to the list.

Distinguishing Active from Inactive Nodules on Soybeans

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At a recent soybean diagnostic field day, our Delaware Extension staff wanted to show photos of active and inactive nitrogen fixing nodules of soybeans but found a lack of web-available photos of inactive nodules. We were able to find both active and inactive nodules on some plants after visiting a number of soybean production fields and would like to share some of the photos we took of the inactive nodules so growers and consultants can more easily determine the status of the nodules on the soybean crop. As soybeans move to the R5 or beginning seed stage of growth nitrogen fixation is critical since the demand for nitrogen (N) to build proteins to be stored in the developing soybean seed is approaching maximum.
Photo 1. Soybean plant at the R3 growth stage from which active and inactive nitrogen fixing nodules were obtained (Photo by R. Taylor).

Photo 2. A small soybean nitrogen fixing nodule shows pink interior color after being sliced open when it is active (Photo by R. Taylor).

Photo 3. A small soybean nitrogen fixing nodule which shows a green interior color after being sliced open is a non-active nodule (Photo by R. Taylor)
Photo 4. Of these four soybean nodules, the two on the left showing pink interior color after being sliced open are active nitrogen fixing nodules but the nodule on the right with a green interior is inactive and the nodule on the lower right side which has a white interior is also an inactive nodule. White interior can also indicate an immature nodule or one that has not begun fixing nitrogen. Not shown but sometimes seen is a nodule with a brown or black interior which also indicates an inactive nodule (Photo by R. Taylor).

Photo 5. The root system of the R3 growth stage soybean plant with an inactive (green interior) nodule is in the center of the photo just to the right of the thumb. A small nodule on another root is appears to be sitting on top of the sliced open inactive nodule (Photo by R. Taylor).

All these photos are great but what can you as a producer do about ensuring good active nodulation for your soybean crop. There are a number of equally important management decisions that can affect nodulation and nodule activity. The following list is given in no specific order of importance as any of the points listed can significantly impact nodulation or nodule activity.

- Manage your soil pH to keep it in the optimum range for your soil type and native fertility levels (especially with respect to manganese availability).
- If a field has been out of soybean production for longer than about three years, use an improved inoculum source when returning to soybean production.
- If a field has never been planted to a soybean crop before such as newly cleared forest land, it is imperative that seed be inoculated just prior to seeding as well as for soil pH to be brought to optimum well before planting soybean.
- Avoid preinoculated, lime-coated soybean seed if possible and apply fresh inoculum (both liquid and dry, graphite- or peat-based, inoculum is available). Although preinoculated and lime-coated forage legume seed is becoming standard in the forage
industry, there have been enough inoculation failures to suggest that producers might be rewarded by going to the extra trouble to apply the inoculum just before planting.

- Avoid manure and commercial N fertilizer applied prior to or shortly after planting since high soil N levels can either delay nodulation or reduce the activity of the nodules so that, when the demand for N peaks during pod development, the nodules are unable to fix enough N to support maximum growth (See Photo 6 and 7).

![Photo 6. Soybean plants from plots that received no nitrogen fertilizer show large active nodules (Photo by S. Tingle).](image)

![Photo 6. Soybean plants from plots that received 100 lb N/acre at planting show many fewer nodules than on plants from the control plots that received no N fertilizer (Photo by S. Tingle).](image)

- Consider using one of the new high efficiency strains of Bradyrhizobia as your inoculum source and apply inoculum to the seed every second or third time you plant soybeans. Many soybean yield trial winners report that they apply fresh inoculum to every soybean crop planted and with the new liquid inoculants the time and expense of applying soybean inoculant is much less than that experienced in the past. Many of the soybean fields in Delaware were found to contain strains of Bradyrhizobia that were either very inefficient at fixing N or actually produced toxins that could reduce soybean yield according to a Delaware Soybean Board project many years ago.
Is It Time to Think about Renovating or Planting a New Pasture or Hay Field? Part 1: The Pre-Planning Process

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Over the years since I first came to Delaware, I have received numerous requests concerning overseeding or renovating pasture and hay fields. Unfortunately, these requests usually come about just before someone wants to actually plant. In reality, producers should begin considering the process as much as a year ahead of the actual time that they want to plant a field. Since our fall plantings of forage crops seem to perform better than spring plantings, it’s a good time to begin a discussion of the process. Often, we find ourselves moving into mid- to late-fall without having taken the time to really consider all decisions that have to go into improving the odds that the planting will be successful. Seed costs alone can equate to more than a hundred dollars per acre in investment expense; and, if we really take into account all the variable costs, a new pasture or hay field can easily represent an investment of hundreds of dollars per acre.

So in the pre-planning process, what’s first? I know many get tired of hearing the phrase but testing the fertility of your soil far ahead of time is still the number one issue. The proper sampling depth is 0 to 4 inches in fields where you will be using a no-till drill to seed the forage and on fields that you do not plan to use deep tillage and have not been applying significant quantities of commercial nitrogen (N) fertilizer. In these instances, you will not be incorporating lime to neutralize acidity from the N fertilizer or incorporating large amounts of phosphorus [P or (P₂O₅)] or potassium [K or (K₂O)] fertilizer. Your expectation is that the soil test will indicate that the soil pH is in the 6.0 to 6.8 range and the P and K levels are in the medium to optimum range. If your expectations do not prove true and the pH is low enough to require several tons per acre of limestone or the P and K levels are low to very low and the fertilizer and lime needs to be mixed into the soil thoroughly, you will need to change plans and consider some type of tillage to incorporate fertilizer and/or lime.

If you have used large quantities of commercial N fertilizer in the past, you really should take both a 0-2 inch depth sample for determining the soil acidity in the upper soil layer as well as a 0 to 4 inch depth sample for nutrient content (phosphorus, potassium, calcium, magnesium and other essential elements). If you are unsure when limestone was last applied to the field, sampling both depths is a good approach since it will provide you with more information about the nutrient status of your field.

The reason for this distinction is that the ammonium or urea N forms that are applied as fertilizer are converted by soil bacteria into nitrate through a process called, nitrification. In this process, the soil bacteria oxidize the reduced form of N and release hydrogen ions that cause the soil to acidify. Since the N is all surface applied, the release of acidity near the soil surface can create a condition known as ‘acid roof’ where the top inch or two of soil is much more acidic than the deeper layers of soil. A second reason involves the very slow movement of limestone
down through the soil. Studies on pastures in Connecticut many decades ago showed that lime moves downward at a rate of about 1 inch per year. Therefore, it takes a very long time to have an impact on the entire rooting zone of the forage grasses and legumes.

In fields where tillage is planned prior to establishing a forage crop, the traditional plow layer sample (0 to 8 inches) for both soil pH (acidity) and essential nutrient status is the appropriate choice. If the soil sample indicates that the soil must be limed, apply the recommended amount of limestone and work it into the soil as soon as possible to allow time for the limestone to neutralize soil acidity before planting time. If the weather after lime application and incorporation remains dry, the limestone will not completely dissolve and neutralize the soil acidity. I recommend that producers take a second soil test before planting in late summer or early fall to determine if any additional lime is needed. Additional agricultural lime and the recommended $P_2O_5$ and $K_2O$ fertilizer as well as any other needed nutrients can be applied and worked into the soil shortly before planting the field.

Everyone asks the question of whether to apply N at the time you plant a new field or seed a field you are renovating. My preference is that you should wait until the new grass is several inches tall and has enough biomass and roots to compete for applied N and store any extra N for future growth. Very small forage seedlings use and need very little N, no more than a couple of pounds N per acre, until they reach 2 to 4 inches in height. Often the residual N from organic matter mineralization during the summer, will supply the small amount of N the seedlings require. Once the forage plants have enough leaf area to capture the sun’s energy and convert it into more plant tissue or into sugars for storage, the demand for N will increase significantly.

When forage seedlings are very small, weeds or current vegetation in renovated fields are likely to be better able to compete with new forage seedlings for N, light, water, and other nutrients. Although annual weeds and/or current vegetation will be present when N fertilizer is finally applied to the new seedlings, the perennial forage seedlings will be in a better competitive position to compete for the components needed for growth and establishment. Summer annual weeds that germinated with the forage crop will be killed at the first fall/winter frost and provide the forage plants with more space, sun, water, and nutrients.

Now that you’ve taken care of any soil fertility issues that can reduce the chance for a successful stand, the next decision involves choosing the right seed to plant. I’ve had the opportunity over the years to read many seed labels on various pasture mixes offered for sale. I understand the convenience of buying a prepared pasture mix and the allure of these mixes. The buyer often assumes that the seller has spent the time and energy studying the issue and has come up with a mixture that in their opinion and experience has the best chance of success. I certainly can’t speak to motivation of the seller but keep in mind that from a business point of view, seed that is mixed and offered for sale needs to be sold over as large an area as possible to justify the expense of wholesaling large quantities of seed as well as blending, packaging, and labeling the seed. In my opinion, this nullifies the expectation that the seller has designed the mix for your particular field or location.

After looking at the species of forages used in the prepared pasture mixes, I find that these mixes are more often a shotgun approach to seeding. A bit of everything is included in hopes that something will establish in all areas of the field. Usually they contain a quick establishing
grass such as annual or perennial ryegrass that can germinate in as little as 5 to 7 days so the buyer can feel comfortable that the new seeding is successful. Horse pasture mixes usually contain the feel-good or highly recognized grasses such as timothy and Kentucky bluegrass along with some orchardgrass and probably an endophyte-free tall fescue to provide more permanent cover. Finally, a legume such as white or ladino clover, red clover, or alsike clover will be in a pasture mix to provide the N-fixing legume everyone wants in a pasture.

The convenience of these mixtures comes from not having to mix them yourself before you fill the seed drill. The allure comes from not having to make a decision other than how much seed per acre to plant and not having to choose individual species to plant. For most buyers, the convenience and allure end up costing them many, many dollars per acre in seed costs for seed of grasses that won’t survive in grazing situations or won’t survive more than a season or two at best or will be unproductive during the middle of the summer grazing season.

So what should you do? I prefer going with a simpler mixture using forage species that are adapted to our region. In most cases, the only species that will survive for many years in our transitional zone climate is tall fescue. Because of endophyte (a fungus growing in some tall fescue plants) issues, many growers have tried the endophyte-free tall fescue varieties and some have had success with keeping a stand for many years while others have seed stands decline or disappear quickly. The newest chapter in this issue has been the development of novel or friendly endophyte tall fescue varieties. The novel endophyte tall fescue varieties do not produce the chemical compound (alkaloids) that interfere with animal performance but still provide benefits to the tall fescue plants helping them survive in many stressful environments. A limitation still in evidence with these new tall fescue varieties is that horse owners who breed horses do not all accept tall fescue as a feed source for their animals. This can limit tall fescue’s acceptance.

What other species can you include in your simple mixture? Orchardgrass is another grass that many producers like to include in a pasture mixture but you should be aware that many orchardgrass fields are failing due to a disease/insect/environment/management complex interaction we’ve been calling orchardgrass decline. If you choose to include orchardgrass, keep it as a small proportion of your mixture. The other grass to include at least on heavier soils and in the northern portion of Delaware is Kentucky bluegrass. Be sure to include several varieties of the Kentucky bluegrass to help with disease resistance. It will be most productive early in the year (early spring to early summer) and mid- to late-fall. Finally, add in a legume to help with providing N for the grass to use as well as to improve the protein and forage digestibility of the pasture. For grazing, most people prefer a ladino-type of white clover. Although slobbers (the animal produces excessive amounts of saliva) is a potential concern with all clovers, it seems to be mostly associated with red clover. Often included in commercially sold horse pasture mixtures, alsike clover is known to cause photosensitivity (sunburn) and sometimes liver injury especially in horses and should not be included in your pasture mix.

One of the new grazing-types of alfalfa should be considered especially by beef producers. These varieties tolerate rotational grazing systems and produce well during the summer period in most years. alfalfa is very deep rooted and can be a great addition to pastures and provide more and higher quality forage in the summer grazing period.
You will find it useful to talk to your seed dealer about the various varieties of each species that are available. Once you decide on the varieties to use and you purchase seed, you can mix your own pasture mix by either purchasing or renting a cement mixer and combining the seed in the proportions you decide are best for your purpose and field. Since many legumes now come pre-inoculated with the N-fixing bacteria and often are coated with a fine limestone, do not over mix the seed and when you re-bag it store it where it is protected from high temperatures and humidity. Stored properly, the seed can be held over the winter if something prevents you from seeding this fall but you should plan to plant as soon as possible after purchasing seed. Not only are the N-fixing bacteria alive; but, if you use a novel endophyte tall fescue variety, the endophyte has a limited storage time (around a year under good conditions) before it needs to be planted. Although tall fescue seed will germinate after longer storage times, the endophyte fungus may no longer be alive. The fungus only lives in the plant and is not soil-borne.

In the next article coming out later this summer, I’ll cover some of the other management issues to consider such as planting date.

**Is It Time to Think about Renovating or Planting a New Pasture or Hay Field? Part II: Planning to Planting**

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In Part I, I covered testing the soil in the field in which you plan to establish a new pasture or plan to do a total renovation and species selection. Depending on how close you are to planting and whether you will be working the soil or planting using a no-till drill, it’s probably time to recheck soil pH and fertility levels in the field to be planted or renovated. The final soil test should be taken approximately 6 to 9 months after the earlier limestone application. This should be enough time for previously applied lime to react with both the active acidity (hydrogen ions in soil solution) and the reserve acidity (hydrogen and aluminum ions on the clay and organic matter cation exchange sites) and the soil pH to be reaching an equilibrium state. In this way if another smaller application of limestone is needed to move the soil pH slightly higher, the lime can be applied and worked in the soil, assuming some type of tillage for incorporation of the limestone. In no-till situations, the process of adjusting the soil pH takes much longer and should be started as much as two or three years in advance of seeding or renovation since lime moves downward through the soil at about one inch per year.

Now that the soil fertility requirements have been completed, it’s on to the planning and planting process. One of the biggest challenges these days, especially if you have a small number of acres in the field, is finding someone with equipment the right size to fit the field and a willingness to do the job in a timely fashion. Of course even if you’re lucky enough to find the equipment and operator, cost is going to be a critical factor when making the decisions of what
parts of the plan are actually doable. Another factor that has become more of a challenge in recent years is the availability of forage seed of the selected species and variety. Many forage seed production fields have been converted to row crop production and in some locations restrictions on burning seed production fields have allowed disease issues such as ‘choke’ to reduce forage seed yield potential.

In planning the whole procedure, your time will be a valuable asset. With high prices, limited seed supplied, and challenges in finding equipment and help to fertilize, lime, control weeds, and plant seeds, the time you take to shop around should pay big benefits. July and August are the time to do these chores since the fall planting season is right around the corner.

For planting date, forage agronomists often list from mid-August through September as being the time to plant as long as soil moisture is adequate. Soil moisture for many hay producers and grazers in the state and region really will be at critically low levels for much of August. This can extend late into September due to the drought and hot weather conditions we usually experience during July and August. With all our pre-planning and planning activities, the final decision on when to plant and even whether to plant on time will be determined by the weather conditions during August and September. You may be tempted to plant as soon as the field receives the first rainfall in the planting window but you should keep in mind that if the deeper layers of soil are deficient in moisture the new planting will likely fail if fall turns dry. Use a shovel or your soil probe to test the soil for moisture at the 6 to 12 inch depth. If the field hasn’t received enough rainfall to supply this soil depth with at least some water, a new planting will be very much at risk if rain events do not continue from planting until winter dormancy takes hold. Only you know the amount of risk you are willing to take to establish the new seeding this season and none of us know what the future weather will be.

What if enough rain to supply water to the deeper soil layers doesn’t fall until very late in September? Certain species, such as low alkaloid reed canary grass, require a specific amount of time between planting and first frost (six weeks minimum for reed canary grass) but almost all species will not only yield less the following year but take a lot more time to reach full establishment if planted late. Again, the hay producer or grazer must evaluate the amount of risk they are willing to take on when deciding to plant after September.

You should maintain frequent contact with your fertilizer/lime dealer, seed dealer, equipment supplier, and others who will be helping you with the process of planting the new pasture or hay field. If you will be using equipment provided through the county conservation districts, be sure to get your name on the list as early as possible since many folks may want to seed about the same time when moisture conditions become favorable.

What’s the best means of seeding fields, no-till or conventional tillage (a prepared, weed-free, firm seedbed)? As with any choice, there are advantages and disadvantages to each method. Both seeding methods allow for weed control activities before seeding but no-till is limited only to herbicide applications. Whenever deciding on an herbicide to use, read the label carefully to be sure there are no rotation restrictions of what can be seeded following the herbicide application or how many days or months must separate the application and seeding activities. Also use the label to determine if a single application will be all that is needed or
whether you will need follow-up applications and if you will at what stage of growth must the
new seedlings reach before the next application is applied. This latter concern is especially
important for perennial and hard to kill weeds such as hemp dogbane, Canada thistle, horsenettle,
and others.

No-till drills must be calibrated properly to deliver the correct amount of seed per acre as
well as be set to place the seed at the correct seeding depth with adequate soil to seed contact for
fast germination and emergence. Never assume that the last person to use the drill set it up
properly for your seeding. When you spend a hundred or more dollars per acre just for seed, you
need to be sure the seed is being planted as best as possible to ensure a successful establishment.
No-till drills also place the seed in rows usually from 7 to 10 inches apart so it often is useful to
cover the seeded area in two directions making a cross hatch pattern over the field to help the
plants fill in the space quicker. Brillion seeders that broadcast seed over a prepared seedbed and
then press the seed into the soil have the advantage of achieving canopy closure much sooner
than no-till seeding.

Canopy closure is when the new plants get large enough that they are able to shade the
underlying soil and therefore reduce the ability of weeds from germinating and establishing in
the field. Fields seeded with no-till drills can be many years (if ever) filling in so that a full
canopy exists during normal grazing activity. This is one disadvantage to the no-till drill
although it is offset by the soil conservation advantage of no-till when a field has enough slope to
allow significant water erosion or enough exposure to allow wind erosion problems if the
weather turns dry again.

Which method is best? Since each has both advantages and disadvantages, it will depend on
your situation. No-till helps conserve the soil in situations where soil can be loss; it reduces
moisture loss since the soil is not disturbed; it doesn’t encourage new weed growth since buried
weed seeds are brought to the surface; it does not introduce oxygen into the soil causing the soil
organic matter to be reduced via oxidation; and when done correctly it ensures rapid germination
and emergence since seeds are placed in the soil and soil is firmed around the seeds. From the
negative side, no-till does not allow nutrients and lime to be worked into the soil profile; no-till
does not help break up compaction issues from previous grazing or haying equipment use; and
no-till seeding is often in rows that can be seen for years in some cases.

Conventional tillage does allow nutrients and lime to be incorporated in the soil; it allows
tillage during the summer to help with weed control issues; it allows for the summer
establishment of annual smother crops for weed control and to introduce organic matter into the
soil; it allows you to rip fields to help alleviate compaction issues; and it allows seed to be
broadcast to ensure rapid canopy closure. Some of the disadvantages include the loss of soil
moisture during the tillage operation as well as the loss of soil organic matter during tillage. The
above lists of advantages and disadvantages are not meant to be exhaustive but to point to some
of the important factors you should consider when deciding on seeding method.
Renovating or Planting New Pasture or Hay Field? Part III: Planting the Crop

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In the earlier sections of this article, I discussed some of the decisions and planning that need to be taken ahead of planting hay and pasture fields. For this article, we have entered the ideal planting time for forage grasses and legumes. However although we are in the ideal window for planting, there will be areas that have received enough rainfall to recharge the topsoil with moisture as well as areas that have not received enough rainfall for a successful seeding. For those areas that remain dry until mid- to late-October, the best decision is likely to postpone planting until next year.

Some species have specific requirements that limit how late in the fall you can plant. For example, reed canarygrass requires at least six weeks between planting and the average date of the first frost; otherwise, the crop could be winterkilled or severely weakened over the winter leaving the crop unable to compete with the usual spring flush of weeds. Other species, such as Kentucky bluegrass, just take a very long time (21 to 28 days) to germinate and should not be planted late in the fall. Before deciding to plant a species or mixture, be sure to study the species in question to avoid missing the ideal planting window.

In areas that have received enough rainfall to replace soil moisture reserves, planting can begin. Early planting can lead to well established forage seedlings that are able to survive winter temperature extremes and get off to an early vigorous start next spring. Early planted stands are better at competing against weeds next spring and often produce higher yields as well. Work by Dr. Marvin Hall at the Pennsylvania State University showed significant yield decreases for all forage species tested as the date of fall planting was delayed with higher losses occurring the further north the site was located.

If planting into a prepared or tilled seedbed, be sure that all weeds have been killed during soil preparation and that a good smooth (clod-free), firm (your shoe should not sink deeper than the sole level) seedbed is prepared for planting. Seed is then broadcast on the seedbed and firmed or pressed into the soil with any number of devices. Seed of small seeded forages should not be buried more than 1/8 to ¼ inch deep. Covering the seed is ideal since seed in contact with moist soil readily absorbs water but is not quickly dried again by the heat from the sun. Seed can also be planted using a Brillion seeder followed by a cultipacker or roller or seed can be placed in the soil using a drill with packing wheels that firm soil over the seed.

Since drills (no-till and conventional drills) place the seed in rows from 4 to 8 inches apart, depending on the drill, I generally recommend that you drill at half the recommended seeding rate and run the drill twice over the field at about a 45 degree angle. This will help new seedlings to cover the soil surface more quickly and reduce the chances for weed seed to germinate and compete with the new forage crop.
Another method of seeding is to use a no-till drill following an herbicide burn-down program. This is especially useful when perennial weeds with underground rhizome systems are present. Examples of these weeds are hemp dogbane, Canada thistle, and horseradish. Often several herbicide applications will be needed to get these weeds under control so plan a weed control program well ahead of seeding. One of the best times to apply a translocated herbicide is in fall when weeds are sending carbohydrates (sugars) down to underground storage organs (rhizomes). If a systemic herbicide that can move inside the plant is used, it will be taken with the sugars down to the rhizomes and help kill the meristem buds that are next year’s growing sites for the weed. Read the herbicide label for the exact interval between treatment and seeding. Generally for Roundup® or glyphosate you should wait several weeks after herbicide application before planting. Since the herbicides used for control of these perennial broadleaf weeds will kill legumes that often are included as a component of pasture mixtures, it is best to work on controlling these weeds a year or two before spending the money to establish a new seeding or to renovate an existing stand.

In all cases I’ve talked about, be certain to calibrate your seeding equipment and make sure the drills and other equipment are clean and functional before entering the field. These days forage seed is quite expensive so make the most of the money you spend by accurately calibrating your equipment. This involves the following procedure: weigh out some seed to add to the planting equipment, determine the width of area covered with seed by the equipment (in feet), run it for a certain number of feet (the length—say 50 or 100 feet); multiplying the two numbers together to get the number of square feet covered by the seed; divide that number by 43,560 (number of square feet in one acre); and finally weigh the amount of seed remaining in the equipment. Subtract the final weight from initial weight and divide that number by the number of acres you covered (usually this will be a number such as 0.15 or even 0.015 or other very small number). If your seed weights were in pounds of seed then the number you calculate at the end will be in pounds per acre or if you had access to an egg scale or something that measures in grams then divide the number of grams of seed used by 454 (grams per pound) to obtain pounds of seed and then divide that number by the number of acres planted in the calibration test. If all else fails, email me or give me a call and I’ll help you do the calculations.

In summary, I’ll list some of the key points to keep in mind.

- Make adjustments to soil fertility well in advance of seeding or renovating.
- Have all perennial weeds under control before establishing a new seeding or conducting a major renovation in a field.
- Monitor soil moisture levels to be sure an adequate reserve of soil water is available to establish the crop.
- Understand the requirements for the forage specie or species chosen especially as it relates to fall planting date.
- Start with a weed-free seedbed whether for conventional tillage or no-till.
- Unless the site is known to be very low in available soil nitrogen (N), allow the new seedlings to develop 2 to 3 leaves before applying N in the fall.
- Don’t delay planting; try to hit the optimum planting window.
- Ideally, cover the seed with just a little soil but at the very least press the seed into the soil to ensure good soil to seed contact.
Most seeding rates really refer to the numbers of pure live seed (viable potential seedlings) that should be planted per acre so do the proper calculations to plant the correct amount especially when using coated seed.

If using preinoculated, lime-coated legume seed as a component of the pasture/hay mix, you should check to be certain the seed has been stored away from heat and high humidity and is not more than a year old, otherwise fresh legume inoculant should be applied to the seed just prior to planting.

Many small seeded species now come with a range of coatings (lime, moisture control compounds, etc.) that can halve the weight of pure live seed in the container so you should be sure to account for this when calculating the correct seeding rate.

In the last article of this series, I’ll discuss how to manage new pasture and hay fields for long-term healthy stands.

Renovating or Planting New Pasture or Hay Field? Part IV: Managing Pasture and Hay Fields for Long-term Health

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In Part III, I discussed the advantages of planting into moist soil during the ideal planting window for the selected forage species. I then discussed the planting options such as conventional seedbed preparation and no-till seeding. Along with these options, I discussed the need for calibration of the planter or drill to ensure the use of the proper number of pure live seed (PLS) per acre. Let us assume that the new planting has emerged from the soil so it is time to think about how to properly manage the new seeding to ensure a successful establishment and long-term productivity.

Usually even before the seed germinates, grazers want to know when they can return animal to the pasture to graze it. Hay producers have an easier time deciding when to begin using a new field especially for fall planted fields since cool-season grasses will signal their successful establishment by flowering in late spring or early summer the year following seeding.

For new pastures, the key to long-term health of the pasture is to wait about 12 to 18 months before grazing a new field. This means that the new pasture will need to be hayed at least once and possibly several times in the year following fall seeding. From a practical viewpoint, few grazers will wait 12+ months since it means not grazing the field until the second spring following fall seeding. At a minimum, a new fall-seeded pasture should be hayed in late spring or early summer the year following seeding and then allowed to regrow to a height of 8 to 12 inches before grazing is begun. It is possible to plant in the fall and begin grazing first thing the following spring but you will be sacrificing stand health and longevity with this practice.
Nutrient management plans call for a new soil test once every three years but a yearly sample will help the grazer manage the pasture better. This is very important if nitrogen (N) fertilizer inputs are used to stimulate the productivity of a pasture. Even without N fertilizer applications, the natural deposition of urine and feces in a pasture creates small areas where the process of nitrification produces acidity that can significantly lower soil pH in the small area. Higher stocking rates and intensive pasture rotations will result in more uniform spreading of the urine and feces (especially for ruminant animals); and therefore, a greater proportion of the pasture will be impacted by lower pH (more acid soil conditions). Since it can take a year for lime to move an inch down through the soil, yearly soil testing will allow the grazer to begin neutralizing soil acidity as it is produced by the soil N-cycle.

Another aspect of soil fertility to consider is the use of fall applied N to improve the rooting of pasture plants as well as help stimulate growth the following spring for early grazing. Although the practice has long been used in the turfgrass industry, those of us in forage management are just realizing the potential benefits to pastures of fall N applications. Small amounts of fall N (about 30 lbs N/acre) should be applied in mid-October and mid-November since at these times topgrowth has ceased but the deep soil layers are still relatively warm. The N stimulates further root growth creating pasture plants with deeper and larger root systems as they enter the winter period. Some of the N is stored in the plant and available to stimulate topgrowth the following spring as the hours of daylight increase and air temperatures warm. This type of fertilization makes for a stronger plant going into the summer months (greater rooting depth and therefore greater available soil water to draw on) and can improve the competitiveness of the pasture grasses against weeds.

Probably the number one key to maintaining the health and competitiveness of a pasture is to use rotational grazing where plants are allowed to fully recover from the prior grazing period (grow to a height of 8 to 12 inches or more) and the grazing interval is kept short enough that the same plants are not grazed over and over again during a rotation cycle. Generally, this means rotating livestock out of a paddock or grazing cell within three days of moving the animals into the paddock. This time can be stretched to as much as a week but the more rapidly the animals are moved among paddocks in the rotational grazing scheme the healthier the pasture. Another aspect to using rotational grazing is to not put animals on pasture when soil conditions are too wet when the presence of animals can lead to compaction issues. Not grazing when plants are under drought stress is also a key consideration. Use the extra forage produced during the spring and fall to make hay that can support animals on a heavy use pad during periods of wet weather, drought, or other conditions leading to poor pasture growth.

Another method used to maintain healthy and vigorous pastures is to periodically overseed pastures in the fall with grasses and/or legumes. Some producers do this every year while others do it every couple of years. In most cases, the new seedlings must compete against the established plants in the pasture so that there is often limited ‘take’ from the germinating seed. However in the weaker areas of the pasture stand, there will be more light, water, nutrients, and space for the seedlings so establishment will be better in these areas. The weak areas would be where weeds could become established but by overseeding the pastures weed encroachment is limited or prevented.
The species to use for overseeding should be those species that can grow rapidly especially in the cool conditions of late summer and early fall. This would include such species as the ryegrasses, festulolium, ladino white clover, and red clover. Although just broadcasting the seed over the surface and then using a chain harrow or other implement to slightly cover the seed has been used, the best seeding method is to use a no-till drill and drill the seed into the soil. Seeding rates typically used are about one-quarter that of a normal new pasture seeding rate since most of the seed will be planted where established plant competition will not allow the new seedlings to establish successfully.

Finally, the producer can manage the balance of legumes and grasses in the pasture by his/her fertilization practices. Potassium and phosphorus applications along with 1 to 2 lbs of boron per acre per year and maintaining a near neutral soil pH (6.5-7.0) will encourage legume growth. If the percentage of legume is too high and the risk of bloat is too great, N application to encourage grass growth can be used to lower the percentage of legume in a pasture. Grasses with their fibrous root system are much more competitive for applied N than are the tap-rooted legumes. The available N will stimulate the grass and help it shade the legumes as well as change the proportion of legume to grass biomass.

**Notices and Upcoming Events**

**November 7-8, 2014**
11th Annual Small Farm Conference, University of Maryland Eastern Shore Richard A. Henson Center, Princess Anne, MD. Contact University of Maryland Extension at the University of Maryland Eastern Shore at (410) 651-6070 or mce@umes.edu for registration or more information.

**November 18-21, 2014**
Mid-Atlantic Crop Management School, Ocean City, MD. Contact either Bob Kratochvil by email at rkratoch@umd.edu or Richard Taylor by email at rtaylor@udel.edu.

**January 12-15, 2015**
Delaware Ag Week, Delaware State Fairgrounds, Harrington, DE. Contact either Dr. Cory Whaley at whaley@udel.edu or Dr. Richard Taylor at rtaylor@udel.edu.

**March 11-12, 2015**
Northeast Pasture Consortium, Waterfront Place Hotel and the Greater Morgantown Conference & Convention Center, Morgantown, WV. Contact James Cropper at jbcropper@yahoo.com for more information.

**March 13-14, 2015**
2015 Appalachian Grazing Conference, Waterfront Place Hotel and the Greater Morgantown Conference & Convention Center in Morgantown, WV. Contact West Virginia University Cooperative Extension for more information.
Newsletter Web Address

The Regional Agronomist Newsletter is posted on several web sites. Among these are the following locations:

http://www.grains.cses.vt.edu/  Look for Mid-Atlantic Regional Agronomy Newsletter

or

www.mdcrops.umd.edu  Click on Newsletter

Photographs for Newsletter Cover

To view more of Todd White’s Bucks County photographs, please visit the following web site:

www.scenicbuckscounty.com