Mid-Atlantic Regional Agronomist Quarterly Newsletter

JUNE 2014

Dr. Richard W. Taylor, Editor
rtaylor@udel.edu
University of Delaware

Supporting Agronomists:
Dr. Wade Thomason, Va Tech
Dr. Bob Kratochvil, University of Maryland
Dr. Greg Roth, Penn State
Dr. Peter Thomison, Ohio State University
Dr. Chris Teutsch, Va Tech

To subscribe or unsubscribe, please send your request to the editor at rtaylor@udel.edu
Comments, suggestions, and articles will be much appreciated and should be submitted at your earliest convenience or at least two weeks before the following dates: February 28, May 30, August 30, and November 30. The editor would like to acknowledge the kindness of Mr. Todd White who has granted us permission to use his scenic photographs seen on the front cover page. Please go to www.scenicbuckscounty.com to view more photographs.
Contributors for This Issue

Ms. Megan Smith, UD

Mr. Pete Steimer, DuPont Crop Protection, Herbicide Discovery

Dr. Chris Teutsch, Va Tech

Dr. Bob Kratochvil, UMD

Dr. Wade Thomason, Va Tech

Mr. Steve Gulick, Va Tech

Ms. Elizabeth Hokanson, Va Tech

Mr. Bobby Clark, Va Tech

Mrs. Holly Walker, UD

Mr. Travis Burk, UD

Dr. Richard Taylor, UD
## Table of Contents

**Issue 9; Number 2**

Contributors for This Issue ............................................................................................................. 2
Table of Contents ............................................................................................................................ 3
Advances in Silage Production ....................................................................................................... 5
  Planting the Silage Crop ............................................................................................................. 5
  Growing Silage ........................................................................................................................... 7
  Harvesting the Silage Crop ......................................................................................................... 8
  Storing ....................................................................................................................................... 10
  Feeding Silage ........................................................................................................................... 10
How Management Practices Affect Herbicide Resistant Weed Populations ................................ 12
Summer Annual Grasses: High Quality Summer Grazing!!! ....................................................... 16
Nitrate and Prussic Acid Poisoning in Summer Annual Forages ................................................. 19
Establishing Small Grains with Vertical Tillage .......................................................................... 20
  Procedures in 2011-2012 .......................................................................................................... 21
  Procedures in 2012-2013 .......................................................................................................... 21
  Results....................................................................................................................................... 22
    Stand Establishment – Fall 2011 ........................................................................................... 22
    Stand Establishment – Fall 2012 ........................................................................................... 23
    Grain Yield 2011-2012 ........................................................................................................... 24
    Grain Yield 2012-2013 ........................................................................................................... 25
    Biomass Production .............................................................................................................. 26
Small Grain Forage Variety Testing in Virginia, 2014 ................................................................. 27
  Introduction ............................................................................................................................... 27
  Management and Weather ........................................................................................................ 27
  Results....................................................................................................................................... 28
Observations of Management Practices and Their Effect on Corn and Soybean Damage Due to Slug Feeding .......................................................... 30
  Situation ................................................................................................................................. 30
  Method .................................................................................................................................... 30
  Results....................................................................................................................................... 31
  Summary/Conclusions .............................................................................................................. 34
  Acknowledgements .................................................................................................................. 35
Genetically Modified Crops and their Effect on Crop Production ................................................. 35
The Green Revolution .................................................................................................................. 41
Establishing and Managing Bermudagrass for Pasture and Hay ................................................. 44
  Variety Selection ..................................................................................................................... 45
  Planting Bermudagrass ............................................................................................................ 46
    Sprigging ............................................................................................................................... 46
    Planting Long Hay, Fresh Material, or Tops ......................................................................... 47
    Seeding ................................................................................................................................. 48
  Weed Control ......................................................................................................................... 49
<table>
<thead>
<tr>
<th>Notice or Event</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Notices and Upcoming Events</td>
<td>50</td>
</tr>
<tr>
<td>2014 Annual Forage and Livestock Field Day</td>
<td>50</td>
</tr>
<tr>
<td>Pasture Poultry Training Session for Extension Professionals (Aug 1) and Farmers (Aug 2)</td>
<td>50</td>
</tr>
<tr>
<td>Valatie Research Farm Field Day: New Tools – New Rotations</td>
<td>51</td>
</tr>
<tr>
<td>Soybean Diagnostic Field Day</td>
<td>51</td>
</tr>
<tr>
<td>Mid-Atlantic Crop Management School</td>
<td>51</td>
</tr>
<tr>
<td>Delaware Ag Week</td>
<td>51</td>
</tr>
<tr>
<td>Newsletter Web Address</td>
<td>51</td>
</tr>
<tr>
<td>Photographs for Newsletter Cover</td>
<td>51</td>
</tr>
</tbody>
</table>
Silage production began over 1,500 years ago in Egypt and spread to the rest of the world, eventually appearing in America in 1876 (Mannetje, 2002). The method of ensiling green plants was a way to preserve forages for livestock (predominately ruminants) and allow for high quality feed consumption all year round. There are many types of forages that can be ensiled, including legumes, grasses, and other cereal crops. However, the most common type is corn silage due to its high energy and neutral detergent fiber (NDF) content and its low acid detergent fiber (ADF) content (Table 1).

<table>
<thead>
<tr>
<th>Crop</th>
<th>Crude protein</th>
<th>Total digestible nutrients</th>
<th>Calcium</th>
<th>Phosphorous</th>
<th>ADF</th>
<th>NDF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barley</td>
<td>14.1</td>
<td>53.0</td>
<td>0.46</td>
<td>0.32</td>
<td>37.7</td>
<td>46.7</td>
</tr>
<tr>
<td>Wheat</td>
<td>12.5</td>
<td>57.8</td>
<td>0.30</td>
<td>0.27</td>
<td>38.7</td>
<td>58.4</td>
</tr>
<tr>
<td>Oats</td>
<td>12.5</td>
<td>49.0</td>
<td>0.37</td>
<td>0.26</td>
<td>38.7</td>
<td>58.5</td>
</tr>
<tr>
<td>Alfalfa</td>
<td>26.1</td>
<td>58.6</td>
<td>1.54</td>
<td>0.24</td>
<td>26.1</td>
<td>33.5</td>
</tr>
<tr>
<td>Clover</td>
<td>16.2</td>
<td>58.1</td>
<td>1.28</td>
<td>0.22</td>
<td>36.1</td>
<td>43.6</td>
</tr>
<tr>
<td>Corn</td>
<td>8.34</td>
<td>68.2</td>
<td>0.20</td>
<td>0.23</td>
<td>28.6</td>
<td>50.5</td>
</tr>
</tbody>
</table>

*Source: Crops for Silage Production, 2010.

Today the production of silage occurs worldwide. Since the discovery of the ensiling process, people have been trying to manipulate this method to decrease dry matter loss and retain the most or increase available nutrients (Davies et al., 2005). This has caused a huge rise in advances in silage production, which can be quantified into five main aspects: planting, growing, harvesting, storing, and feeding (Figure 1).

**Planting the Silage Crop**

The first step of silage production is the process of planting the crop. Even before the seed hits the soil, there are a number of factors that have been developed and countless hours of research dedicated to helping that seed grow. For example, the use of biotechnology in the development of seed has increased dramatically, leading to a wide assortment of hybrid seed varieties specifically designed for silage production (Manhanna, 2013). Although hybrids have been available for a number of years, they continue to improve, gaining more beneficial characteristics. The hybrid seeds are genetically altered and specifically designed for silage production to improved yield and standability, longer seed fill, increased tolerance to higher populations, decreased seed protein content, increased resistance to pests, and increased tolerance to various stresses (Bittman and Kowalenko, 2004).
There is a number of leading seed distributors, each with their own unique view on the future of hybrid selection for corn silage production. For example, Monsanto’s “research is focused on identifying traits for insect and disease resistance, herbicide tolerance, enhanced food characteristics and processing quality that can be used to improve crops” (Bittman and Kowalenko, 2004). They are also “working within the existing genome of the corn plant to identify genes and genetic combinations that enhance yield and performance through improved drought and cold tolerance, disease resistance and yield,” as well as identifying and incorporating the stay-green characteristic and bm1, bm2, and bm3 genes for brown midrib corn (Bittman and Kowalenko, 2004).

Secondly, another leader in seed biotechnology, Mycogen, is looking toward hybrids which are known for high yield and increased cell wall digestibility, which will lead to higher dry matter and total nutrient intake, in addition to the ability to utilize higher forage diets (Bittman and Kowalenko, 2004).

Finally, Pioneer Hybrid proudly produces seed that will produce silage that is of excellent quality and has outstanding agronomic stability by utilizing relatively recent innovations like associative breeding and transgenic technology (Bittman and Kowalenko, 2004). Table 2 summarizes a few of the hybrid varieties of corn seed for silage production available from Monsanto, Mycogen, and Pioneer Hybrid.

Additionally, the use of hybrids and other genetic modification has allowed the ecosystem of the corn plant to be modified. This modification of the environment has led to higher populations, narrower rows, and earlier planting dates, which have allowed for increased population density (plants per acre or ppa) and longer growing seasons.
Table 2. Hybrid varieties of corn seed for silage production available from Monsanto, Mycogen, and Pioneer Hybrid.


Growing Silage

The second step of silage production is growing. Two advances of the growing phase are high nitrogen (N) application and increased weed and pest control. Both of these can be attributed to various factors that occur at planting as well. For instance, prior to planting, a soil test should be conducted to not only test pH of the soil and other factors, but to also examine the N concentration as well. According to Davies (2004), “Nitrogen supply is particularly critical, too much and the silage produced is likely to have a high ammonia and butyric acid concentrations; too little and yields and crude protein content could be poor.” It is with this importance that researchers have developed management tools and recommendations to increase N efficiency and ensuring appropriate application rates. For example, as stated by researchers at Penn State, it is best to “delay application of the nitrogen until the corn is between 10 and 20 inches tall. If the field has a history of manure and/or legumes, delay all of the N. If there is no history of manure and/or legumes, split the N, applying one-third near to planting and delaying the balance. Adjust this recommendation for any previous legume in the rotation and for residual N from previous manure applications. The PSNT or chlorophyll meter test can be used to refine N recommendations for corn, especially where manure is major nutrient source.” (Penn State Extension, 2013). Penn State Extension (2013) has also created a flow chart to better explain this management scheme (Figure 2). In addition to N recommendations, there are additional recommendations for various other minerals.

However, one downfall to increased N and other mineral application is an increase in competition from other plants (weeds), which can also lead to increased incidence of pests (insects). As discussed previously in the planting phase section, various selections of hybrids allow farmers to choose plants which are resistant to pests (Round-Up Ready™) or resistant to certain types of insects. A combined strategy incorporating monitoring, cultural controls, mechanical or physical controls, biological controls, host plant resistance, and chemical control tactic advances has aided in helping to increase both weed and pest control in the field.
**Harvesting the Silage Crop**

The third step of silage production is harvesting. One of the major advances of this stage of silage production is technology. Three leading tractor and equipment manufacturers—John Deere, Case International, and New Holland—have developed new and innovative ways to improve the harvest of fresh crops to be used for silage. For example, John Deere has developed the John Deere HarvestLab™ and Constituent Sensing module. This piece of equipment can be mounted to John Deere Self-Propelled Forage Harvesters, or it can be disconnected and used as a stationary unit nutrient analyzer (John Deere, 2014).

The John Deere HarvestLab™ allows the farmer to “determine the content of several quality parameters simultaneously in various crops and organic matter” (John Deere, 2014). Near infrared (NIR) technology is used to obtain real time, precise measurements, for dry matter as well as other constituents such as starch, protein, ADF, and NDF. Data is collected 17 times per second continuously throughout the field, allowing the farmer to gather information from a huge sample size and improve harvest times depending on crop conditions. Furthermore, this feature allows farmers to know exactly how many tons of dry matter is harvested and the nutrient composition of the crop, allowing fertilizer usage to be adjusted, leading to cost savings (John Deere, 2014).

The John Deere Constituent Sensing takes information gathered from the HarvestLab™ feature and automatically adjusts silage additives depending on the dry matter and starch content of the crop. This allows for less spoilage and higher silage quality during storage and at feed out (John Deere, 2014). Finally, with the option to remove the module, the John Deere HarvestLab™ and Constituent Sensor acts as a portable feed ration analyzer, allowing the farmer...
to test forages for nutrient composition as much and as often as he or she wants, improving “ration accuracy and ration cost effectiveness” (John Deere, 2014).

John Deere, Case International, and New Holland are also leading the way with improved forage harvesting equipment. Their forage harvesters allow for smooth and even feeding of the crop via multiple power-driven feed rolls. They have more uniform chopping and kernel processing, allowing for increased feed input and decreased fuel and power requirements.

Additionally, the harvesters have a built in knife sharpener and adjustable shearbar. There are also multiple choices for length of cut, allowing for precise and exact lengths desired.

Forage harvesters are also equipped with electronic metal detectors, which quickly stops the machine by reversing the gear output drive, stopping the feedrolls, and shutting power off to an electric clutch on the gearbox and shifts it into neutral, stopping power to the whole feedroll system. The feedroll control switch can then be used to back the material out of the harvester, saving equipment from being broken and cattle from eating pieces of metal (John Deere, 2014; Case International, 2010; New Holland, 2006).

Finally, global positioning systems (GPS) have been added to many pieces of equipment, allowing the tractors to essentially harvest the crop for the farmer with minor effort. Although many of these factors are not recent technologies, they continue to be improved, allowing for more efficient and profitable harvesting.

The most recent innovation in the corn silage world, developed by dairy nutritionists is “shredlage”. Shredlage is defined as “longer cut corn measuring 26 -30 mm theoretical length of cut (TLC) with the stalk ripped length wise into planks and strings allowing for improved effective fiber, better packing, and greater exposure to the inner cells of the plant” (Shredlage, LLC, 2014). Shredlage will supply more physically effective fiber (peNDF) in dairy cattle diets, allowing farmers to replace other peNDF sources (such as hay, straw, or cottonseed), while still slowing the rate of passage through the rumen. Since the kernel is essentially shattered in the opposite direction, as opposed to conventional corn silage, there will be increased surface area of the kernel, along with a high level of processing that will allow for more readily available starch in the rumen.

The slower passage rate from higher peNDF and increased starch availability will allow the cow to extract the most possible nutrients from the feedstuffs she is consuming, leading to decreased energy wasted. Initial research conducted in an experiment involving 112 lactating dairy cows at the University of Wisconsin demonstrated that cows receiving shredlage as opposed to conventional corn silage, ate 1.5 more pounds of feed a day and produced 3.0 to 4.5 pounds more milk (3.5% fat-corrected milk [FCM]), 4% higher total tract NDF digestibility, and 1.9% higher total tract starch digestibility (Hansen, 2014). However, this study also reported no difference in FCM feed efficiency (FCM/DMI), which was 1.78 for both the control and experimental group (Hansen, 2014). Although additional research is needed to confirm the value of shredlage, one downfall to this product is that it can only be harvested with a custom set of processing rolls, which at the moment, is only available on Claas HD and HP models.
Storing

The fourth step of silage production is storing. Regardless of the storage method, whether it be in an upright silo, bunker silo, bag silo, etc., storing is a major factor in making silage. The overall goal is to minimize dry matter loss and improve yield, as well as increase nutritive value. This is done by decreasing the pH of the fresh crop as quickly as possible and thus creating an environment that minimizes yeast and mold colonies, while also allowing for maximum populations of homofermentive and heterofermentive lactic acid bacteria.

It is impossible to eliminate all dry matter loss due to the metabolism of microorganisms which convert water soluble carbohydrates into water, heat, and CO₂, a form of carbon lost to the atmosphere (Mahanna, 2013). Nutritive value also increases due to increased starch and fiber digestion and availability. However, there are techniques and recent advances which create the most favorable environment for high quality silage production; these include inoculants, acids, and salts.

Silage inoculants are the most common type of silage additive. They include predominantly lactic acid bacteria (LAB) and are most effective when the carbohydrate levels are high. The purpose of adding LAB is to aid in the natural fermentation process of the silage. Although there is already LAB in the silage, the addition of LAB increases the formation of lactic acid and will thus reduce the pH faster (Hanson & Möhring, 2012).

The second most popular type of silage additive is acid. Although not as common as they once were, acid additives contain propionic acid, which rapidly lowers the pH, similar to LAB. However, adding acid to silage is more detrimental to machinery, causing premature corrosion and posing a threat to humans (Hanson & Möhring, 2012).

The final type of silage additive is salts. Salts are basic (alkaline) and can be used on a wider range of crops, including both wet and dry forages (Hanson & Möhring, 2012). One major advantage of salts is their ability to inhibit secondary fermentation after the silage is exposed to oxygen.

Feeding Silage

The fifth and final step of silage production is feeding. Proper silage feed-out management is the key to maintaining a consistent high quality product and inhibiting secondary fermentation. Similar to harvesting, there have been a few revolutionary technologies employed in this area to ensure top quality silage. These technologies include thermal imaging and near infrared (NIR) dry matter testers.

Thermal imaging sensors can be used on any type of silage; however, they are most common when the silage is stored in a bunker silo, pile silo, or bag silo. They have been demonstrated to have the highest dry matter losses (Muck, 2013). This tool has improved feeding of silage due to the fact that it will show thermal images and temperatures of the face of the silo. This information allows farmers to determine if there has been any silage spoilage, the extent of
spoilage, and the location, allowing them to discard low quality and unwanted silage, ensuring that their animals only receive the best quality.

The second type of technology used during the feeding phase is the NIR dry matter tester. On the market today, there is only one NIR dry matter tester. This piece of equipment is designed by Digistar and known as the Moisture Tracker™. This is a handheld device available for purchase by farmers and will enable them to accurately and precisely test their forages for dry matter content and immediately get results. The dry matter values can then be used to adjust the total weight of the forage going into the feed, which will ensure that the diet that was formulated is the diet that is actually being fed to the cows. This will lead to a consistent inclusion rate and maintain optimal ruminal function by eliminating dry matter content variation of the diet.

The advances in silage production that have been demonstrated thus far in the various stages of the silage process— including, planting, growing, harvesting, storing, and feeding— continue to be improved. Although this production process has been in existence for over 1,500 years, it continues to be manipulated to achieve the overall goal of limiting dry matter losses and improving the nutritive value of the final product.

References


Herbicide resistance has been a rapidly growing issue in agroecosystems worldwide. Herbicide resistance is when a weed develops resistance to a particular group of herbicides and will not be controlled by the application when the sensitive biotype of that species would. Resistance issues can develop fairly quickly in weeds after a repeated use of the same herbicide or a similar herbicide with the same target site in the plant. The first case of herbicide resistance was in 1968 with triazine resistant weeds and then by 1991 there were 120 weed biotypes resistant to triazine herbicides and resistance issues with 15 other herbicide families as well (Gunsolus, 2013). With such rapid resistance development, growers need to pay close attention to the how frequently the same herbicide is being used. With the stacked trait technology being used in crops, growers are becoming more dependent on just a few herbicides but need to consider the resistance issue prior to getting comfortable with the same application year after year. There are many management practices that growers today can implement in order to combat the fast growing resistance issue appearing in fields worldwide.

The best option for combating resistant weeds is to use herbicides that target a different site of action within the weed. A site of action is where the herbicide binds within the plant to disrupt physiological processes within the weeds. If you use herbicides that bind to the same site of action, resistance issues could develop. According to Gunsolus, “A change in a site of action that results in resistance to a particular herbicide may or may not result in resistance to other herbicides that are active at the same site of action. The reason for this is there can be many different binding sites at a particular site action and those binding sites can be very herbicide
specific” (2013). Weeds will develop resistance to some herbicide groups much faster than others.

ALS inhibitors and triazines (photosystem II disruptors) are among the faster modes of action that weeds will develop resistance to. As stated above, with new herbicide resistant crops, growers will need to pay careful attention to still rotate herbicides in order to continually combat resistant weed populations. With crops being tolerance of compounds like glyphosate that provide non-selective weed control it becomes easy to fall into the habit of using glyphosate year after year. Glyphosate resistant weeds are now found worldwide and I think the rapid increase can be contributed to the use of herbicide resistant crops being marketed. Now with stacked trait crops you can have crops that are resistant to multiple herbicides and this should help farmers with herbicide rotations and not depend so heavily on glyphosate usage.

Even with the heavy dependence on glyphosate, an addition of a short residual herbicide will help to control potentially glyphosate resistant weed seeds that have contaminated the field over the years. Having a short residual herbicide applied to a field will provide weed control during the critical emergence period before planting that seasons crop occurs. “Using herbicides that do not persist in the soil for long periods and are not applied repeatedly within a growing season reduces the selection of herbicide-resistant weeds. However, repeated applications within a growing season of a herbicide with no soil activity (e.g., Gramoxone) has resulted in weeds resistant to the herbicide” (Mallory-Smith, 2014).

While paying attention to what the mode of action of the herbicide is, you must also be sure to follow the recommendations on the label for use rates. Often times the use rate will depend on the soil type or the organic matter content of the soil. Using rates well over the recommended rate is not only illegal but also can speed up herbicide resistance in weeds as the strongly resistant biotypes will not be controlled and add the highly resistant seed to the fields seedbank. On the other end, if growers begin to use under the recommended use rates then metabolic herbicide resistance can develop within the weeds over time. As you apply rates that may not control the weeds, the plants can build up a tolerance or learn to metabolize the low amount of the compound. Over time this metabolic resistance can become stronger and stronger until even a higher dose of the compound will not control the biotype. All growers must adhere to labels for legal reasons as well as minimizing the chance of herbicide resistance developing in their fields.

While rotating herbicides is the most common recommendation for combating herbicide resistant weeds there are several other practices that can be used to help slow the ever-growing problem. Simply rotating crops can also help to combat herbicide resistance issues since different crops will have different herbicides labeled for weed control in those systems. UC Davis Extension states, “Crop rotation is one of the best tools for preventing resistance” (DiTomaso et. al., 2000).

Growers must be careful that when rotating crops they are still rotating the mode of action used for weed control. For example, you do not want to use an ALS inhibitor in a corn field then use another ALS inhibitor targeting the same site of action in the winter wheat planting following the corn harvest. Another benefit of rotating crops is that different weeds prefer and
grow in different situations. During a winter wheat season you will see far different weeds emerging than in a field of a summer annual like corn. Therefore, crop rotations will help to reduce the weed seed bank in a particular field since you will be killing both winter and summer growing weeds.

Another essential practice in maintaining control of herbicide resistant weeds is to scout newly sprayed fields to ensure the expected weed control is achieved. Sometimes there can be issues with the actual application but if no distinct pattern is easily visible then chances are there is a resistance issue. If a patch of weeds that should be controlled by the herbicide application is found then the grower may need to turn to mechanical control instead of relying on chemical control. Many growers do not want to start hand weeding fields but the benefits to hand weeding are far greater than letting a herbicide resistant weed go to seed. Weed seeds can persist in a field’s seed bank for decades so the extra effort to hand weed is well worth it. UC Davis Extension found, “A 90 percent or greater rate of weed removal reduces the chances that a resistant plant will produce seed” (DiTomaso et. al, 2000).

There are many non-chemical methods that can be used for management of herbicide resistant weeds. The use of tillage is a common and effective method to fight these detrimental pests. Performing a conventional till on a field will help to bury any newly emerged weeds while also disrupting the current seeds in the seed bank. Seeds deeper in the soil will be brought to the surface and will bake in the sun until the seed is no longer viable.

On the other hand, having a residue or mulch can also help reduce weed emergence and lower the number of resistant plants that can make it through the mulch. Many growers are using plastic and synthetic mulches but organic mulches and crop residues also help with effective weed control.

In some parts of the county, soil solarization can also be used to raise the soil temperatures so high that certain species of weeds seed cannot survive. This generally can only be done on small scale farms as it takes lots of time and resources to lay clear plastic over an entire field. Most fields will require the use of both chemical and non-chemical practices in order to successfully control resistant weed populations.

One of the last, but often overlooked, practices that is essential to preventing the spread of herbicide resistant weed populations is sanitation. DuPont Biotechnology states on their website, “Equipment clean out is essential to reduce the spread of resistant weed seed” (Herbicide Tolerant Crops & Weed Management, 2013). Thoroughly cleaning all equipment prior to switching between fields is essential in not spreading seed. Sometimes it becomes easy to finish one field and continue to the next, but this can contaminate multiple fields with the same resistant weed if all equipment is not cleaned prior to moving to a new field. Packed soil in tires is a common way that weed seeds can be missed when cleaning off equipment. If a grower takes careful mind to clean all equipment when moving between fields then the spread of resistant weed seed can be minimized on their plot of land.

Herbicide resistance is an ongoing issue in the world and most companies are racing to discover the next new herbicide that can control resistant weeds but the fact is, if growers follow
the management recommendations available then we can begin to combat resistant weeds immediately. Simple practices like being aware of labels and becoming familiar with the various modes of action can help growers make economical decisions while contributing to suppressing the rapidly growing issue with herbicide resistance. But also things like tillage, timely scouting, use of mulches, and sanitation can help to greatly reduce resistant weed populations showing up in fields worldwide. The more growers that are educated on this issue and what management practices they can implement to help stop the spread of these weeds, the easier it should become to suppress these growing resistant populations.

Works Cited


In summer months cool-season grass growth is limited by not only moisture, but also temperature. Once leaf temperature exceeds 70 F, photosynthesis in cool-season grasses becomes inefficient. In contrast, warm-season grasses do not reach peak photosynthesis until leaf temperature is 90 to 100 F. In practical terms this means that warm-season grasses have the potential to respond to summer rainfall, whereas cool-season grasses cannot due to temperature limited growth.

Warm-season annual grasses can provide safe and relatively high quality forage when properly managed. Advantages to using summer-annuals include fast germination and emergence, rapid growth, high productivity, and flexibility of utilization. Disadvantages include the high cost of annual establishment and the increased risk of stand failure due to variable rainfall in late spring and early summer when annuals are being established.

The primary summer-annual grasses grown in the mid-Atlantic region include sudangrass, sorghum-sudangrass, pearl millet, and to a lesser extent crabgrass (see adjacent descriptions). Approximately one-third to one-half acre will provide adequate grazing for one mature animal during the critical summer months. Seeding one-half of the acreage as early as possible and the remainder four to six weeks later can extend the useful period of these supplemental forages. In order to optimize production, summer annual grasses should receive 60 to 80 lb nitrogen per acre at seeding and 40 to 60 lb nitrogen per acre after each grazing or harvest.

The most efficient way to utilize summer annual grasses is by grazing. These grasses should be rotationally stocked to maximize production and utilization. The grazing area should be restricted to supply only enough forage for one to three days. This will result less waste and allow animals to be removed from the area before regrowth accumulates. Grazing should be initiated when summer annuals have reached a height of 20 inches. It is important to leave adequate stubble if regrowth is desired, never graze closer than 5-7 inches. This especially important for pearl millet which depends more on terminal buds for regrowth.
In some cases summer annual grasses cannot be grazed or get ahead of the animals under good growing conditions. In these cases, summer annuals may need to be harvested as hay or silage. Harvesting summer annuals as round bale silage eliminates the problems associated with curing summer annuals for dry hay. If dry hay is the only option, then the following suggestions will help to ensure that rapid and successful curing is achieved: 1) do not allow forage to become overly mature, cut at 30-40 inches in height, 2) always use a cutter-conditioner to crush stems, 3) make mower swaths as wide as possible to maximize surface area for drying, and 4) do not windrow forage until plants on top of the swaths are dry enough to bale.


**Sorghum-Sudangrass and Sudangrass**

These are tall erect growing summer annul grasses that are in the sorghum family. Sudangrass hybrids tend to have a finer stem and are a better choice if hay is the end use. Some varieties contain the brown midrib or BMR trait. As the name implies, the midrib of the leaf is a brownish color instead of white. This is in many cases, but not always, associated with increased digestibility and higher animal performance. If you are considering a BMR variety, ask your seed supplier for digestibility data. Sorghum species are adapted statewide and grow the best on well drained to somewhat poorly drained soils that possess medium to high fertility and of pH of 6.0 or higher. They possess very good drought tolerance and make better use of water than cool-season grasses.

Sorghum-sudans and sudangrass should be planted in late spring after the soil temperature has reached 65° F. The seeding rate for sorghum-sudangrass hybrids is 30 to 40 lb per acre and 15-20 lb per acre for sudangrass. Seeding depth should not be deeper than one inch. In some cases, prussic acid and nitrates can accumulate in the plant and pose a health risk to grazing livestock (see next article).
Pearl Millet

Pearl millet has smaller stems and tends to be leafier than sudangrass and sorghum-sudangrass hybrids. It is adapted statewide and grows the best on well drained to somewhat poorly drained soils that possess medium to high fertility and a soil pH above 5.5. It does better than sudangrass or sorghum-sudangrass on sandier soils and soils with a lower pH. Pearl millet should be planted approximately two weeks after corn, when the soil temperature has reached at least 65°F. It is more sensitive to cold temperatures that the sorghum species and should be not be planted too early. The seeding rate for pearl millet is 20 to 30 lb per acre. Seeding depth should not be deeper than one inch.

A primary benefit of pearl millet is that it does not contain prussic acid like the sorghum species. It can, in some cases, accumulate nitrates (see adjacent article).

Crabgrass

Crabgrass is commonly considered a weed, but possesses significant potential for supplying high quality summer forage. A primary advantage of crabgrass is its high digestibility. Research at the Noble Foundation has shown that well managed crabgrass can produce average daily gains of more than 1.75 lb/day. Only two varieties of improved crabgrass available (Estel Farm and Seeds, 1-800-858-7333). It is best adapted to well-drained soils that have a soil pH above 5.5 and a medium level of soil fertility. Crabgrass should be seeded when the soil temperature has reached 60°F. The seeding rate is 4-6 lb per acre and it should not be seeded deeper than one-half of an inch.

Crabgrass is best utilized by grazing. Grazing should be initiated at a height of 6 to 8 inches and stopped at 3-4 inches. Crabgrass is a summer annual that acts like a perennial through prolific self-reseeding. Therefore, it must go to seed at least once during the growing season. Like pearl millet, crabgrass does not contain prussic acid, but can accumulate nitrates (see adjacent article).
Nitrate and Prussic Acid Poisoning in Summer Annual Forages

Dr. Chris D. Teutsch
Associate Professor, Va Tech’s Southern Piedmont AREC
Blackstone, VA
Email: cteutsch@vt.edu

In cattle, nitrate poisoning occurs when nitrate in the forage tissue is converted to nitrite in the rumen of the animal. The nitrite is absorbed into the blood stream where it interferes with the blood’s ability to carry oxygen. The onset of symptoms and death is rapid and usually occurs within one to two hours. In animals affected by nitrate poisoning, the blood will take on a brownish chocolate color, giving the non-pigmented skin and mucus membranes a muddy brown color.

Nitrates can accumulate to toxic levels in commonly used summer annual grasses such as pearl millet, sudangrass, sorghum-sudangrass, and crabgrass. This most often occurs when heavy nitrogen fertilization is followed by drought. Nitrates are taken up by the plant, but not utilized since plant growth is restricted by the drought. Any factor that slows plant growth in combination with heavy nitrogen fertilization can result in nitrate accumulation. Drought stressed plants should not be grazed or harvested for hay until growth has resumed after rainfall (usually 4-5 days). Nitrates are stable in hay and can cause poisoning months later. It is very important to have all suspect forages tested before grazing or feeding. For more information on nitrate testing contact your local extension office or veterinarian.

Another potential problem with the sorghum species (sudangrass, sorghum-sudangrass, and naturally occurring johnsongrass) is prussic acid or cyanide poisoning. Under normal conditions, these forages contain little free cyanide. However, when freezing, drought stress, wilting, or mechanical injury damages plant tissue, an enzymatic reaction occurs and free cyanide is produced. If forage is ingested during this period, cyanide is readily absorbed into the bloodstream where it interferes with normal cellular respiration. Symptoms of cyanide poisoning are similar to nitrate poisoning with death occurring in a matter of minutes to several hours. In contrast to nitrate poisoning, the blood of animals affected by cyanide poisoning is fully oxygenated and bright cherry red in color.

In most situations, sorghum species (including johnsongrass) pose little danger to grazing animals when properly managed. Young plants or regrowth after grazing contain higher concentrations of prussic acid and should not be grazed until plants have reached a height of at least 20 inches. Drought stressed plants should not be grazed until growth has resumed after rainfall (usually 4-5 days). Plants that have been frosted should not be grazed for 7-14 days or until the leaves are dead and dried out. Cyanide does escape from plant tissue; therefore, hay that has been properly cured is safe to feed. For more information on nitrate and prussic acid poisoning, contact your local extension office of veterinarian.
Establishing Small Grains with Vertical Tillage

Dr. Bob Kratochvil
Extension
University of Maryland
Email: rkratoch@udel.edu

Small grains (wheat and barley) for commodity grain production are annually planted on ~250,000 acres in Maryland. These crops have traditionally been planted using a grain drill that with appropriate adjustments can place the seed into the soil at a depth of 1-2 inches, the depth considered optimum for good stand establishment. During the past couple years, an increasing number of Maryland farmers have opted to broadcast the seed for their commodity small grain crops followed by soil incorporation of the seed using vertical tillage. Farmers who use this technique cite faster and less expense compared to using a grain drill. Since vertical tillage does not disturb the soil as aggressively as a chisel plow or disk, it avoids placement of some of the seed so deeply into the soil that it cannot emerge. However, use of vertical tillage may either leave some of the seed on the soil surface or place some of the seed too shallow to support good seedling emergence and growth, particularly if heavy amounts of previous crop residue are present.

The objective of this 2 year project was to compare the performance of wheat and barley that was broadcast followed by soil incorporation using vertical tillage with performance when a grain drill was used.

Project Summary

- Acceptable barley and wheat stands can be established using either a grain drill or broadcasting the seed followed by incorporation with a turbo-till.

- **In all cases, grain yield for barley and wheat was best when the seed was planted with a grain drill.**
  - Barley yield average was 10.5% greater (range = 6 – 21%) with a grain drill.
  - Wheat yield average was 10.2% greater (range = 7.6 – 14%) with a grain drill.
  - This occurred because uniformity of stand was better when seed was planted with a grain drill.

- The results for 2011-2012 and 2012-2013 indicated that the use of one vertical tillage pass for stand establishment is adequate.

- There is no need to increase the amount of seed planted above the recommended volume rates for barley and wheat. The results attained in 2012-2013 showed that using a seeds/ft² approach for determining seeding rate will establish good stands and result in yield comparable to the recommended volume rates. This can result in cost-savings via the planting of less seed.
**Procedures in 2011-2012**

Three study sites were established during the fall of 2011. Two of the sites (Wye Research and Education (R&E) Center and Central Maryland R&E Center-Beltsville) had the study following corn and a second site at Beltsville followed soybean. All sites were planted on 24 October, 2011. Seed was either planted using a Great Plains grain drill at a rate of 120 lb/acre or it was broadcast onto each plot and then incorporated into the soil using a Turbo-Till® vertical tillage implement. Additionally, either one or two passes were made over the broadcast planted plots with the Turbo-Till. All plots received split applications of 40 lb N/acre with each application during spring 2012. Barley plots were harvested 5 June and wheat plots on 15 June at Wye. Both barley and wheat plots were harvested at Beltsville on 25 June.

Biomass production at early spring was measured at Beltsville for the 2011-2012 study. Biomass produced by spring is one measure of cover crop performance. Interest in the performance of broadcast seed followed by incorporation with vertical tillage is widespread among farmers who plant cover crops. During early April of 2012, each plot had three one ft² areas of plant vegetative growth clipped from areas that would not be harvested for grain. The biomass collected was dried at 60º C for 72 hours to ensure all water was evaporated. Dry weight was measured and converted to lb/acre biomass produced. Data for biomass harvest are shown in Table 5.

**Procedures in 2012-2013**

Three study sites (Wye after corn and Beltsville after corn and soybean) were established during the fall of 2012. Plant date for Beltsville was 13 October and at Wye 17 October. Corn stalks at Beltsville were left untouched prior to planting while at Wye the corn stalks were chopped. The barley variety used was Thoroughbred (90% germination) and the wheat variety was Jamestown (90% germination). Seed was either planted using a Great Plains grain drill or it was broadcast onto each plot and then incorporated using a Turbo-Till® vertical tillage implement. The broadcast treatments included 1 or 2 vertical tillage passes.

Per the results of 2011-2012 that determined the 125% of volume seeding rate (150 lb/acre) for both barley and wheat provided no yield benefit, the seed rate treatments were changed for 2012-2013. Two seeding rates for barley and wheat were used for the drilled and broadcast treatments. The first was the MDA mandated 120 lb/acre for both barley and wheat. The second rate was based on seeds/ft². For barley, the amount of seed used was based on 30 seeds/ft². The seed size for barley was 12,250/lb which when adjusted was 107 lb/acre. For wheat, the amount of seed used was based on 25 seeds/ft². Seed size for the wheat was 11,500/lb and equated to a seed rate of 95 lb/acre. All plots received split applications of 40 lb N/acre with each application during spring 2013.

Barley plots at Beltsville were not harvested in 2013. This was because the plot combine was located on the Eastern Shore when the barley reached maturity at Beltsville. The plan was to harvest both the Beltsville wheat and barley plots at the same time which would avoid moving the combine across the Bay Bridge twice. Unfortunately, rainy harvest weather delayed small grain harvest on the Eastern Shore. This resulted in excessive lodging and weed emergence.
through the barley plots canopy at Beltsville. Wheat was harvested 24 June at Wye and not until 9 July at Beltsville.

**Results**

**Stand Establishment – Fall 2011**

Seedling emergence counts were made 16 days post-planting at Beltsville and 25 days post-planting at the Wye (Table 1). Stand establishment was considered good for all plots at all locations.

For barley, all three sites have a greater number of seedlings established for the vertical till (VT) treatments than for the drilled treatment (Table 1). Stand establishment for barley in the VT treatments was as good with 120 lb/acre and one pass with the Turbo-Till as occurred with the 150 lb/acre rate and two passes with the Turbo-Till.

For wheat, all three sites had the greatest number of seedlings established for the VT treatments. Stand establishment for the VT treatments at Beltsville following both corn and soybean was comparable to the grain drill stand (Table 1). The 120 lb/acre broadcast seeding rate with a single pass with the Turbo-Till established a comparable number of seedlings to the drilled treatment. Only at Wye was there a greater number of seedlings established using the VT technique (Table 1). Also at Wye, significantly more seedlings were established when the seeding rate was 125% of the volume rate (150 lb/acre). The seedling counts for the

<table>
<thead>
<tr>
<th>Species</th>
<th>Planting technique</th>
<th>Seed amount Lbs/acre</th>
<th>Location and previous crop</th>
<th>Location and previous crop</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Beltsville corn</td>
<td>Beltsville soybean</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>-----------------</td>
<td>---------------------</td>
</tr>
<tr>
<td>Barley</td>
<td>Drilled</td>
<td>120</td>
<td>1,093,453 c³</td>
<td>1,127,526 b</td>
</tr>
<tr>
<td></td>
<td>VT 1¹</td>
<td>120</td>
<td>1,412,506 b</td>
<td>1,352,102 a</td>
</tr>
<tr>
<td></td>
<td>VT 2²</td>
<td>120</td>
<td>1,561,190 ab</td>
<td>1,350,554 a</td>
</tr>
<tr>
<td></td>
<td>VT 1</td>
<td>150</td>
<td>1,652,570 a</td>
<td>1,424,896 a</td>
</tr>
<tr>
<td></td>
<td>VT 2</td>
<td>150</td>
<td>1,401,664 b</td>
<td>1,386,176 a</td>
</tr>
<tr>
<td>Wheat</td>
<td>Drilled</td>
<td>120</td>
<td>1,116,795 b</td>
<td>1,143,014 b</td>
</tr>
<tr>
<td></td>
<td>VT 1</td>
<td>120</td>
<td>1,279,309 ab</td>
<td>1,036,147 b</td>
</tr>
<tr>
<td></td>
<td>VT 2</td>
<td>120</td>
<td>1,249,882 ab</td>
<td>1,110,490 b</td>
</tr>
<tr>
<td></td>
<td>VT 1</td>
<td>150</td>
<td>1,268,467 ab</td>
<td>1,189,478 b</td>
</tr>
<tr>
<td></td>
<td>VT 2</td>
<td>150</td>
<td>1,367,883 a</td>
<td>1,390,822 a</td>
</tr>
<tr>
<td></td>
<td>LSD₀.₁₀</td>
<td></td>
<td>207,526</td>
<td>157,339</td>
</tr>
</tbody>
</table>

¹One pass was made across the treatment plots with the Turbo-Till.
²Two passes were made across the treatment plots with the Turbo-Till.
³Seedling number means within a column and for a species that have the same lower case letter are not significantly different at P≤0.10.
broadcast/Turbo-Till plots at Wye are believed to be somewhat inflated due to the difficulty in counting individual seedlings once they attain 2-3 leaf stage of growth (Table 1).

**Stand Establishment – Fall 2012**

Seedling emergence counts during fall 2012 were made 20 days post-planting at Beltsville and Wye (Table 2). Stand establishment was considered good for all plots at all locations.

Seedling emergence for barley was best within the drilled treatments at the three sites (Table 2). There were no emergence differences between the two seeding rates for the drilled treatments. For the VT1 treatments, comparable seedling emergence to the drilled treatments occurred for both seeding rates with the exception of the seeds/ft² (107 lb/acre) rate at Wye where it had the lowest number of emerged seedlings. The use of two VT passes consistently produced the lowest number of emerged barley seedlings.

As with barley, the two drilled treatments consistently had the best wheat seedling emergence numbers (Table 2). The seeds/ft² treatment was not different from the volume rate treatment indicating that a cost-savings can be attained by reducing the seeding rate while not impacting stand establishment. For the VT treatments, one pass with a Turbo-Till produced similar wheat

| Table 2. Fall 2012 seedling emergence counts for wheat and barley that was either planted with a Great Plains grain drill or broadcast on the soil surface followed by incorporation with a Turbo-Till. |
|---|---|---|---|
| **Species** | **Planting technique** | **Seed amount Lbs/acre** | **Location and previous crop** |
| | | | Beltsville corn | Beltsville soybean | Wye corn |
| | | | ------------------ | ------------------ | ------------------ |
| Barley | Drilled | 120 | 2,028,928 a⁴ | 1,719,768 ab | 2,190,503 a |
| | Drilled | 107³ | 1,657,216 ab | 1,943,744 a | 1,703,705 ab |
| | VT 1¹ | 120 | 1,263,240 ab | 1,301,960 ab | 1,807,740 ab |
| | VT 1 | 107 | 1,689,160 ab | 1,558,480 ab | 1,056,330 c |
| | VT 2² | 120 | 963,160 b | 958,320 b | 1,829,520 ab |
| | VT 2 | 107 | 1,118,040 b | 1,147,080 ab | 1,259,910 bc |
| | LSD⁰.⁰⁵ | | 903,541 | 847,494 | 638,258 |
| Wheat | Drilled | 120 | 1,810,260 a | 1,866,344 a | 1,797,336 ab |
| | Drilled | 95³ | 1,347,456 a | 1,572,032 a | 1,884,707 a |
| | VT 1¹ | 120 | 1,810,160 a | 1,413,280 a | 1,782,330 ab |
| | VT 1 | 95 | 1,563,320 a | 1,427,800 a | 1,484,670 b |
| | VT 2 | 120 | 1,490,720 a | 1,965,040 a | 1,673,430 ab |
| | VT 2 | 95 | 1,631,080 a | 1,824,680 a | 1,473,780 b |
| | LSD⁰.⁰⁵ | | 903,541 | 847,494 | 345,304 |

¹One pass was made across the treatment plots with the Turbo-Till.
²Two passes were made across the treatment plots with the Turbo-Till.
³Seeds/ft² rates for barley and wheat are 30/ft² and 25/ft², respectively.
⁴Seedling number means within a column and for a species that have the same lower case letter are not significantly different at P≤0.05.
seedling emergence to the drilled treatments in nearly all cases. There was no benefit in seedling emergence for wheat attained by using two passes of the Turbo-Till.

**Grain Yield 2011-2012**

**Barley**

Barley yield was best at each of the three testing sites when it was planted with a grain drill (Table 3). At 2-3 testing sites (after corn at Beltsville and Wye), comparable yield to the use of the grain drill was attained by broadcasting a volume rate of seed followed by incorporation using 1 pass of a Turbo-Till (Table 2). Though it generally did not cause a yield reduction, there was no barley yield benefit attained with two Turbo-Till passes indicating that one pass would be more cost-effective.

**Wheat**

Wheat yield also was consistently best at each of the three testing sites when it was planted with a grain drill (Table 3). At 2-3 testing sites (after corn and soybean at Beltsville), comparable yield was achieved with a volume rate of wheat seed that was incorporated twice with the Turbo-Till (Table 3).

**Table 3. The 2011-2012 crop grain yield for wheat and barley that was either planted with a Great Plains grain drill or broadcast on the soil surface followed by incorporation with a Turbo-Till.**

<table>
<thead>
<tr>
<th>Species</th>
<th>Planting technique</th>
<th>Seed amount Lbs/acre</th>
<th>Location and previous crop</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Beltsville corn</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Bu/acre</td>
</tr>
<tr>
<td>Barley</td>
<td>Drilled</td>
<td>120</td>
<td>66.1 a&lt;sup&gt;3&lt;/sup&gt;</td>
</tr>
<tr>
<td></td>
<td>VT 1&lt;sup&gt;1&lt;/sup&gt;</td>
<td>120</td>
<td>67.2 a</td>
</tr>
<tr>
<td></td>
<td>VT 2&lt;sup&gt;2&lt;/sup&gt;</td>
<td>120</td>
<td>60.9 ab</td>
</tr>
<tr>
<td></td>
<td>VT 1</td>
<td>150</td>
<td>50.3 b</td>
</tr>
<tr>
<td></td>
<td>VT 2</td>
<td>150</td>
<td>70.3 a</td>
</tr>
<tr>
<td>Wheat</td>
<td>Drilled</td>
<td>120</td>
<td>62.6 a</td>
</tr>
<tr>
<td></td>
<td>VT 1</td>
<td>120</td>
<td>57.3 ab</td>
</tr>
<tr>
<td></td>
<td>VT 2</td>
<td>120</td>
<td>57.7 ab</td>
</tr>
<tr>
<td></td>
<td>VT 1</td>
<td>150</td>
<td>55.1 b</td>
</tr>
<tr>
<td></td>
<td>VT 2</td>
<td>150</td>
<td>61.2 a</td>
</tr>
</tbody>
</table>

<sup>1</sup>One pass was made across the treatment plots with the Turbo-Till.

<sup>2</sup>Two passes were made across the treatment plots with the Turbo-Till.

<sup>3</sup>Means within a column specific for a small grain crop at the same location and previous crop that have the same letter are not significantly different at p≤0.05.
Grain Yield 2012-2013

Barley

Grain yield for barley was best (approximately 17% greater) when planted with the grain drill compared to the VT treatments. There was no yield difference between the volume rate and the seeds/ft² rate indicating that a cost savings can occur when using the seeds/ft² technique. Barley plots were not harvested at Beltsville.

Wheat

Grain yield for wheat at the Wye was best for the drilled treatments with both the volume rate and the seeds/ft² rate equivalent (Table 4). The seeds/ft² rate had approximately 20% less seed planted which would indicate that a cost-savings can occur by using this approach. At Beltsville, wheat yield was similar following corn and soybean crops for all the seeding technique treatments so the yield data is shown as the average for those two situations. No yield differences were observed among any of the seeding techniques. This indicates that use of a vertical till incorporation technique along with broadcast of the wheat seed can be an effective method for establishing a wheat crop. However, there was more variability in the uniformity of the stands that were established with vertical tillage compared to planting with a grain drill (data not shown).

Table 4. The 2012-2013 crop grain yield for wheat and barley that was either planted with a Great Plains grain drill or broadcast on the soil surface followed by incorporation with a Turbo-Till.

<table>
<thead>
<tr>
<th>Species</th>
<th>Planting technique</th>
<th>Seed amount Lbs/acre</th>
<th>Location and previous crop</th>
<th>Wye corn Bu/acre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barley</td>
<td>Drilled</td>
<td>120</td>
<td>Not harvested</td>
<td>116.8 a</td>
</tr>
<tr>
<td></td>
<td>Drilled</td>
<td>107</td>
<td>Not harvested</td>
<td>117.1 a</td>
</tr>
<tr>
<td></td>
<td>VT 1</td>
<td>120</td>
<td>Not harvested</td>
<td>102.6 b</td>
</tr>
<tr>
<td></td>
<td>VT 2</td>
<td>107</td>
<td>Not harvested</td>
<td>98.2 b</td>
</tr>
<tr>
<td>Wheat</td>
<td>Drilled</td>
<td>120</td>
<td>72.6 a</td>
<td>105.8 a</td>
</tr>
<tr>
<td></td>
<td>Drilled</td>
<td>95</td>
<td>73 a</td>
<td>107 a</td>
</tr>
<tr>
<td></td>
<td>VT 1</td>
<td>120</td>
<td>71.3 a</td>
<td>100.1 b</td>
</tr>
<tr>
<td></td>
<td>VT 1</td>
<td>95</td>
<td>74.4 a</td>
<td>97.9 b</td>
</tr>
<tr>
<td></td>
<td>VT 2</td>
<td>120</td>
<td>72.5 a</td>
<td>101 b</td>
</tr>
<tr>
<td></td>
<td>VT 2</td>
<td>95</td>
<td>70.6 a</td>
<td>100.9 b</td>
</tr>
</tbody>
</table>

LSD_{0.05}
Biomass Production

Though treatment influence on biomass production varied for barley and wheat behind corn and soybean (Table 5), the general outcome was that broadcasting the seed and using vertical tillage to incorporate it can be an effective method for establishing cereal cover crops. Since no improvement in biomass production occurred with the use of a 125% of volume seeding rate for broadcasting seed, it is not necessary to do so when using this technique. This outcome coincides with other cover crop planting research that I have conducted. This approach to establishing cover crops likely has a cost-saving benefit associated with it.

Table 5. Biomass production (measure of cover crop performance) for wheat and barley in 2012 that was planted during fall 2011 either with a Great Plains grain drill or broadcast on the soil surface followed by incorporation with a Turbo-Till.

<table>
<thead>
<tr>
<th>Species</th>
<th>Planting technique</th>
<th>Seed amount Lbs/acre</th>
<th>Location and previous crop</th>
<th>Beltsville corn</th>
<th>Beltsville soybean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barley</td>
<td>Drilled</td>
<td>120</td>
<td></td>
<td>3390 ab</td>
<td>4781 a</td>
</tr>
<tr>
<td></td>
<td>VT 1†</td>
<td>120</td>
<td></td>
<td>3326 ab</td>
<td>2766 b</td>
</tr>
<tr>
<td></td>
<td>VT 2‡</td>
<td>120</td>
<td></td>
<td>2862 ab</td>
<td>2798 b</td>
</tr>
<tr>
<td></td>
<td>VT 1</td>
<td>150</td>
<td></td>
<td>2782 b</td>
<td>3342 b</td>
</tr>
<tr>
<td></td>
<td>VT 2</td>
<td>150</td>
<td></td>
<td>4205 a</td>
<td>3806 ab</td>
</tr>
<tr>
<td></td>
<td>LSD 0.05</td>
<td></td>
<td></td>
<td>1406 lb/A</td>
<td></td>
</tr>
<tr>
<td>Wheat</td>
<td>Drilled</td>
<td>120</td>
<td></td>
<td>4589</td>
<td>3822</td>
</tr>
<tr>
<td></td>
<td>VT 1</td>
<td>120</td>
<td></td>
<td>2990</td>
<td>3822</td>
</tr>
<tr>
<td></td>
<td>VT 2</td>
<td>120</td>
<td></td>
<td>4557</td>
<td>3374</td>
</tr>
<tr>
<td></td>
<td>VT 1</td>
<td>150</td>
<td></td>
<td>3358</td>
<td>2806</td>
</tr>
<tr>
<td></td>
<td>VT 2</td>
<td>150</td>
<td></td>
<td>3742</td>
<td>4237</td>
</tr>
<tr>
<td></td>
<td>LSD 0.05</td>
<td></td>
<td></td>
<td>1595 lb/A</td>
<td>(no differences among treatments)</td>
</tr>
</tbody>
</table>

†One pass was made across the treatment plots with the Turbo-Till.
‡Two passes were made across the treatment plots with the Turbo-Till.
¶Means within a column specific for a small grain crop at the same location and previous crop that have the same letter are not significantly different at p≤0.05.
Introduction

A forage production trial of commercial barley, oats, rye, triticale, and wheat cultivars has been conducted yearly from 1994-2014 at the Northern Piedmont AREC, Orange. Results from the 2013-14 crop season are presented in this report.

Management and Weather

Preplant fertilizer of 30-60-20 was applied on October 1, 2013. Plots were planted on Oct. 09, 2013 and were seven, seven inch rows wide by 13 feet long, trimmed to 9 feet for harvest. Nitrogen as UAN at a rate of 60 lb of N per acre was applied on March 11, 2014. All plots were harvested for forage yield at the boot (GS 45) stage as each entry reached that stage. Two rows, the entire length of the plots (were harvested with a 12-inch Jari sickle-bar mower and weighed with an electronic hanging scale.

Temperatures in October were below the long-term average and, combined with rain showers, wheat and barley planted acres were 10% behind the 5-yr average by the third week of October. Overall, temperatures in November were colder than normal as well and while topsoil moisture was mostly reported do be adequate fall growth was slowed. In mid-November 95% of the intended barley crop and 78% of wheat was seeded. Wheat was rated 85% good or excellent, but only 62% of barley was rated in these categories due to slow growth and reduced tillering. Most of the state received adequate rainfall in December but also experienced wide swings in temperatures. Many areas of the Commonwealth received significant snow in January and nighttime lows below zero degrees. February conditions were much the same and small grain was rated as 68% in good or excellent condition with 24% fair. Continued wet and cool to cold weather hampered small grain progress and the portion of the crop rated as good or excellent was
reduced to 61%. Crop condition for both wheat and barley improved in April. Major storm events delivered significant rainfall to many areas of Virginia in early May. By May 12, 66% of the wheat crop was headed, compared with 74% on the same date in 2013. High temperatures in the high 80’s and 90’s resulted in a rapid increase in wheat heading to 84% by May 19.

Figure 1. 2013-14 and 72-yr mean monthly growing season precipitation measured at the Northern Piedmont Center, Orange, VA

Figure 2. Monthly average growing season temperatures, 2013-14 and 30-yr mean, Orange, VA.

Results

Results are reported for 35 percent dry matter (DM) yield, DM yield, and nutritive value for wheat, barley, rye, and triticale crops.
Experimental plots vary in yield and other measurements due to their location in the field and other factors which cannot be controlled. The statistics given in the tables are intended to help the reader make valid comparisons between cultivars. The magnitude of differences which may have been due to experimental error has been computed for the data and listed at the bottom of columns as the LSD (.05) (least significant difference with 95 percent confidence). Differences must be greater that the LSD to be believed to truly exist.

Table 1. Small Grain Forage Variety Test, Northern Piedmont AREC, Orange, Va 2013-2014, Boot Stage Harvest

<table>
<thead>
<tr>
<th>Cultivar</th>
<th>Species†</th>
<th>Date Maturity</th>
<th>Zadoks Height (inches)</th>
<th>Lodging</th>
<th>% Crude Protein</th>
<th>ADF %</th>
<th>NDF %</th>
<th>TDN %</th>
<th>35% DM Yield (tons/ac)</th>
<th>DM Yield (tons/ac)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thoroughbred</td>
<td>B</td>
<td>5-May</td>
<td>62</td>
<td>30</td>
<td>0</td>
<td>13.68</td>
<td>32.31</td>
<td>59.03</td>
<td>61</td>
<td>3.89</td>
</tr>
<tr>
<td>Nomini</td>
<td>B</td>
<td>28-Apr</td>
<td>57</td>
<td>27</td>
<td>0</td>
<td>14.97</td>
<td>28.24</td>
<td>49.59</td>
<td>65</td>
<td>2.02</td>
</tr>
<tr>
<td>VA08B-85</td>
<td>B</td>
<td>28-Apr</td>
<td>59</td>
<td>21</td>
<td>0</td>
<td>14.45</td>
<td>28.08</td>
<td>50.64</td>
<td>65</td>
<td>2.01</td>
</tr>
<tr>
<td>Atlantic</td>
<td>B</td>
<td>28-Apr</td>
<td>60</td>
<td>22</td>
<td>0</td>
<td>12.97</td>
<td>28.87</td>
<td>51.42</td>
<td>64</td>
<td>1.81</td>
</tr>
<tr>
<td>VA07H-31WS</td>
<td>HB</td>
<td>5-May</td>
<td>59</td>
<td>26</td>
<td>0</td>
<td>14.65</td>
<td>28.78</td>
<td>51.75</td>
<td>64</td>
<td>2.56</td>
</tr>
<tr>
<td>Wintergrazer 70</td>
<td>R</td>
<td>28-Apr</td>
<td>58</td>
<td>31</td>
<td>0</td>
<td>17.17</td>
<td>29.60</td>
<td>53.95</td>
<td>64</td>
<td>2.90</td>
</tr>
<tr>
<td>Trical 336</td>
<td>T</td>
<td>13-May</td>
<td>61</td>
<td>34</td>
<td>0</td>
<td>13.87</td>
<td>33.84</td>
<td>61.59</td>
<td>60</td>
<td>4.92</td>
</tr>
<tr>
<td>Trical 815</td>
<td>T</td>
<td>13-May</td>
<td>60</td>
<td>35</td>
<td>0</td>
<td>13.21</td>
<td>35.39</td>
<td>61.92</td>
<td>59</td>
<td>4.07</td>
</tr>
<tr>
<td>Trical 342</td>
<td>T</td>
<td>13-May</td>
<td>63</td>
<td>39</td>
<td>0</td>
<td>12.30</td>
<td>35.29</td>
<td>64.42</td>
<td>58</td>
<td>3.83</td>
</tr>
<tr>
<td>Monarch</td>
<td>T</td>
<td>13-May</td>
<td>62</td>
<td>34</td>
<td>0</td>
<td>11.71</td>
<td>34.97</td>
<td>62.18</td>
<td>58</td>
<td>3.42</td>
</tr>
<tr>
<td>154</td>
<td>T</td>
<td>5-May</td>
<td>60</td>
<td>29</td>
<td>0</td>
<td>16.10</td>
<td>30.39</td>
<td>56.29</td>
<td>63</td>
<td>2.88</td>
</tr>
<tr>
<td>Featherstone 258</td>
<td>W</td>
<td>13-May</td>
<td>59</td>
<td>31</td>
<td>0</td>
<td>11.28</td>
<td>32.43</td>
<td>58.70</td>
<td>60</td>
<td>3.82</td>
</tr>
<tr>
<td>Merl</td>
<td>W</td>
<td>13-May</td>
<td>59</td>
<td>29</td>
<td>0</td>
<td>11.55</td>
<td>31.00</td>
<td>56.53</td>
<td>61</td>
<td>3.52</td>
</tr>
<tr>
<td>Jamestown</td>
<td>W</td>
<td>13-May</td>
<td>60</td>
<td>29</td>
<td>0</td>
<td>12.18</td>
<td>32.55</td>
<td>58.76</td>
<td>60</td>
<td>3.30</td>
</tr>
<tr>
<td>LSD 0.05</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2.39</td>
<td>2.06</td>
<td>2.86</td>
<td>2</td>
<td>0.60</td>
</tr>
</tbody>
</table>

† B - Barley, HB - Hulless Barley, R - Rye, T - Triticale, W- Wheat

Compared to 2013, forage yield over all entries was 2.7 tons/ac lower in 2014. Crude protein was, over all entries, 1.5 % higher than 2013 while TDN was 2% higher. These values are above the 5-yr average in this study, but similar to what was measured in 2012. Overall, the triticale and wheat entries produced the highest for a yield, 3.8 and 3.6 ton/ac, respectively. Rye and all the hulled barley entries except Thoroughbred reached the boot stage of maturity much earlier than the triticale or wheat. This difference in maturity should be considered when evaluating the performance among species.
Observations of Management Practices and Their Effect on Corn and Soybean Damage Due to Slug Feeding

Robert A. Clark
Senior Extension Agent, Virginia Cooperative Extension
Email: raclark@vt.edu

Situation:

There is a widespread goal to increase the acreage of corn and soybean that are planted no-till. The benefits of no-till include: (1) a reduction in non-point source pollution; (2) improved farm profitability; and (3) carbon sequestering. In the mid-Atlantic region, however, farmers practicing no-till have a higher incidence of damage due to slug feeding compared to farmers using conventional tillage systems. Many farmers are beginning to wonder if there are specific no-till management practices that can increase or decrease the incidence of damage due to slugs. This survey was an attempt to isolate management practices that appear to result in a higher (or lower) incidence of slug feeding pressure.

Method:

In the late summer of 2013, a survey was developed. It was reviewed by the Mid-Atlantic High Residue Working Group. Beginning in mid-October 2013, farmers throughout the Northern Shenandoah Valley (the Virginia Counties of Clarke, Frederick, Page, Northern Rockingham, Shenandoah, and Warren) were contacted. The original survey was designed to collect data for 2012 and 2013. After meeting with about five farmers, it became evident that no one could remember the incidence of slugs or their management well enough to report accurate data for the 2012 crop season. It also became evident that all farmers would need to be personally interviewed to complete the survey. Thus, all farmers were surveyed via direct communication (either by a personal visit or a telephone interview). Almost every farmer contacted had had interaction with the Extension agent (Bobby Clark). This included all farmers who had participated in the Slug Cost Share Grant Program (SCSGP).

Forty-one farmers were surveyed representing 16,546 acres of corn and soybean. It is important to note that this survey is not a statistically valid subsample of all acres within the Northern Shenandoah Valley. The Census of Agriculture shows there was 33,000 acres of corn and soybean in the Northern Shenandoah Valley in 2007. Due to high grain prices, acreage likely increased to slightly above 40,000 by 2013. Thus, results can only be stated as observations with no statistical confidence. The questions asked of the farmers are summarized below:

- What was the cropping practice in 2012 (or what crops were grown in 2012)?
- How was the crop grown in 2013 (was it no-till or conventional)? All turbo-tilled crops were considered conventional.
- How many acres had slug damage?
- When no-till planting a field, how often is an insecticide sprayed with your pre-plant herbicide? [Always (on every acre of the past two to four years), sometimes (not on every...
What crop rotation was used?

Results:

Table 1 summarizes the acreages reported by tillage system and the number of farmers surveyed.

<table>
<thead>
<tr>
<th>Table 1. Basic information about the survey.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of farmers surveyed</td>
</tr>
<tr>
<td>Total acres surveyed</td>
</tr>
<tr>
<td>Number of no-till acres</td>
</tr>
<tr>
<td>Number conventional acres</td>
</tr>
<tr>
<td>Percent acreage no-tilled</td>
</tr>
</tbody>
</table>

Table 2 and 3 represent the data on no-till cropping systems and conventional cropping systems. It is important to note that the acres represented under some of the cropping systems are relatively small. This means the experience of a single farmer on a single field might have great influence on the percent of the crop injured by slugs. Table 2 shows that in 2013 the majority of the fields that had injury from slugs were no-till crops following corn for grain (either with or without cover crop). Table 4 more specifically shows that no-till corn or soybean following soybean had 23 percent reduction in slug injury compared to no-till corn or soybean following corn.

Table 2: Survey data for no-till cropping systems summarized and sorted by slug damage percentage.

<table>
<thead>
<tr>
<th>Cropping system</th>
<th>Total acres</th>
<th>Acres damaged</th>
<th>Acres not damaged</th>
<th>Percent damaged</th>
</tr>
</thead>
<tbody>
<tr>
<td>No-till soybean following corn with a cover crop</td>
<td>208</td>
<td>142</td>
<td>66</td>
<td>68%</td>
</tr>
<tr>
<td>No-till corn following corn with a cover crop</td>
<td>561</td>
<td>146</td>
<td>415</td>
<td>26%</td>
</tr>
<tr>
<td>No-till soybean following corn with no cover crop</td>
<td>1,832</td>
<td>468</td>
<td>1,364</td>
<td>26%</td>
</tr>
<tr>
<td>No-till corn following soybean with a cover crop</td>
<td>442</td>
<td>95</td>
<td>347</td>
<td>21%</td>
</tr>
<tr>
<td>No-till corn following corn with no cover crop</td>
<td>2,005</td>
<td>360</td>
<td>1,645</td>
<td>18%</td>
</tr>
<tr>
<td>No-till corn following soybean with no cover crop</td>
<td>2,629</td>
<td>357</td>
<td>2,272</td>
<td>14%</td>
</tr>
<tr>
<td>No-till soybean following Soybean with No Cover Crop</td>
<td>733</td>
<td>82</td>
<td>651</td>
<td>11%</td>
</tr>
<tr>
<td>No-till corn following corn silage with a cover crop</td>
<td>646</td>
<td>24</td>
<td>622</td>
<td>4%</td>
</tr>
<tr>
<td>No-till corn following corn silage with no cover crop</td>
<td>1,025</td>
<td>10</td>
<td>1,015</td>
<td>1%</td>
</tr>
<tr>
<td>No-till soybean following corn silage with no cover crop</td>
<td>65</td>
<td>0</td>
<td>65</td>
<td>0%</td>
</tr>
<tr>
<td>No-till soybean following soybean with a cover crop</td>
<td>40</td>
<td>0</td>
<td>40</td>
<td>0%</td>
</tr>
<tr>
<td>No-till corn following small grain for hay or silage</td>
<td>673</td>
<td>0</td>
<td>673</td>
<td>0%</td>
</tr>
<tr>
<td>No-till soybean following small grain for hay or silage</td>
<td>75</td>
<td>0</td>
<td>75</td>
<td>0%</td>
</tr>
<tr>
<td>No-till corn following grass hay or alfalfa</td>
<td>661</td>
<td>0</td>
<td>661</td>
<td>0%</td>
</tr>
<tr>
<td>No-till soybean following grass hay</td>
<td>90</td>
<td>0</td>
<td>90</td>
<td>0%</td>
</tr>
<tr>
<td>No-till corn double-cropped</td>
<td>39</td>
<td>0</td>
<td>39</td>
<td>0%</td>
</tr>
<tr>
<td>No-till soybean double-cropped</td>
<td>884</td>
<td>0</td>
<td>884</td>
<td>0%</td>
</tr>
<tr>
<td><strong>Total acreage</strong></td>
<td><strong>12,608</strong></td>
<td><strong>1,684</strong></td>
<td><strong>10,924</strong></td>
<td><strong>31</strong></td>
</tr>
<tr>
<td>Cropping system</td>
<td>Total acres</td>
<td>Acres damaged</td>
<td>Acres not damaged</td>
<td>Percent damaged</td>
</tr>
<tr>
<td>-----------------------------------------------------------</td>
<td>-------------</td>
<td>---------------</td>
<td>-------------------</td>
<td>-----------------</td>
</tr>
<tr>
<td>Conventional tillage soybean following corn with no cover crop</td>
<td>1,442</td>
<td>47</td>
<td>1,395</td>
<td>3%</td>
</tr>
<tr>
<td>Conventional tillage corn following corn with a cover crop</td>
<td>120</td>
<td>0</td>
<td>120</td>
<td>0%</td>
</tr>
<tr>
<td>Conventional tillage corn following corn with no cover crop</td>
<td>706</td>
<td>0</td>
<td>706</td>
<td>0%</td>
</tr>
<tr>
<td>Conventional tillage corn following soybean with a cover crop</td>
<td>200</td>
<td>0</td>
<td>200</td>
<td>0%</td>
</tr>
<tr>
<td>Conventional tillage corn following soybean with no cover crop</td>
<td>635</td>
<td>0</td>
<td>635</td>
<td>0%</td>
</tr>
<tr>
<td>Conventional tillage soybean following corn with a cover crop</td>
<td>675</td>
<td>0</td>
<td>675</td>
<td>0%</td>
</tr>
<tr>
<td>Conventional tillage soybean following small grain for hay or silage</td>
<td>140</td>
<td>0</td>
<td>140</td>
<td>0%</td>
</tr>
<tr>
<td>Conventional tillage soybean following grass hay</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>-68</td>
</tr>
<tr>
<td>Conventional tillage soybean following soybean with no cover crop</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>-68</td>
</tr>
<tr>
<td>Conventional tillage corn following grass hay</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>-68</td>
</tr>
<tr>
<td>Conventional tillage corn following small grain for hay or silage</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>-68</td>
</tr>
<tr>
<td><strong>Total acres</strong></td>
<td><strong>3,938</strong></td>
<td><strong>47</strong></td>
<td><strong>3,891</strong></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cropping system</th>
<th>% Following corn</th>
<th>% Following soybean</th>
<th>% Point change</th>
</tr>
</thead>
<tbody>
<tr>
<td>No-till corn with cover crop</td>
<td>26</td>
<td>21</td>
<td>-5</td>
</tr>
<tr>
<td>No-till corn with no cover crop</td>
<td>18</td>
<td>14</td>
<td>-4</td>
</tr>
<tr>
<td>No-till soybean with cover crop</td>
<td>68</td>
<td>0</td>
<td>-68</td>
</tr>
<tr>
<td>No-till soybean with no cover crop</td>
<td>26</td>
<td>11</td>
<td>-15</td>
</tr>
<tr>
<td><strong>Average</strong></td>
<td></td>
<td></td>
<td><strong>-23</strong></td>
</tr>
</tbody>
</table>

There was a decrease in the percentage of acres showing slug damage when no cover crop was used versus using a cover crop regardless of whether the crop followed corn as grain or corn for silage or after a soybean crop (Table 5). In no-till soybean systems, a large decrease occurred for the no-till soybean after corn system (a reduction of 42 percentage points).

There were several management practices that had a very low to no incidence of slug injury. For several of the practices, the fact that there was minimal crop residue on the soil surface (such as no-till corn or soybean after corn silage and no-till corn or soybean after small grain for hay or
Silage) is likely the explanation for the low amount of slug damage. One management practice that stood out was that no-till corn or soybean following grass hay had no slug feeding pressure. This is typically a high residue situation. Finally, all systems with no-till corn or soybean following small grain for grain (double-cropped) had no slug injury.

Table 5. Percentage of acres in no-till fields with damage following a cover crop or no cover crop.

<table>
<thead>
<tr>
<th>Cropping system</th>
<th>% With cover crop</th>
<th>% Without cover crop</th>
<th>% Point change</th>
</tr>
</thead>
<tbody>
<tr>
<td>No-till corn after corn</td>
<td>26</td>
<td>18</td>
<td>-8</td>
</tr>
<tr>
<td>No-till corn after soybean</td>
<td>21</td>
<td>14</td>
<td>-7</td>
</tr>
<tr>
<td>No-till corn after corn silage</td>
<td>4</td>
<td>1</td>
<td>-3</td>
</tr>
<tr>
<td>No-till soybean after corn</td>
<td>68</td>
<td>26</td>
<td>-42</td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td></td>
<td>-6</td>
</tr>
</tbody>
</table>

Table 6 sorts the incidence of slug injury by frequency of pre-plant insecticide use. When the survey was conducted farmers were asked the question: “How often do you spray insecticides when you are spraying pre-plant herbicides to no-till corn and soybean?” Always means every time either corn or soybean will be no-tilled, sometimes means that insecticide is used about half of the time, and never means that insecticide is never sprayed when applying pre-plant herbicides. These data reflect each farmer’s experience irrespective of acreage. Sixty-five percent of the farmers who always apply insecticide when spraying pre-plant herbicides experienced slug injury. The numbers drop to 27 percent and 13 percent of farmers who spray insecticide “some of the time” and “never,” respectively.

Table 6. Number of farmers with slug damage.*

<table>
<thead>
<tr>
<th>Total number of farmers</th>
<th>Farmers with slug damage</th>
<th>Percentage of farmers with slug damage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Always use insecticide</td>
<td>20</td>
<td>13</td>
</tr>
<tr>
<td>Sometimes use insecticide</td>
<td>13</td>
<td>3</td>
</tr>
<tr>
<td>Never use insecticide</td>
<td>8</td>
<td>1</td>
</tr>
</tbody>
</table>

* When the survey was conducted farmers were asked the question: “How often do you spray insecticides when you are spraying pre-plant herbicides to no-till corn and soybean?” Always means every time either corn or soybean will be no-tilled, sometimes means that insecticide is used about half of the time, and never means that insecticide is never sprayed when applying pre-plant herbicides.

An attempt was made to remove three cropping systems that had no slug feeding pressure from the data to determine if the removal of this data would have an impact on the results shown in Table 2. The cropping systems that were removed included: no-till corn or soybean following small grain for silage, no-till corn or soybean following grass or alfalfa hay, and no-till corn or soybean double cropped. Removing these cropping systems, however, did not have a noteworthy impact.

One management practice emerged as potentially resulting in less slug injury was growing small grain for grain. During the survey interviews, there were several instances when farmers would say “On field x, y, or z in 2012 I grew wheat (or barley) for grain followed by soybeans and the 2013 crop (either no-till corn or soybean) did not have injury.” The interviewer was not
able to determine which fields specifically had this management so that these fields could be separated and reported individually. Two questions that could be asked are: 1) are there beneficial insects that thrive in fields where small grain is grown for grain production; and 2) does growing small grain for grain disrupt the slug life cycle. In contrast, Extension specialists from other states noted that in past years, this particular crop rotation has been problematic for slugs.

**Summary/Conclusions:**

This is a summary of observations by 41 farmers located in the Northern Shenandoah Valley of Virginia representing 16,546 acres of corn and soybean (with 12,608 of these acres no-tilled). There are several limitations to the data summarized in this report. First it is important to remember that these data are a collection of observations that cannot be statistically validated. Second, this survey only encompasses one growing year. It will be necessary to collect data for two or three years before solid conclusions are possible. A few farmers stated that in the prior year their slug damage was worse in a different cropping system. Finally, the report summarizes farmers’ observations about damage caused by slugs. There may have been slugs present and possibly a small amount of injury in fields with no damage (i.e. don’t assume that “no damage” means there were no slugs present or there was no feeding injury).

- In this survey slug damage appeared to be higher anytime either corn or soybean was no-till planted followed corn for grain compared to anytime either corn or soybean was no-till planted following soybean. Specialists from other states noted that in prior years corn planted following a wheat/soybean double crop had typically been the most problematic.

- In this survey, planting a cover crop appeared to increase the incidence of slug damage. It is likely that 90% of the cover crop planted in the Northern Shenandoah Valley is a small grain (wheat, barley or rye) that is planted at two bushels per acre. This survey did not distinguish how the cover crops was planted (i.e. was it no-tilled or was the ground disked)? There is some thought that heavy disking prior to planting cover crop will destroy slugs and slug eggs. Also this survey does not differentiate different cover crop species or blends. The majority of cover crop planted in this area is small grain. There are also daikon radish, crimson clover and daikon radish/oat mixes represented in this survey that did not have slug injury (it was simply classified in the broad category “cover crop”).

- Based on this data and prior years’ observations, planting no-till corn or soybean following grass hay (a perennial grass sod such as orchardgrass, fescue, or bluegrass) does not appear to result in slug damage. Alfalfa is not included in this statement because the survey only included one or possibly two fields where corn followed alfalfa.

- Based on this data and prior years’ observations, planting no-till corn or soybean following small grain for hay or silage does not appear to result in slug damage. This survey does not distinguish how the small grain was planted (i.e. was it no-tilled or was the ground disked)? There is some thought that heavy disking prior to planting cover crop will destroy slugs and slug eggs.
• Based on this data and prior years’ observations, planting no-till corn or soybean double-crop (i.e. following small grain for grain) does not appear to result in slug damage.

• This survey attempted to assess the effect of broadcast application of insecticide pre-plant (i.e. applying insecticide mixed with the pre-plant herbicide application) on slug damage. The general theory is that these broadcast applications of insecticides may be killing a beneficial insect that could potentially limit the number of slugs in a field. There are many aspects of this issue that need further study before any major conclusions can be reached. First we do not know if there are beneficial insects that actually control slugs in any situations. Second, we do not know if a single application of insecticide in the early spring causes long term damage to the population of these beneficial insects. Also, we know that there are areas within the mid-Atlantic region were farmers need to spay pre-plant insecticides to control cutworms or armyworms. Thus, while the data in this report is intriguing, more study is needed to better assess the impact of pre-plant broadcast application of insecticide on slug damage.

Acknowledgements: Thank you to Dr. Wade Thomason, VCE; Joanne Whalen, UD; Dr. Ronald Hammond, OSU; Dr. John Tooker, Penn State; Dr. Richard Taylor, UD; and Thomas Archibald, VCE for their assistance with completing this report.

Genetically Modified Crops and their Effect on Crop Production

Mrs. Holly L. Walker
Ph.D. Candidate, Department of Entomology and Wildlife Ecology
University of Delaware
Email: hollylyn@udel.edu

There have been many advances over the years to crop production in the agricultural industry; however, none are as controversial or potentially beneficial to growers as the introduction of genetically modified (GM) crops. There is a long history of introduction of new genetic material into plant species through the use of selective breeding programs in agronomic crops. These practices have been used for a variety of purposes, some of which include trying to increase genetic diversity. This is done by selecting plants for specific traits to increase yield or to provide protection or tolerance to a range of different kinds of pests (Wieczorek and Wright 2012). Despite improvements to crops through selective breeding, a more specialized tool was developed that has allowed for better precision and less negative side effects when mixing genetic material. Through the use of genetic engineering scientist have been able to move beneficial genes from selected species into new genetically modified organisms. Genetically modified organisms (GMOs) are defined as any organisms that has had its’ genetic material (DNA) altered by means of genetic engineering techniques. Most people however associated it with altering an organism’s DNA in such a way that would not occur under normal circumstances in nature (WHO 2014). This has led to a lot of suspicion and lash back from the general public, anti-GMO organizations and even some countries.
The first direct transfer of DNA from one organism to another through genetic engineering occurred in 1973 by Herbert Boyer and Stanley Cohen (Grace 2006), and even then there was much concern and controversy about what role genetic engineering should play in the creation of GM crops. For this reason the first commercially available genetically modified crop would not be released until almost twenty years later in 1994. The Flavr Savr tomato was engineered to delay the onset of ripening and provide better resistance to rotting through the introduction of an antisense gene. While the tomato did exhibit these beneficial traits, the product was an overall commercial flop (Bruening and Lyons 2000). However, two of the most important and notable introductions of genetically engineered crops occurred only two years later in 1996 when both herbicide-resistant crops and the first Bt crops were introduced to commercial markets (Benbrook 2004). Since then a wide variety of new GM crops have become available to commercial growers, many of which are changing the way in which we produce and manage crops across the United States. Moving forward these GM crops may have a more global impact as we figure out how to feed our growing human population.

Currently, crops that have genetically modified varieties includes but is not limited to maize, soybean, cotton, rice, canola (rapeseed), potatoes, tomatoes, sugar beet, eggplant, papaya, and peas (ISAAA 2014). A genetically modified variety of alfalfa was originally released in 2005; however it was pulled from the market after a legal injunction. The variety was re-released in 2011 following an Environmental Impact Study conducted by the USDA (Putnam, 2013) and work is in progress for the development of a genetically modified wheat variety (Monsanto 2014). The term GMO relates to a wide variety of organisms, however, for the purposes of this paper I will specifically be looking at genetically modified crops and how that has changed modern day crop production practices.

At the moment, there are two main methods used to create genetically modified plants. The first is the use of Agrobacterium, a bacterium that serves as a vector of DNA, to transfer foreign DNA into the host organism. The bacterium is given a small sequence of DNA including the beneficial trait that will end up the host plant. Once the foreign DNA is secured inside the bacterium it is than able to infect the host plant and insert parts of its own DNA sequence into the host organism’s genetic material (Valentine 2003). This method has been found to work best on broad leaf dicots, though recent research is making it applicable to monocot crop species. The other major way to create genetically modified crops is to use a biolistics method, also referred to as a gene gun, in which the DNA sequences that are meant to be inserted into the host organism are coated onto minute gold particles and fired into the host plant’s cells. The DNA coated on the gold particles eventually migrates and integrates into the host plant cells’ DNA. This method tends to work best on primarily monocots crop species (Wang and Ge 2006). Outside of these two methods, which are very precise in there movement of specific DNA sequences, there is also the ability to induce mutations that can cause insertions, deletions or reorganizing of genetic material, this method is primarily used in the early stages of research studies to gauge and look for potential traits of interest.

Genetically modified crops have greatly influenced crop production practices. Crop production refers to the management practices used to control plant growth factors to maximize crop yields. It is the goal of every grower to try and maximize crop yields within economic
limitations, which from what we will see is an important part of a grower’s decision whether to plant GM crops or not.

One of the primary ways in which GM crops affect current crop production practices is in the way that we manage a broad category of pests. Pest control is a major factor of crop production and is important to the grower because it can directly affect yield results (Qiam and Zilberman 2003). Again, maximizing crop yield is the main goal of crop production, so the ability to control pests and release crops from competing pest species is important to the grower’s bottom line. Agricultural pests can refer to a variety of pest organisms including weeds, insect pests and pathogens. With that being said, one of the most commonly used and widely accepted GM traits currently available has been the herbicide-resistance trait found in a range of crop species. Herbicide-resistant crops are specifically engineered to be tolerant to glyphosate, a commonly used herbicide, also referred to by its trade name: Roundup. These plants that are glyphosate tolerant are often described as being ‘Roundup Ready’ (RR), which is another common name for this set of GM crops. Once seedlings of an herbicide-resistant crop have emerged the grower can spray glyphosate herbicide without fear of killing their crop plants (Ronald 2011).

Weeds can become a serious issue in agriculture fields and in forage fields by out competing with desired crop for light, nutrients, water and space. In addition some weeds can make harvesting difficult while adding to the overall cost of operation for growers as they try to manage weeds with traditional herbicide and cultural practices (Labrada and Parker 1999, Gianessi 2005). In 2005 Leonard Gianessi estimated that the total savings that U.S. growers could expect to see from switching to herbicide-resistant crops was roughly $1.2 billion. In addition to the impact to the economic decisions a grower has to make about whether or not to plant herbicide resistance crops, GM crops impact a grower’s decision about what types of tillage systems they are going to use (CAST 2012). In the past when growers rotated tillage systems they often would also rotate their herbicide treatments. However, with the increased dependence on using herbicide-resistant crops more growers seem to be moving to no-till or conservation tillage systems (Duke 2005). Conservation tillage helps to reduce costs associated with fuel, labor and equipment costs. Another benefit of switching to conservation tillage is that it reduces compaction. However, as growers depend more on herbicide-resistance crops they also no longer rotate their herbicide programs as frequently. This can become a serious problem when weeds also begin to develop herbicide resistance due to constant selection pressure from using the same herbicide treatments and practices continuously over multiple growing seasons (Duke 2005, CAST 2012). So while herbicide-resistant traits have been very successful and are dramatically changing the way farmers control for weeds; the technology may not last long if growers do not rotate tillage systems and weed control practices.

In addition to weeds as an important pest to growing crops, insect pests are also a major factor for growers trying to maximize yields. Many insect species prefer agronomic crops because the plants are often breed to contain reduced level of toxins, which may make the plant less appealing in taste, and because agronomic fields tend to be monocultures the full range of beneficial insects that help control insect pest populations are usually not present. Most growers were left with little options other than heavy regiments of highly toxic broad spectrum insecticide sprays that would also kill any beneficial insects that may be in the field as well (Altieri 1999). Since insects are often a major food source for other animals such as birds,
spiders, and even small rodents the effects of these heavy chemical sprays were beginning to have effects on surrounding wildlife populations and their health. In addition some insect pests of major agronomic crops began to show signs of resistance to frequently used broad spectrum insecticides (Roush and Tabashnik 1990). Other concerns with traditional chemical pesticides sprays include their effect on human health, particularly of field laborers in underdeveloped countries that have reported high numbers of pesticide poisonings (Ronald 2011). Agricultural biotechnical companies responded by developing GM crops that could produce their own insecticides and offer limited effects on non-target hosts, including humans. These self-protecting plants were created in the form of Bt crops, which are plants that contain genes from the soil bacterium, *Bacillus thuringiensis* (Bt). The Bt genes allow the plant to produce insecticidal proteins in its tissue that protect it from severe feeding damage of any herbivorous insect that feeds upon it (Ronald 2011). The most notable of these being Bt corn, which has gained widespread adoption across the U.S. corn belt.

Many traits have been discovered under the umbrella of Bt technology, and each of these Bt traits produces a different insecticidal protein that often targets specific groups of insects. Meaning that a grower who only has issues with Coleopteran pests can choose a variety with Bt traits targeted for that insect group, without applying selection pressure to other insects that may occasionally feed on corn (Cullen et al. 2008). While Bt crops most directly affect pest control measures they can also effect decisions about crop rotations and plant variety decisions. It can also impact economic decisions because in general GM crops tend to cost more than conventional crop varieties and with the introduction of stacked and pyramid GM crops, which contain more than one genetically engineered trait, prices will continue to rise.

However, despite increases in seed costs for GM crops the benefits often outweigh the price. Stephan O. Duke (2005) stated, “Anything that allows for more efficiency in production of a product, whether industrial or agricultural, reduces the cost of production, ultimately providing a competitive advantage.” In the agricultural industry where growers are constantly looking for ways to streamline production and reduce costs GM crops seem like a natural answer. Studies by Fernandez-Cornejo and Caswell (2006) showed that when insect pressure was high for major agronomic crops the lower costs associated with fewer insecticide applications and less insect damage provided growers with significant profit compared to growers who used conventional pesticide management strategies. In the end the ability to control pests allows growers to reach their higher yield goals that would otherwise be lost to pest damage and competition, or just lost financially in the costs to pest control measures (Qiam and Zilberman 2003, Monsanto 2012).

On a final note it is important to point out that GM crops are not a fool proof method and the use of GM crops requires a lot of thought and additional management practices to ensure the longevity of these genetically modified traits. As hinted at before, there many researchers who are concerned that with constant selection pressure, weeds and insect pests will begin to develop resistance to these methods similarly to how they done with conventional herbicides and pesticides. One of the ways to delay resistance for many GM crops is to plant a proportion of the field with non-GM crop plants that serve as a refuge for non-resistant pest species. However, planting a refuge, which can be as much as 20% of a field’s crop, often requires additional planning and separate planting. This often leads to growers who choose or accidently fall out of compliance (Cullen et al. 2008). Other issues raised include concerns to public health and the
environment. Many groups feel that not enough research has been done to guarantee that there is not serious negative health effects associated with GM crops. Finally, there are issues with contamination of genetically modified material with neighboring non-GM crops. This can have serious impact for organic growers and in areas where selective breeding practices and cultivar development is taking place, such as areas that participate in land races. These are only a few of the controversies surrounding GM crops, however as the human population continues to grow and there is less availability of suitable farming land, technology will have to find way to compensate for the increasing food production demands over the next twenty to one hundred years (Tester and Langridge 2010).

GM crops, like most aspects of crop production, are not a silver bullet and come with its own series of decisions that have to be made. However, under the right conditions it can be an extremely useful tool to growers and seems to be the direction in which we are heading as crops for food and fuel begin to be in higher demand.

**Literature Cited:**


The Green Revolution

Travis C. Burt
M.S. Candidate, Department of Plant and Soil Science
University of Delaware
Email: burtrav@udel.edu

Agriculture is one of the most important industries to our worldwide economy. It is the backbone of our economic system. Agriculture not only provides food and raw materials to the world but also employment opportunities to a very large proportion of the world population. Today, the business of agriculture is one of the most well-researched and competitive industries in the world. The licensing of pesticides, herbicides, and now even germplasm has opened a new world of opportunity, while also changing the landscape of farming and how farmers produce their crops and livestock. Because of these advancements, farmers have been able to continue to feed an ever growing world population. Without the “Green Revolution” of the 1960’s, this incredible feat would have never been possible.

The seeds for the Green Revolution were planted in 1944 when Norman E. Borlaug was hired to create a wheat research program established by the Rockefeller Foundation in Mexico (Fitzgerald- Moore, 1996). Their goal was to make Mexico self-sufficient in the production and distribution of cereal grains. Borlaug's team set out to develop varieties of wheat that grew well in the various environmental conditions in Mexico while also increasing their efficiency. These varieties would also depend on an increased input of crop management including inorganic fertilizers, pesticides, herbicides, and irrigated water. These technologies already existed, but were not widely available to many underdeveloped countries. He completed this goal by breeding plants in central Mexico during the summer and then in Northern Mexico during the winter. In doing this, he was able to double the rate of the wheat breeding program and due to the differing conditions at the two locations the resulting plants proved extremely adaptable. Borlaug and his team had successfully developed high yield varieties (HYV) of wheat that were suited for the unique environmental conditions in Mexico. Phenotypically these plants were short stemmed varieties that also reached maturity at a faster rate. Mexican farmers had been growing long stemmed varieties that would lodge when the wheat was ready to be harvested causing widespread yield losses (Miller, 2012). Mexico, which previously had to import wheat, became a self-sufficient cereal-grain producer by 1956 by utilizing the techniques that Borlaug had brought to Mexico and the varieties he helped develop. Borlaug described the twenty years from 1940’s to 1960’s as the "silent revolution" that set the stage for the more dramatic Green Revolution to follow.

In 1961, a devastating famine was threatening India and Pakistan, similarly to Mexico some 20 years earlier. Borlaug went to the subcontinent to try to persuade governments to import the new varieties of wheat he had bred in Mexico. Borlaug’s expertise as a bridge between the industrialized world and underdeveloped countries would again be crucial in saving countless lives. India’s grain monopolies wanted no part of these new varieties and worked with the government of India to stop their importation of new seed. It wasn’t until 1965 when Borlaug was able to overcome resistance to the unfamiliar crop and its foreign seeds. His new varieties
caught on quickly after being tested in Punjab, an area with great agricultural success and steady water supply. By 1970, 55 percent of the 35 million acres of wheat in Pakistan and 35 percent of India's 35 million acres of wheat were sown with the Mexican dwarf varieties or varieties derived from them (Curran, 2013). The same intensive crop management techniques were also introduced in these areas leading to the drilling of thousands of wells for irrigation. Both India and Pakistan became self-sufficient in cereal production by 1974 (Fitzgerald-Moore, 1996).

Borlaug had solved cereal production issues in three countries and offered solutions to many other wheat producing countries with the advent of his new, optimized wheat varieties and intensive crop management; however rice was still the bulk of caloric intake by the people of Asia. In order to do for rice what the Mexican program had done for wheat, The International Rice Research Institute in the Philippines was founded in 1960. Scientists set out to develop new HYV of rice that could also withstand the unique environments presented in India and Pakistan. Researchers addressed the problem of intermittent flooding of rice paddies by developing strains of rice that would thrive even when submerged in water for extended periods of time. The new varieties also produced five times as much rice as the traditional varieties and opened flood-prone land to rice cultivation. Other varieties were more disease-resistant or more suited to tropical climates. By crossing two varieties called Dee-Geo-woo-gen and Peta, researchers were able to create a variety called IR8, which doubled yields and became known as "miracle rice" (Hazel, 2009). Now, two of the world’s most important cereal crops had been optimized by scientific research and rethinking how farmers manage their fields.

With the introduction of these HYV and improved crop management techniques the ball of progress started rolling and led to more and more advances in agriculture and improved yields across crops in underdeveloped countries. Since farmers were able to produce more yield, they were also able to increase their profits, which in turn lead to the ability for farmers to increase their productivity and yield captured. Farmers in these countries were now capable of replacing draft animals with efficient, more powerful machinery. This creates an exponential cycle leading to an overall increase in prosperity. This led these underdeveloped countries, which had been struggling economically, to be able to prosper in trade and commerce as a nation, since feeding their population was no longer a primary concern.

It is important to understand that it is not the new varieties alone that led to the revolution of improved worldwide agriculture. These new varieties were the only novel technology developed during the Green Revolution, since intensive crop management existed in more industrial countries. One could argue that the spread of intensive management techniques was the primary reason for the huge spike in world crop production. If the HYV are grown in suboptimal conditions then the HYV might very well do worse than the original varieties being grown in the same suboptimal conditions. In 1968, Indian agronomist S.K. De Datta published that IR8 rice yielded about 5 tons per hectare with no fertilizer, and almost 10 tons per hectare under optimal conditions (De Datta, 1968). In order to achieve the huge gains in yield from these high yield varieties, farmers needed to input chemical fertilizers, pesticides, herbicides, and irrigation.

Because of this change in crop management, critics argue that the Green Revolution primarily benefited large farm operations that could more easily obtain fertilizer, pesticides, and modern equipment, and that it helped displace poorer farmers from their land, driving them to...
sell their farms to larger entities. Other people have objected to the use of chemical fertilizer, which replaced animal manure or mineral fertilizer in many areas. The increased use of synthetic pesticides has also been vilified, as they may harm beneficial insects, such as pollinators, or even humans. The use of irrigation was also condemned by many because it often required drilling wells and tapping underground water sources which could drastically alter the natural landscape of an area. Critics also worry about genetic diversity in crops. The overall crop diversity is reduced because the HYV varieties of rice and wheat come from a narrow genetic base. This lack of diversity could lead to an epidemic outbreak of a pathogen, since the majority of a given crop species are genetically identical (Evenson, 2003). There are also claims that the Green Revolution actually weakens the world’s food security because of the shift from farmers growing subsistence- oriented crops to cropland used for growing more economically motivated crops. In India, land used for growing pulse crops switched to wheat, which was not a large part of the underprivileged diet (Spitz, 1987).

I can understand the environmental and social concerns of the critics of the Green Revolution; however the good outcomes of this revolution greatly outweigh any bad consequences. Simply put, land is becoming more and more limited worldwide as population continues to grow. The Green Revolution enabled farmers to extract much more yield out of the same amount of land. It is estimated that if farmland productivity had not tripled in the second half of the twentieth century, it would have been necessary to clear half of the world's remaining forest-land for conversion to agriculture (Brown, 2001). Most importantly, the Green Revolution also saved countless lives in developing countries by preventing widespread famine.

Another huge positive outcome of the Green Revolution is that the science of agriculture became much more widely researched outside of developed countries. The two original institutes that started the Green Revolution have given rise to an international network of research establishments dedicated to agricultural improvement and the development of agricultural resources in developing countries. Even more so, agriculture became a huge business opportunity for private industry, leading to industrial research that has been able to vastly improve crop yields through countless patents for herbicides, pesticides, synthetic fertilizers, and plant varieties. Because of this input of research, the field of agriculture has been able to help farmers produce more yield and improve techniques all over the world.

Today, I would argue that most agronomic crop farmers (cereals, corn, soy, etc.) have adopted the crop management and varietal selections that were initiated during the Green Revolution. Now, the practices of applying fertilizer, pesticide, and herbicide are common practice on most agronomic farms worldwide. Most of today’s best performing and most desirable varieties require the use of these inputs to maximize their yield potential. In a world where land resources are at an all-time low, the sustainability of agriculture depends on efficiency. Norman Borlaug saw this truth some 70 years ago and was able to fundamentally change the way we view agriculture by bridging the gap between modern farmers in industrial countries and more rural farmers in countries where agricultural technology had yet to be introduced. The Green Revolution paved the way for the techniques and technologies that currently shape our agricultural principles and has enabled farmers around the world to continue to feed an ever growing world population.
Establishing and Managing Bermudagrass for Pasture and Hay

Richard W. Taylor, Ph.D., CCA  
Extension Agronomist  
University of Delaware  
Email: rtaylor@udel.edu

Bermudagrass [Cynodon dactylon (L.) Pers] is a warm-season grass that typically has been used as a hay and pasture grass in the hot, humid areas of the southern United States. With breeding efforts that have included winter hardiness selection as well as the natural adaptation of the species, the northern limit of bermudagrass adaptability has been moving to the north and now encompasses Delaware. This grass produces 80 to 85% of its growth during the period of
May 15 to September 15 when Delaware-adapted cool-season grasses, tall fescue, orchardgrass, timothy, and Kentucky bluegrass, grow slowly. Bermudagrass has excellent tolerance to the high summer temperatures experienced in Delaware, making its best growth at 80-90°F.

**Variety Selection**

There are now basically three categories of bermudagrass varieties, common seeded, hybrid types from seed, and vegetative hybrids that produce little viable seed. Many if not most of the common seeded varieties are just selections of common bermudagrass that are generally planted using seed although at least some of these variety selections can be sprigged or planted vegetatively. The original hybrid bermudagrass varieties produced very little if any viable seed and had to be planted using sprigs or ‘long-hay’ for a vegetative less-expensive method of planting. Sprigs are the crowns of plants with roots attached, stolons (above ground horizontally growing stems) with or without roots, and rhizomes (below ground stems) with roots attached. Pieces of the crowns, stolons, and rhizomes are dug with a sprig digger or other equipment and then immediately (within 24 hours) planted into a prepared weed-free, firm seedbed. Sprigs can be planted mechanically with a machine designed specifically for planting springs about 1 to 2 inches below the soil level and firming the soil overtop of the sprigs, or they can be broadcast and disked lightly into the seedbed and then firmed into the soil, or planted in rows using a modified tobacco setter.

In the near future, certified sprigs will be available from a producer in the mid-Atlantic area which should make the selection of bermudagrass to supplement forage production during the summer growth period a viable option. It is unknown which varieties might be available for sprigging beginning around 2016 but below a description of some of the possible varieties that could be available will assist growers in selecting an adapted variety.

**Tifton-44:** Tifton-44 is a hybrid cross between Coastal bermudagrass and a bermudagrass that had survived in Berlin, Germany. It is a fine-stemmed, winter-hardy variety that reportedly has survived as far north as Michigan. It does start growth earlier in the spring than many bermudagrass varieties and is more resistant to foliage diseases than Midland.

**Quickstand:** This variety was collected at the University of Kentucky Robinson Substation by Dr. Harold Rice and has been released by UK, NRCS, and the USDA. Quickstand is high yielding and shows vigorous stolon production. It also has fine stems that cure fast when cut for hay but is shorter than Tifton-44 and makes a dense sod. In tests at Beckley, West Virginia, the winter hardiness and yield of this variety exceeded that of Midland and other varieties tested. This variety has been grown in southern Pennsylvania and in many locations in Maryland and survived winter.

**Ozark:** The variety “Ozark” is a new and distinct hybrid bermudagrass variety. The plant was derived from an F1 hybrid cross of bermudagrass varieties A9959 × “Coastal.” Ozark bermudagrass has relatively tall, upright growth and exhibits superior cold tolerance relative to previous bermudagrass varieties, yielding well in the northern part of the bermudagrass belt. It was jointly released in 2001 by the Missouri, Oklahoma, Kansas, and Arkansas Agricultural Experiment Stations, the USDA-ARS, and the Samuel Robers Noble Foundation. It is a clonally
propagated forage type bermudagrass (not seeded). It appears to have good resistance to diseases that may cause stand thinning and it is highly resistant to leaf spotting diseases.

**Wrangler:** This is a relatively new seeded variety developed in Oklahoma. It has good winter hardiness and was seeded in Delaware in about 2010 and remains in the pasture even after the winter of 2013-2014. It has slightly lower yield potential than Tifton-44 and similar quality.

**Cheyenne II:** This is a five clone synthetic variety developed by Judy Brede for Pennington Seed, Inc. The original clones were selected for their cold tolerance and vigorous growth habit. This variety is a seeded variety that establishes rapidly under desirable growing conditions in as little as 45 to 60 days although it should not be grazed until the next growing season. This variety is as cold tolerant as Tifton 44.

### Planting Bermudagrass

**Sprigging:** This method is a common but relatively expensive way to establish bermudagrass. The entire rhizome or ‘sprig’ is planted either in a furrow immediately behind an opening device, covered, and rolled all in a single operation or is spread with equipment such as a manure spreader, disked lightly, and ten cultipacked or rolled to firm the soil over the springs. The depth of planting is determined by the availability of soil moisture and the soil’s texture. In dryland situations with sands, sandy loams, and loams, planting 2 to 2.5 inches deep is adequate. If irrigation is available, plant at a depth of 1.5 to 2 inches deep so that some portion of the sprigs show above ground. If the soil is dry, water should be applied as soon after planting as possible to prevent desiccation of sprigs.

Sprigs should be fresh and after digging they should be kept moist and cool and planted within 24 hours. Exposure of the sprigs to the sun and wind after digging increases the risk of desiccation and rapidly reduces the viability of the sprigs. Sprigs exposed to sun and wind for four hours following digging around noon can drop to less than 10% viability but if shaded and kept moist can retain most if not all their viability.

A bushel of sprigs normally has about 1,000 sprigs which is equivalent to 1 square yard of bermudagrass sod. One bushel is about 1.25 cubic feet of sprigs but there is a wide variation in the number of sprigs per bushel since the density of the bushel varies a lot. A minimum sprigging rate of 20 bushels per acre is recommended although heavier sprigging rates of 30 to 40 bushels per acre generally help improve initial stands and produces a faster coverage of the soil surface especially for the slower growing hybrids.

There are two generalized methods of sprigging bermudagrass in the South. One is a dormant sprigging and the other is a spring sprigging. In the dormant method, springs are dug and then planted before the plants emerge from winter dormancy. This ensures that sprigs have the maximum amount of energy since new spring growth that pulls stored sugars/carbohydrates from the crown, roots, rhizomes, and stolons has not begun. A dormant sprigging takes place in March to early April in this area of the country.
Spring sprigging takes place in mid- to late-spring (May to June in the mid-Atlantic). The carbohydrate reserves in the sprigs is generally lower but bud dormancy is typically broken at this time and rapid emergence from the soil is typical of all the proper planting procedures are used. If irrigation is available to keep the newly planted sprigs moist, spring sprigging can be successful even into July.

Some keys to successful sprigging include the following:

- Start with a well fertilized seedbed with a pH of 6.2 to 6.8 and high optimum levels of phosphorus and potassium.
- Avoid a ‘fluffy’ seedbed by firming it before sprigging.
- Firm the seedbed both prior to planting and following sprigging to ensure good soil to sprig contact and reduce the possibility of air pockets in the soil that can lead to excessive drying.
- Don’t plant sprigs too deep.
- Irrigate immediately after sprigging if possible or sprig into moist soil.
- Plant sprigs as soon as possible after they are dug.
- Reduce the potential weed seed bank as much as possible.
- Control weeds as soon as possible after they emerge to reduce shading on the newly emerging sprigs.
- Don’t overgraze if using grazing to control weeds after sprigging.
- Delay topdressing with nitrogen (N) until sprigs show an inch or two of topgrowth (about one month after planting).
- After another 30 day interval, apply an additional 30 to 50 pounds (lbs) N/acre.

**Planting Long Hay, Fresh Material, or Tops:** Planting long hay or tops is different from planting sprigs of established bermudagrass. Tops are above-ground, green, mature stems and, unlike sprigs, tops must develop roots at the nodes to become an established independent plant. For a top, an upright stem or stolon, to root, it must be mature which means about 6 weeks old, 18 to 24 inches long, and have 4 to 6 or more nodes. A producer can plant a small nursery area in bermudagrass and then use the mature tops to transplant to larger fields as the tops or runners mature. This practice can decrease the cost of paying for complete sprigging, can be done by the producer, and often can be done with equipment already owned by the producer.

Varieties of bermudagrass differ in how adapted they are to this planting method. The method works best when irrigation is available to keep the soil moist following the planting process. The fresh cuttings or clippings are cut like hay but gathered while still green and unwilted. They are quickly spread over a prepared seedbed and lightly incorporated into the soil so that at least a portion of leaf material and preferably a portion of the long stems are above the soil and at least two or three nodes are buried in the soil. The cuttings can be spread in rows or broadcast with a manure spreader and then incorporated or partially covered with a disk. New roots will emerge from the buried nodes if the soil is moist. Tops should be spread on moist soil, irrigated immediately after spreading, or rainfall should be expected for the area within 12 to 24 hours after incorporation.
Some keys to successful planting of tops include the following:

- Choose a variety or hybrid known to be easy to root by tops or experiment on very small acreage with several varieties to determine which will perform best.
- Plant 5 to 7 bales per acre (approximately 225 to 350 lbs of long hay per acre).
- Cut the tops with a sickle mower, bale immediately (do not allow to wilt), and plant as soon as possible before the bale begins to heat hot enough to kill the grass. With small acreage, you can use a pitch fork and load the windrowed long hay onto a trailer or truck and spread in rows or broadcast with a manure spreader and obtain a successful stand.
- Scatter and disk the tops into moist soil before they wilt. Tops can die within minutes in bright sun, high air temperatures, and low humidity.
- Pack the soil immediately after disking with a roller or cultipacker so soil is compressed around the new runners to prevent excessive moisture loss and provide good soil contact to stimulate and support root growth.
- Even with irrigation, about 6 to 8 weeks of growth will be required before frost in the fall to prevent winterkill. In Delaware, the first frost can occur as early as the third week of September although the third week of October is more likely.

Seeding: Bermudagrass seed germinates when soil temperature reaches 65° F, so mid-May to mid-June planting dates are recommended. You should keep in mind that other grassy weeds such as crabgrass either have germinated or are likely to germinate at about the same time so weed control even prior to planting is essential for success. Also planting after June 15 can be adversely affected by dry summer weather leading to an inadequate root system and a lack of rhizome development which seems to be a key to winter survival.

For seeding, variety selection is very important. Many common bermudagrass varieties have been developed that may not have the cold tolerance necessary for winters in Delaware. In addition, seed companies often develop blends of bermudagrass cultivars that include seed of a Giant-type or Arizona common both of which are non-winter hardy types. Although these varieties will provide quick sod cover, they will die overwinter leaving the field open again the following year. They can be so aggressive that any winter-hardy variety in the mix will be inhibited due to competition for light, water, and nutrients and may not successfully establish according to our experience in Delaware.

The non-winter-hardy varieties produce numerous fibrous roots but few of the rhizomes needed for winter survival. These types also often have good to excellent seedling vigor, spread quickly after seeding, and produced seedling-year yield. The winter-hardy varieties have lower seedling vigor, spread more slowly, but produce many rhizomes that improve their winter survival. Winter-hardy varieties typically produce less seed and correspondingly have higher seed cost than the non-winter-hardy varieties. In this instance, economy does not pay.

Bermudagrass has about 2 million seeds per pound for hulled seed or about 1.5 million per pound for unhulled seed. Hulled seed will germinate in about 5 days if the soil is warm but unhulled seed can take 7 to 10 days to germinate. Commercial varieties are often a 50:50
mixture of hulled and unhulled seed. The mixture of hulled and unhulled seed can provide a longer germination window that can be useful if adverse conditions occur shortly after planting.

The typical seeding rate for bermudagrass is about 4 to 8 pounds of pure live seed (PLS) per acre. If you take the average germination rate and the percentage purity from the seed tag on purchased seed and multiply the two together, you can determine the percentage pure live seed in the bag of seed. Divide the selected seeding rate (4 to 8 lbs PLS/acre) by this percentage PLS and the answer is the final seeding rate to use. Many seed companies are coating seed with finely ground limestone and germination enhancers to improve seedling establishment. The lime coating results in about half the weight of the seed lot being inert ingredients so coated seed often contains only about 800,000 seeds per pound. Some university research indicates that the seed coatings do improve seedling survival enough so that coated seed can be planted at the same rate as uncoated seed with no reduction in stand. I would still recommend using the mid-point of the seeding rate for PLS to determine the amount of seed to plant per acre.

Light stimulates germination in bermudagrass, so a planting depth of ¼ inch or less is recommended. Just as for sprigging, a smooth, well-tilled, clod-free, firm seedbed with adequate moisture should be prepared. If you walk across the seedbed and your shoe print is more than 1/8th to ¼ inch deep, then the seedbed has not been firmed adequately. Planting too deep is a very common cause of establishment failure.

Seed can be drilled or broadcast on a conventional tilled seedbed or planted with a no-till drill on killed grass sod. If drilled, seed at ½ the calculated seeding rate and run the drill over the area twice at a 45 degree angle to obtain better coverage of the area and to help with weed control by shading as the seedlings will be closer together and able to close the canopy, shading the soil faster.

Nitrogen fertilizer should not be applied at planting to reduce weed competition. When newly formed stolons have reached a length of 3 to 6 inches, N should be applied at a rate of 30 to 50 lbs N/acre. A second application of 30 to 50 lbs N/acre can be applied 30 days later but do not apply N to bermudagrass after about August 15th to ensure that the N has been used up before the plants shut down growth in late-September or early-October. Target soil fertility levels are a pH of 6.2 to 6.5 and P and K levels in the upper optimum range. Soil acidity adjustment should be made at least one year prior to planting bermudagrass since limestone can take 9 to 18 months to completely react. It is advisable to recheck the soil pH prior to working the soil or planting no-till to make an additional adjustment if needed.

Weed Control

This is the major factor in obtaining a viable stand of bermudagrass. Bermudagrass is very intolerant of shade and is especially sensitive during the seedling stage. Grassy weeds are common problems for new seedings of bermudagrass whether planted from seed, sprigs, or long-hay (tops). In this region, crabgrass, foxtail, fall panicum, and goosegrass are the common grassy weeds with which to be concerned. A key for success is to do as much as possible before planting bermudagrass to reduce the size of the soil weed seed bank and to use every cultural practice possible to have the bermudagrass emerge rapidly and grow rapidly. Bermudagrass
seedlings are very intolerant of shade and fast growing grassy weeds can substantially reduce seedling vigor and ultimate stand. Weeds compete with bermudagrass for water, nutrients, and sunlight at all growth stages and can delay seedling establishment for years or completely inhibit stand establishment.

If weeds do become a problem, some of the options available include flash grazing or mowing during the establishment phase (the first growing season). Flash grazing consists of placing animals on the area at a stocking density such that the animals graze the weeds and some bermudagrass down to a 3 to 4 inch height within a short period of time, from a few hours to no more than 48 hours. The animals are removed and if the pasture was not evenly grazed to a uniform height, the pasture is mowed to remove non-grazed plant material. Periodic mowing can also be used as long as the growth is not excessive enough to cause shading from mowed clippings. Producers should try to allow bermudagrass to accumulate at least 4 to 6 inches of regrowth during the last 4 to 6 weeks of the growing season to help plants survive winter with minimal losses.

For weeds such as crabgrass, goosegrass, and certain annual broadleaf weeds, diuron can be applied immediately after sprigging as a preemergence weed control option. Sprigs should be planted at least 2 inches deep to help lessen the possibility of injury to bermudagrass. Already emerged bermudagrass may be temporarily injured. There are restrictions on how soon the bermudagrass can be grazed or fed so refer to the label for the most current information. To work properly, products containing diuron should be ‘watered in’ either by rainfall or by irrigation. In Delaware, a diuron product called Direx 4L is labelled for newly sprigged bermudagrass but must be applied before weeds emerge.

If a broadleaf problem does develop after emergence/establishment, there are some broadleaf herbicides (those containing Banvel and/or 2,4-D) that can be used but consult your county Ag Extension Agent or regional weed control specialist for the correct herbicides, application rates, application timing, and the time interval that must elapse before the forage can be grazed or cut for hay. These products also have the potential to volatilize under certain environmental conditions such as high temperatures or inversions and can cause injury to sensitive plants offsite so be sure to read and follow all label restrictions.

Notices and Upcoming Events

July 31, 2014
2014 Annual Forage and Livestock Field Day, Va Tech Southern Piedmont Agricultural Research and Extension Center, 2375 Darvills Road, Blackstone, VA 23824. For more information, contact Margaret Kenny at 434-292-5331 or by email makenny@vt.edu or RSVP on-line at http://tinyurl.com/forages2014

August 1-2, 2014
Pasture Poultry Training Session for Extension Professionals (Aug 1) and Farmers (Aug 2), Delaware State College, Dover, DE. For more information, contact Dr. Brigid McCrea at 302-857-6432 or by email bmcerea@desu.edu
August 19, 2014
Valatie Research Farm Field Day: New Tools – New Rotations, Walking Farm Tour from 12:15 to 3:30 pm at 128 State Farm Road, Valatie, NY 12184. For more information contact Steve Hadcock at 518-828-3346.

August 12, 2014
Soybean Diagnostic Field Day, University of Delaware Research and Education Center, Georgetown, DE. For more information, contact Dr. Mark VanGessel at mjv@udel.edu.

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. More information will be available in future issues of the newsletter.

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