



Mid-Atlantic Regional Agronomist Quarterly Newsletter

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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.

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Fall Fertilizer Nitrogen or No Fall Fertilizer Nitrogen for Wheat?

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Many Maryland farmers plant wheat following either corn or soybean. University of Maryland Extension's recommendation for fall fertilizer nitrogen (N) use at wheat planting is 0 - 30 lb/acre. The need for fall fertilizer N is dependent on the amount of residual soil nitrate that is present following harvest of corn or soybean. This article describes a wheat fall nitrate-N soil test (WFNT) that can be used as a decision-making tool for determining the need for wheat fall fertilizer N.

Wheat after Corn

A study was conducted to assess the response of wheat to fall fertilizer N across representative Maryland locations and soil types using production practices commonly used by Maryland farmers. To avoid causing unnecessary variability, management practices were kept similar across the locations. Wheat production on a total of 21 non-irrigated sites was studied over a period of 5 years. For all 21 sites, corn was the previous crop. Each corn main plot was divided into 4 corn N rate sub-plots, 0, 120, 180, and 240 lb N/acre to establish varying amounts of soil residual nitrate following corn harvest. After corn harvest, soil samples were collected for soil nitrate analysis to a 2 ft. depth from all sub-plots. Wheat was planted into each of the corn N rate sub-plots. Wheat for all studies was planted using a seeding rate of 1.5 million seeds/acre within a three-week window after the Hessian fly-free date for the area. Each wheat plot was divided into two parts; one part received no fall nitrogen and the other part received 30 lb N/acre. In the spring, a total of 100 lb fertilizer N/acre was applied to the entire plot area in split applications with the first application (50 lb N/acre) March 1 (or ASAP after that date), and the second application (50 lb N/acre) at jointing.

Wheat yield response to fall N was associated with the amount of soil nitrate present following corn. Even though soil samples were collected to a 2 ft. depth, the soil nitrate concentration in the surface 6 inches adequately determined the level needed to make the decision about fall fertilizer N use. At 16-21 sites, the average amount of residual soil nitrate following corn harvest was less than 15 ppm at the 0-6 inch depth.

Across those 16 sites, the average yield increase was 3.5 bu/acre when 30 lb fertilizer N/acre was used. For the sites where the residual soil nitrate concentration was 15 ppm or greater, the average wheat yield response was less than 3.5 bu/acre. Most importantly, as the residual soil nitrate concentration decreased from 15 ppm to 10 ppm or less, the probability of a significant wheat yield response improved considerably (Fig. 1).

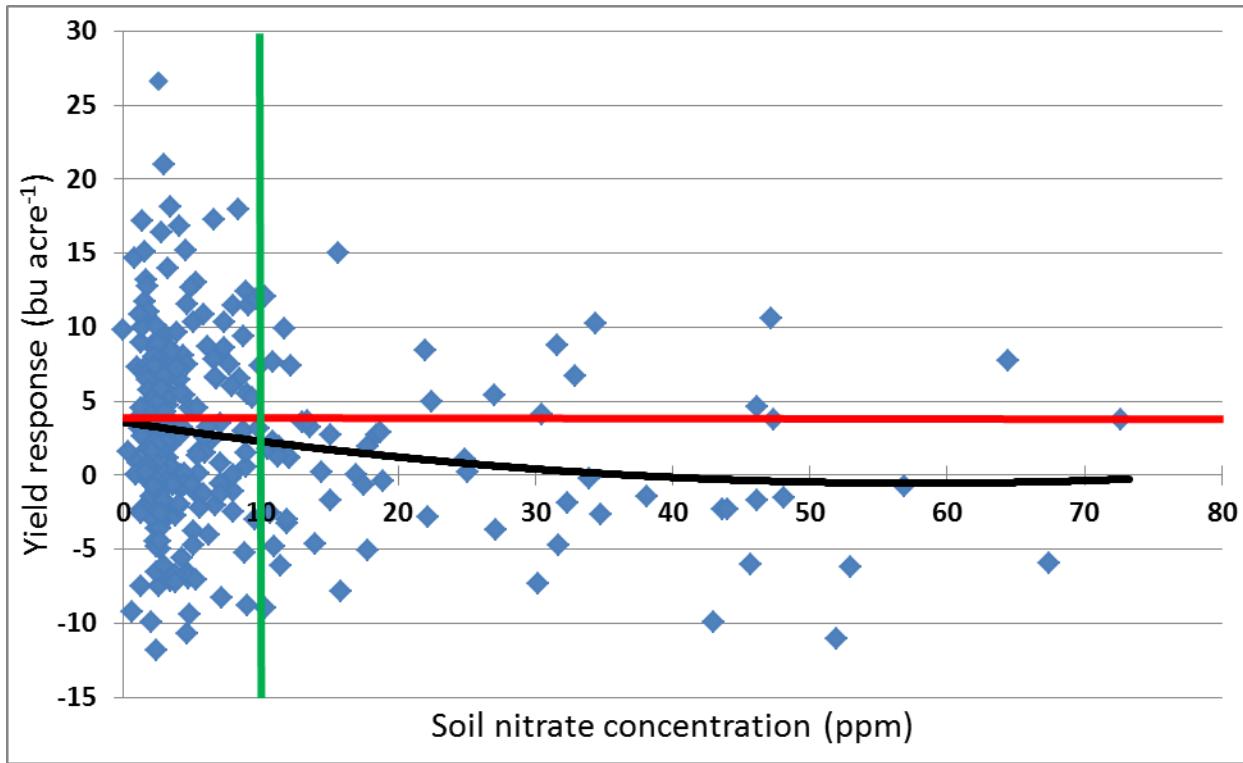


Figure 1. Wheat yield response to 30 lb acre⁻¹ fall fertilizer nitrogen at different residual soil nitrate concentrations (x-axis) following corn harvest. Each diamond represents the yield difference observed for two adjacent plots that either received 30 lb fertilizer N/acre or no fall fertilizer N. The heavy black line represents the average agronomic yield response as soil nitrate concentration increases. The red line represents the economic breakeven point for use of 30 lb fertilizer N/acre. The green line intersects the soil nitrate concentration at 10 ppm, the point where the probability for a positive economic return for fertilizer N use was 50:50.

Of course, simply getting a positive yield response is not the most important goal when using fall fertilizer N. The goal should be a positive economic return for the fertilizer N. Consideration needs to be given to the cost of the N, the cost to apply it, and the anticipated price you will receive for the wheat. Over the five years of this study, the average yield improvement necessary for a positive economic return to the use of 30 lb N/acre was 3.5 bu/acre; the same as the average agronomic response. The agronomic yield response exceeded the level needed to pay for the N approximately 33% of the time (points above the red line, Fig. 1). At soil nitrate concentrations 10 ppm or less, the frequency of a positive economic response (points above the red line and to the left of the green line) increased. At soil nitrate concentrations of 10 ppm or less, the odds for a positive economic return were approximately 50:50. **This 50% positive economic response is the basis for the recommendation that use of fall fertilizer N is warranted when soil residual nitrate concentration in the surface 6-inches is 10 ppm or less.** However, this does not mean there will always be a positive economic return.

Wheat after Soybean

Wheat yield response to fall fertilizer N following soybean was evaluated at five sites during 2008-2010. At each site, wheat was planted into plots where six soybean varieties representing six maturity groups (MG 2.0 to MG 4.5) had been grown. Prior to planting wheat, soil samples (0-6 inch depth) were collected to measure residual soil nitrate-N. Each wheat plot was split

with half receiving 30 lb fall fertilizer N and the other half receiving no fertilizer N. Spring fertilizer nitrogen (80 lb N acre⁻¹) was applied to the entire plot area in a split application with the first application (40 lb N acre⁻¹) as close to March 1 as possible and the second application (40 lb N acre⁻¹) at jointing.

Fall residual soil nitrate-N following soybean averaged less than 10 ppm (6.6 ppm) over the five sites. Averaged over the five sites, there was no yield difference between 30 lb/acre fall fertilizer N and no fall fertilizer N (74 bu/acre compared to 73.5 bu/acre, respectively). Soybean maturity did not affect the outcome for fall fertilizer N use. Based on this work, the likelihood of a significant yield response to fall fertilizer N for wheat planted after soybean is low. **The UM Extension recommendation is to not use any fall N for wheat following a soybean crop.**

Is a Quick Soil Test Available?

One of the disadvantages of a soil test is the time required for the results to be returned from the laboratory. However, there are some labs that will provide very quick turn-around. Since time is limited between harvest and planting wheat, quickly knowing what the soil nitrate concentration is advantageous.

A component of the research behind the FWNT recommendation was an accuracy comparison of the soil NO₃-N results obtained when testing the soil samples using a Nitracheck test kit (same kit that is used to conduct the Pre-Sidedress Nitrate Test [PSNT] for corn in the spring) with the results obtained using the standard laboratory analysis. The use of the Nitracheck test kit would be considered a quick test since these kits are available in every UME office.

The Nitracheck kit used for this research provided very good results. The coefficient of determination (R^2) value for the samples analyzed with both the quick Nitracheck field kit and the standard laboratory analysis method was 0.988. A value of 1.000 would have indicated that the NO₃-N measurements were exactly the same for every comparison. However, since it is known that there is some variability in the nitrate concentration results obtained for the same sample when using different Nitracheck kits and/or different operators, additional test kits and operators were used to analyze the same samples. Twenty-four samples of soil with known nitrate concentration (samples ranged between 2 and 64 ppm) as measured by standard laboratory analysis were divided among 10 University of Maryland Extension Nutrient Management Consultants. Each consultant tested the samples using their Nitracheck kit. The results for these comparisons determined that the Nitracheck measurements were within +/- 2 ppm of the stringent laboratory measurements, 81% of the time. When the measurements obtained by the nutrient management consultants were used to test the yes/no fall nitrogen fertilizer application question, a correct choice occurred 90% of the time.

Interpreting the Fall Wheat Nitrate Test Results

Farmers have two options for testing fall soil nitrate concentration. Soil samples can be sent to a commercial laboratory where standard analysis procedure will be used. For commercial laboratory results, if the residual soil nitrate concentration is 10 ppm or less, an application of 30

lb fall N fertilizer/acre is recommended. If the soil test result is greater than 10 ppm nitrate, no fall fertilizer N is required. For results obtained using a Nitracheck test kit, when a soil nitrate concentration of 12 ppm or less is found, use 30 lb fall fertilizer N acre⁻¹. The advantage to the second option is possibly a quicker result because there is a Nitracheck test kit located in every University of Maryland Extension office.

How to Conduct the Quick Fall Wheat Nitrate Soil Test

The steps for collecting the soil samples and conducting the quick test using the Nitracheck meter are:

1. Call your local University of Maryland Extension office and alert the nutrient management consultant that you want to have the fall nitrate test for small grain conducted. Let them know how many samples you will be testing.
2. Randomly collect soil cores (1 per acre) to a depth of 6-inches from across the field.
3. Avoid sampling in areas of the field that either have been managed differently or have different soil properties. In other words, try to make the sampling sites representative of the field.
4. Mix your composite sample thoroughly and then place approximately 1-2 cup of soil into either a plastic bag or a soil test bag.
5. Store samples in a refrigerator until you either deliver them to the soil testing laboratory of your choice or can deliver them to the University of Maryland Extension office for testing with the Nitracheck kit.
6. Use the fall nitrate test results and the decision-making flow chart (Figure 2) to determine the need for fall fertilizer nitrogen.

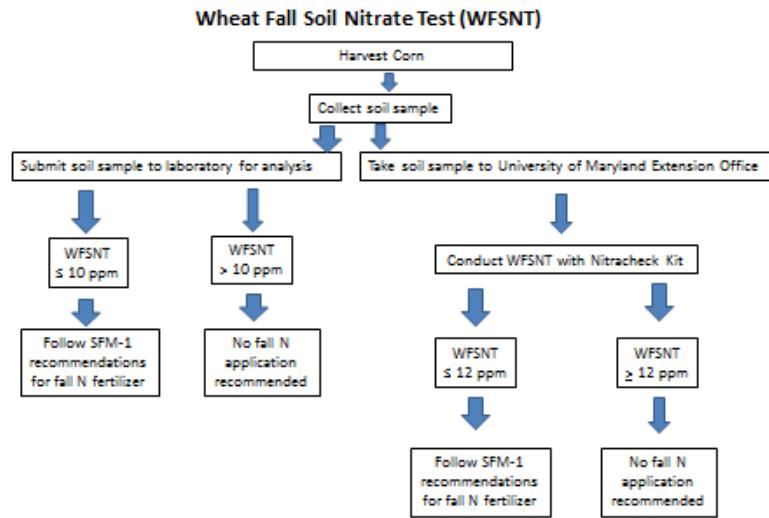


Figure 2. This flow chart describes how to determine the need for fall fertilizer nitrogen for wheat. Use 30 lb fertilizer N/acre for a test result of 10 ppm soil nitrate or less if you have done a commercial laboratory analysis or 12 ppm soil nitrate or less if you use the quick fall nitrate test using a Nitracheck kit. Please note that the use of this decision-making tool will not be a guarantee that using fall fertilizer N will give you a positive economic response.

Winter Water for Horses

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Horse owners and caretakers pay careful attention to the quantity and quality of water that horses consume during the hot summer months. However, water consumption during the winter months is just as critical to our horses' health.

The body of an adult horse is approximately 62-68% water (about 70% water in foals). Proper hydration is essential to the horse's fluid balance. Among the most important considerations for adequate water consumption is water's role in keeping the horse's digestive tract moving and functioning properly. Adequate winter-water intake can reduce the risk of impaction colic. The occurrence of colic increases between December and March, mainly because horses don't drink enough water in winter months (Swinker, 2012).

We can help our horses maintain adequate hydration in the winter by providing them with plenty of clean, fresh water that is the proper temperature. Research conducted at the University of Pennsylvania during cold weather in the mid 1990's demonstrated the effects of water temperature on water consumption in horses. This research showed that during cold weather, horses offered warm water consume significantly more water (as much as a 40% increase) than if they were offered only ambient, near freezing water.

Heated buckets and stock tank heaters are good options to help keep your water temperature warm in the winter and encourage horses to drink. For owners who have 3- 5 horses, providing a heated bucket or tank heater is certainly less expensive than the cost of one vet call to treat an impaction colic. Remember that stock tank heaters should be plugged into a GFCI protected outlet to prevent your horse from potentially getting shocked. Generally speaking the plug type stock tank heaters are safer than the floating style, especially in a plastic tank. If you have a horse that likes to paw in its water tank even in the dead of winter, you may need to install a plywood lid to limit access or a metal grate that sits over the plug heating element to protect it from being damaged or broken.

If tank heaters and water bucket heaters aren't an option for your management system, then consider another interesting observation that resulted from the University of Pennsylvania drinking water temperature study. Researchers observed that stalled horses in the study that

were fed hay and grain tended to do most of their drinking within 3 hours after feeding. Knowing this implies the necessity to coordinate your watering to coincide with this period of time when horses tend to consume the most water. This will also allow you to keep the water temperature warmer than if it is left sitting in the bucket or tank all day long.

During the winter months, as recommended during other times of the year, water should always be available to ensure the horse's daily maintenance water requirement of 8-10 gallons is met. This means horses housed in stalls should have access to two, 5 gallon buckets. Additionally, a stock tank needs to be large enough to comfortably provide each horse it serves with a minimum of 10 gallons of water per horse.

An easy way to warm up stall water buckets is to carry gallon jugs full of very hot water from your house and add it to the bucket [or tank] water, remembering to always warm both buckets. Warming stall water has an especially profound positive effect for our older horses.

Further recommendations to help keep your horses properly hydrated in winter months include providing free choice salt, and feeding a diet that is largely forage based. Free-choice access to a trace mineral or salt block will increase water consumption. High forage diets contain more water than a diet that is mainly grain based. However, harvested forages such as hay are drier than pasture grasses, and therefore adequate water consumption is extremely important during this time of year when horses are being transitioned from a diet consisting primarily of pasture to a hay-based diet. The transition between forage in the diet provided by pasture and forage provided by hay should occur gradually. Changes in the variety or type of hay being fed also need to be made gradually to reduce the risk of digestive disturbances.

Additional Winter Management Tips:

1. Make sure your horses are in adequate body condition going into the winter. It is much harder to put weight on a horse during the winter months.
2. Keep a close watch on your horse's body condition. With heavy winter coats, a visual inspection is not enough. Make sure you run your hands over your horse to feel for ribs.
3. Provide plenty of good quality forage to your horse. Digesting forage takes longer and actually produces more body heat for a horse than digesting grain. The average 1,000 lb. horse that receives the majority of their ration as hay should be fed about 20 lbs. of hay per day.
4. Provide free choice plain white salt.
5. Don't lock the barn up tight. Make sure that there is adequate ventilation so you aren't trapping ammonia and disease organisms in with your horses.
6. If you blanket your horses, make sure that you remove the blankets and check their body condition regularly. Check blankets for proper fit and damage and make any necessary adjustments and repairs immediately. Check your horse(s) regularly to make sure blankets are not creating rubs or sores.
7. We tend to have mud in the winter on the Delmarva Peninsula. Pick hooves regularly so that frogs have a chance to dry out and reduce your risk of thrush. Chronic mud on a

- horse's legs can result in bacterial or fungal infections such as scratches. Also, be sure to remove ice buildup from your horse's feet.
8. Keep your horses as clean and dry as possible to reduce the risk of developing scratches or rain rot.
 9. Have a plan to deal with the potential loss of electricity on your farm due to a snow or ice storm. If water on your farm is provided from a well, do you have a back-up water source should you lose power?

Resources and Further Reading

Kristula, M.A. and McDonnell, S.M. *Drinking Water Temperature Affects Consumption of Water During Cold Weather in Ponies*. Journal of Applied Animal Behavior Science. Volume 41, issues 3-4, August 1994. pp. 155-160.

Swinker, A., *In Cold Weather Horses Will Reduce Water Consumption and Be At Risk of Colic*. Equine News. Pennsylvania State University Cooperative Extension. November 2012.

Survey for a Potential New Invasive Species, the Kudzu Bug (*Megacopta cribraria*), in Delaware Soybean Fields*

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The kudzu bug (*Megacopta cribraria*) is an invasive species that was first detected in the Southeastern United States in 2009. It is native to Asia and commonly referred to as the globular stinkbug, bean plataspid, lablab bug, and kudzu bug. Since its initial detection in northern Georgia in 2009, it has rapidly spread across eight southeastern states (Figure 1). Unlike stink bugs that feed on pods, the kudzu bug adults and nymphs feed on soybean stems and leaf veins resulting in a reduction in pod set, beans per pod and a reduction in seed size. Previous research in Georgia has documented yield losses as high as a 47 percent.

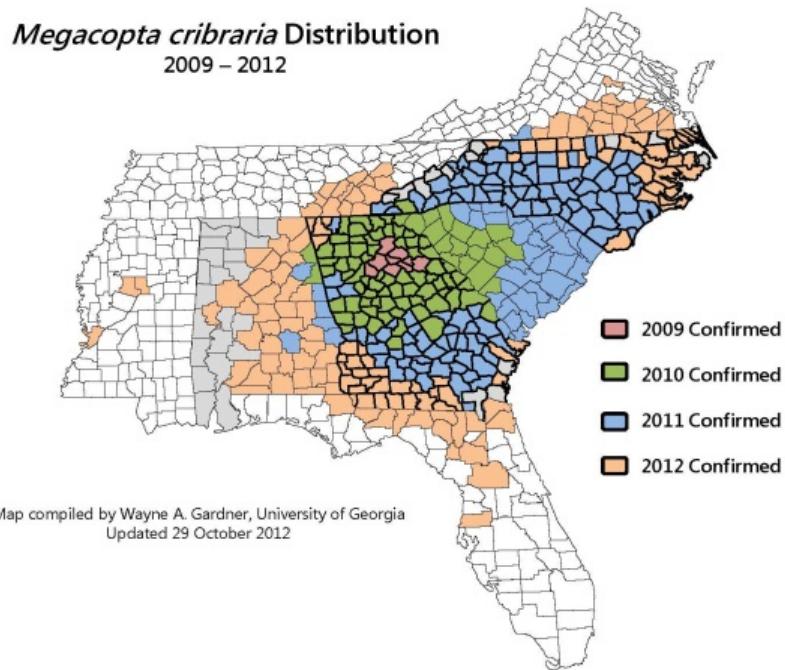


Figure 1. Kudzu Bug Distribution Map

A statewide survey sponsored by the Delaware Soybean Board was conducted on 72 soybean fields throughout the state to determine if kudzu bugs were present. Full season and double crop soybean fields were included in the survey and have been sampled on a weekly basis starting in mid-June and continued through mid-September. Fields were sampled by conducting one hundred sweep net counts and visually inspecting plants in ten locations for kudzu bug adults, nymphs, and egg masses. Five kudzu “patches” in close proximity to soybeans were surveyed season long using sweep net counts and direct visual observations. All known kudzu patches throughout the state were also surveyed once at the beginning and end of September (Figure 2). It was thought that the kudzu bug would initially be detected on kudzu. New information from South Carolina indicates that this may not be the case. To date, the kudzu bug has not been detected in

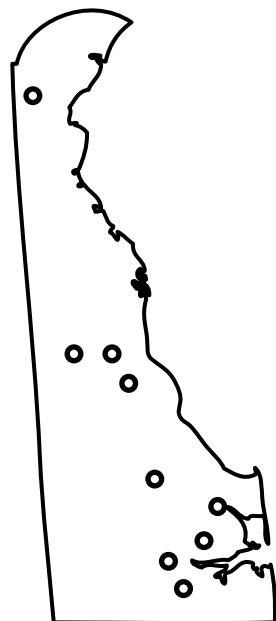


Figure 2. Kudzu Sampling Locations

Delaware. However, it continues to slowly move north. In 2011, it was first identified along the southern border of Virginia in Patrick County, Virginia. To date, it has now been identified in a total of 19 counties in Virginia reaching as far north as Goochland County which is located approximately in the middle of the state.

A significant amount of research addressing the management of kudzu bug has been conducted in South Carolina and Georgia. The following information will need to be validated under Delaware conditions when/if this insect makes it to our state:

- Yield losses range from 0 to 47 percent with an average yield loss of 18 percent.
- The immature stage of the kudzu bug appears to cause significant loss so it is important to control them before they complete a generation.
- The R-3 and R-4 soybean growth stages appear to be the stages when kudzu bug causes the most damage to soybeans.
- Tentative thresholds: 1 nymph per sweep at R-3 to R-4 growth stage; for later growth stages the threshold may be 2 nymphs per sweep but more research is needed.

* This project was sponsored and funded by the Delaware Soybean Board. Please visit their web site (<http://www.desoybeans.org/>) for continuing information and click on the box titled 'Soybean Research'.

Management of the Stink Bug Complex in Delaware Soybean Fields*

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The Delaware Soybean Board and United Soybean Board sponsored research aimed at the brown marmorated stink bug (BMSB) which is a relatively new pest in Delaware. The project set out to determine the distribution of the BMSB in the state as well as to evaluate two control strategies. The project set out to evaluate the effectiveness of perimeter treatments to manage BMSB in soybeans and to evaluate the effectiveness of insecticides to control this pest on soybeans.

Methodology

Distribution of the BMSB in Delaware: A statewide survey was conducted on 72 fields to determine the distribution of BMSB. Full-season and double-crop fields were included in the survey and sampled on a weekly basis from mid-June to mid-September. Fields were sampled by conducting one hundred sweep net counts and visually inspecting plants in ten locations for BMSB adults and nymphs on the field perimeters (0-100 ft) and field interiors (>100 ft). The data collected was used to determine the distribution of BMSBs in Delaware soybean fields and to track its movement within the state.

Perimeter Treatments to Manage BMSB in Soybeans: Two fields were identified to evaluate the effectiveness of perimeter treatment as a control strategy to manage stink bugs in soybeans. Perimeter treatments were applied on one full-season soybean field located in Cecil County, Maryland and on one double-crop soybean field located in New Castle County, Delaware (part of the statewide survey). Stink bug populations were monitored pre and post-treatment on a weekly basis by performing 300 sweep net samples in the field perimeters (0-100 ft) and in the field interiors (>100 ft). Although no threshold is available for BMSB in soybeans, the same threshold established for native stink bugs (5 per 25 sweeps) was used to time insecticide applications.

Once populations reached a “threshold” level, treatments were applied using commercial application equipment. The BMSB was the predominant species in both fields.

BMSB Insecticide Efficacy Trial: ‘NK brand 539U2’ soybeans were planted on May 14 at the University of Delaware’s Research Farm located at Newark, Delaware. Plots 10 ft wide (4 rows) x 20 ft long were arranged in a randomized, complete block design with four replications along a wooded field edge to take advantage of BMSB’s tendency to congregate field perimeters. Plots were sampled on a weekly basis from July 26 through August 21 using a sweep net and counting the total number of adults and nymphs of all stink bug species found in ten sweep net samples per plot. From August 21 to September 21, both sweep net counts and a timed two-minute visual inspection were used to evaluate population levels. Once BMSB populations reached levels high enough to evaluate efficacy; August 17, 30 and September 6, treatments were applied with a CO₂ pressurized back pack sprayer equipped with a 6 nozzle boom delivering 18 gpa at 40 psi. Treatments consisted of (1) Baythroid XL, (2) Leverage 360, (3) Lannate LV, (4) Lannate LV + Asana XL, (5) Warrior II, (6) Cobalt Advanced, (7) Acephate 97UP, and (8) an untreated check.

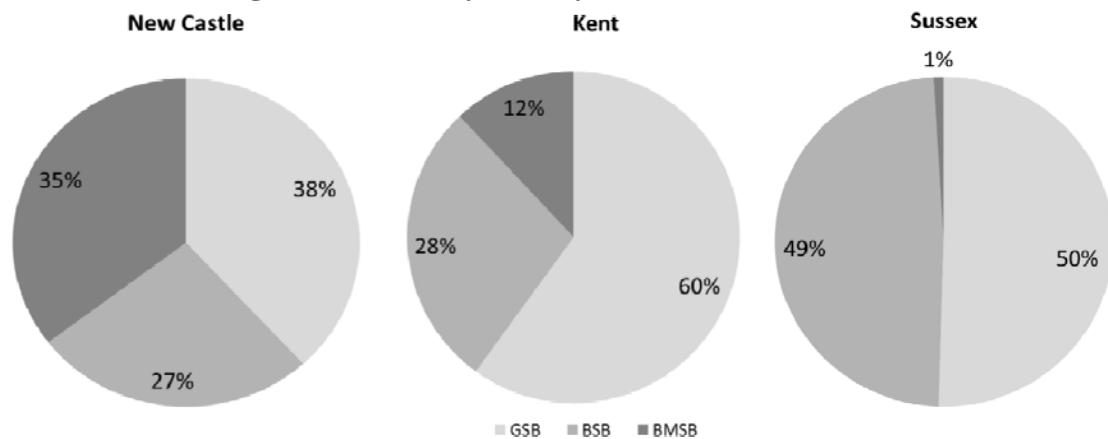
As the plants began to senesce, the plots were evaluated for “stay green” effects by visually inspecting the plants for green leaves and by counting the number of green stems from 20 randomly selected plants in each plot. A five plant subsample was evaluated for the number of flat pods in each plot. Seed quality data was collected at full maturity (R8) on October 19, by randomly harvesting 20 plants per plot and evaluating a 100 seed subsample for the percent moldy and shriveled seeds as well of the number of seeds with purple stain disease.

Results and Discussion

Distribution of the BMSB in Delaware: BMSB was first identified in Delaware soybean fields in 2010 in New Castle County. In 2011, a survey was conducted as part of a DSB funded project to determine how widely distributed the BMSB was in Delaware soybean fields. The findings of the survey documented BMSB infestations in eighty percent of the New Castle County soybean fields and in ten percent of the Kent County fields included in the survey. No BMSB were detected in soybean fields surveyed in Sussex County. Of the fields surveyed in New Castle County, ten percent were found to be at or above the tentative economic threshold of five BMSB per twenty-five sweeps. None of the Kent County fields had economic population levels of BMSB. When factoring in the complex of stink bug species within a field including green stink bug (GSB), brown stink bug (BSB) and BMSB, twenty percent of the New Castle County fields and nineteen percent of the Kent County fields were at threshold for the stink bug complex.

In 2012, the survey was expanded to include areas of the state not surveyed in 2011. Survey results confirm that BMSB continue to pose the greatest threat in New Castle and Kent County. Of the fields surveyed in New Castle County, sixty-eight percent were infested with BMSB. However, none of the fields were at an economic threshold when considering BMSB alone or when factoring in all the stink bug species. In Kent County, BMSB infestations were documented in fifty-two percent of the fields surveyed and three percent were at or above threshold, a significant increase compared to the 2011 survey results. When factoring in all the stink bug species including BMSB, GSB and BSB, twenty-three percent of the fields were at or above threshold. Twelve percent of the fields surveyed in Sussex County were infested with BMSB. This is a significant increase from the findings in 2011 in which none of the Sussex County fields surveyed had BMSB infestations. When only considering BMSB, none of the fields reached economic threshold. When factoring in all the stink bug species, eighteen percent of the fields reached or exceeded the economic threshold, attributed primarily to GSB and BSB populations.

BMSB have become fully established across New Castle County and are slowly expanding their range to parts of Kent and Sussex counties. While they do not currently pose as great a threat in Sussex Counties compared to New Castle and Kent County, the survey results indicate that they are increasing in population throughout the state. In 2012, BMSB accounted for thirty-five percent of the stink bug population in New Castle County, twelve percent in Kent County and one percent in Sussex County (Table 1). Despite the fact that BMSB populations are greatest in New Castle and Kent County, the addition of BMSB to the stink bug complex could ultimately result in an increase the number of fields that reach threshold for the stink bug complex.

Table 1. Stink Bug Distribution by County

Perimeter Treatments to Manage BMSB in Soybeans: In 2011, research was conducted by University of Maryland and Virginia Tech researchers to evaluate whether or not perimeter treatments could be used as a management strategy for BMSB. Initial findings suggest that perimeter treatments can be successful in gaining control of BMSB in soybeans. However, it was determined that additional research was needed to confirm this.

In 2012, perimeter treatments were evaluated on two grower fields and monitored on a weekly basis to determine if a timely perimeter treatment would be successful in reducing BMSB populations and prevent them from penetrating into the field interior. In each of the two fields where perimeter treatments were applied, BMSB populations were significantly reduced along the field perimeters and stink bug populations remained low in the field interiors (Table 2 and Table 3). The BMSB was the predominant species in both fields, although the data does include low levels of native green and brown stink bugs. These findings along with prior year's research suggest that perimeter treatments can be used as a successful management strategy to control BMSB in soybeans. There are exceptions however, that must be taken into consideration such as the size of the field and the timeliness of application which would have an impact on the success and practicality of using a perimeter treatment.

Table 2. Evaluation of Perimeter Treatment: Grower Field 1

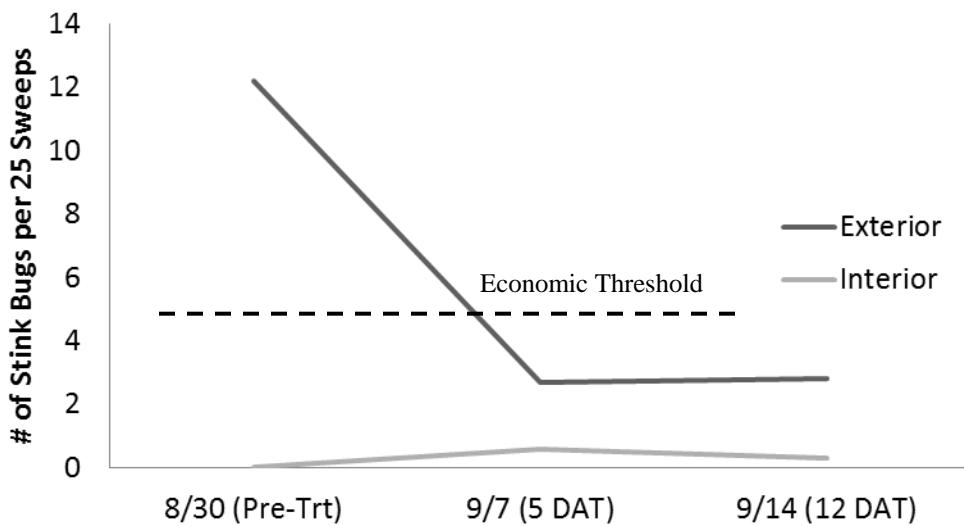
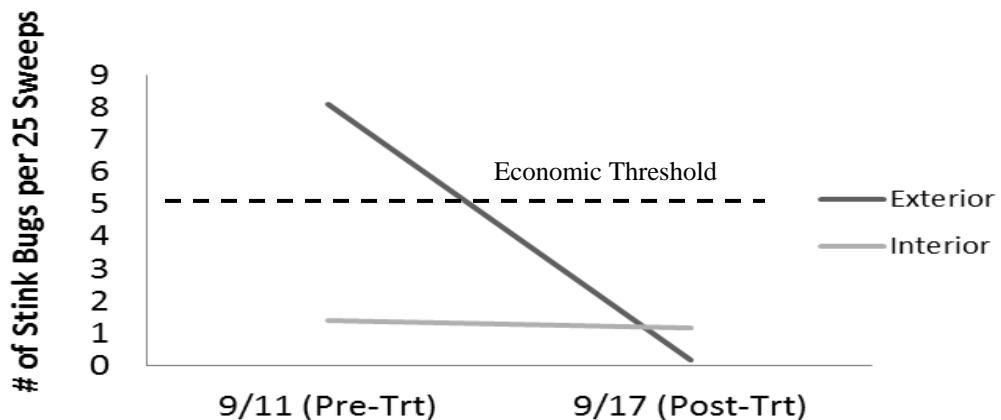


Table 3. Evaluation of Perimeter Treatment: Grower Field 2



BMSB Insecticide Efficacy Trial: Insecticide treatments were applied on three dates, August 17, August 30, and September 6, application 1, 2, and 3, respectively. Data collection as presented in Table 4 and 5 is labeled with the number of days after treatment (DAT) followed by the application number. For Table 4, 7 DAT1 refers to data collected 7 days after the first application date.

The treatments applied on August 17 were not successful in significantly reducing BMSB populations at 7 DAT1 and 15 DAT1 compared to the control (Table 4). The lack of control can be attributed to the observed re-infestation of plots from an adjacent wood lot. At 6 DAT2 for the second application, all of the treatments provided a significant reduction in the number of BMSB per 2 minute search compared to control except Lannate LV at 1.5 pt/A (Table 5). There were no significant differences among treatments compared to the control based on sweep net

sampling and 2 minute search at 5 DAT3 and 15 DAT3 for any of the sample dates after the third application applied on September 6. However, numerically, there were fewer BMSB adults and nymphs in each of the treated plots compared to the control except the stand alone Lannate LV treatment, which is consistent with the results of the second application (Table 5). All of the products tested provided some level of control for BMSB in soybeans.

A damage assessment was performed at harvest time, October 19, to detect symptoms of “stay green” and to evaluate the seed for quality and stink bug feeding injury. A visual inspection of the plots as the plants began to senesce found anywhere from 50 to 100 percent of the plots contained plants with green leaves. While significant, this is most likely a result of environmental conditions and soil moisture levels. Subsamples of 20 plants per plot were also selected to estimate the percent of plants with green stems which ranged from 75 to 85 percent. However, there were no significant differences among treatments.

A five plant subsample was collected from each plot and evaluated for flat pods. Acephate 97UP had significantly fewer flat pods compared to the Leverage 360 treatment but was not significantly different from the control. The Leverage 360 treatment had the greatest number of flat pods; however, it was not significantly different from the control (Table 6). There were significant differences among treatments for the percent moldy seed but the mold developed from not being properly stored and cannot be attributed to stink bug feeding injury. There were no significant differences among treatments for the percent shriveled seed and the percent seed with purple stain disease.

* This project was sponsored and funded by the Delaware Soybean Board (DSB) and the United Soybean Board. Please visit the DSB web site (<http://www.desoybeans.org/>) for continuing information and click on the box titled ‘Soybean Research’ .

Table 4. Application 1 - Pre and Post-Treatment Sampling Results

Treatment	Rate/A	BMSB/10 sweeps	BMSB/2 minute Count	(15 DAT1) August 29 ¹	
		Pre-Trt – Aug 14 ¹	(7 DAT1) Aug 21 ¹	BMSB/10 sweeps	BMSB / 2 minute count
Baythroid XL	2.8 oz	2.00a	4.00a	1.75a	5.00a
Leverage 360	2.8 oz	2.25a	1.50a	1.00a	1.00a
Lannate LV	1.5 pt	4.75a	3.50a	5.75a	9.75a
Lannate LV + Asana XL	1.5 pt + 6 oz	2.50a	1.25a	2.00a	3.25a
Warrior II	1.92 oz	2.50a	1.00a	2.00a	3.25a
Cobalt Advanced	22 oz	3.50a	4.00a	1.25a	2.50a
Acephate 97UP	1 lb	2.00a	1.75a	1.00a	1.50a
Untreated	--	2.50a	4.75a	4.50a	10.75a

¹ Means within a column followed by the same letter are not significantly different (Tukey's; P=0.05).

Table 5. Application 2 and 3 - Post Treatment Sampling Result

Treatment	Rate/A	Number BMSB per 2 minute ¹			Number BMSB per 10 sweeps ¹		
		(6 DAT2) Sept 5	(5 DAT3) Sept 11	(15 DAT3) Sept 21	(6 DAT2) Sept 5	(5 DAT3) Sept 11	(15 DAT3) Sept 21
Baythroid XL	2.8 oz	2.25b	2.50a	5.25a	2.00a	3.75a	2.00a
Leverage 360	2.8 oz	3.75b	1.00a	3.25a	1.00a	0.75a	1.00a
Lannate LV	1.5 pt	8.00ab	15.50a	5.75a	2.75a	12.75a	3.75a
Lannate LV +Asana XL	1.5 pt + 6 oz	1.25b	0.75a	0.50a	1.50a	1.25a	1.50a
Warrior II	1.92 oz	2.25b	2.75a	2.25a	0.50a	2.00a	1.50a
Cobalt Advanced	22 oz	1.00b	0.75a	1.50a	0.00a	1.00a	0.50a
Acephate 97UP	1 lb	1.00b	1.50a	1.50a	1.25a	1.00a	1.75a
Untreated	--	20.25a	12.75a	1.50a	3.50a	5.50a	0.50a

¹ Means within a column followed by the same letter are not significantly different (Tukey's; P=0.05).

Table 6. Damage Evaluation

Treatment	Rate/A	Stay Green			Seed Evaluation (100 Seed Subsample)		
		% Plots with Green Leaves	% Green Stems ¹	Average Number of Flat Pods ¹	% Moldy Seed ¹	% Shriveled Seed ¹	% Purple Stain ¹
Baythroid XL	2.8 oz	75	85.0a	13.25ab	5.5a	7.25a	1.0a
Leverage 360	2.8 oz	100	78.75a	32.25a	1.25ab	0.5a	4.75a
Lannate LV	1.5 pt	100	83.75a	10.0ab	1.5ab	2.25a	1.25a
Lannate LV + Asana XL	1.5 pt + 6 oz	100	77.5a	11.0ab	1.75ab	3.0a	3.25a
Warrior II	1.92 oz	75	75.0a	14.5ab	1.25ab	1.5a	1.75a
Cobalt Advanced	22 oz	75	71.25a	11.0ab	0.75b	3.25a	7.75a
Acephate 97UP	1 lb	75	81.25a	5.25b	0b	1.5a	1.75a
Untreated	--	50	70.0a	7.75ab	0.5b	1.5a	0.75a

¹Means within a column followed by the same letter are not significantly different (Tukey's; P=0.05).

Summary of 2012 Slug Management Program

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In terms of slug management in corn and soybean, 2012 will probably be remembered as “One for the Record Books.” I have yet to talk to a farmer who can remember a more problematic year. It was fortunate that I was focused on slug management during 2012 (my dad would probably say “even a blind hog can find an acorn sometimes”). Needless to say, a lot of farmers gained experience with slugs and slug management strategies this past year. The following is a summary of the results from the 2012 Scouting Season:

The important number from the text box below is that 35 percent of all pre-enrolled acres likely needed slug control. This includes pre-enrolled acres that did not receive slug bait but needed to be re-planted. In 2011, we scouted 3,102 acres and found only 244 acres that needed treatment. This was about 8 percent of the no-till corn and soybean land. Most farmers felt 2011 was a year with relatively low slug pressure.

So what is the prediction for 2013 and how do farmers use the information gained this past year? Here are some of my thoughts:

- First and foremost, we have no way to predict what 2013 will bring.
- Broadcast application of slug bait cost about \$35 per acre (\$27 for bait plus \$8 for application cost). If we need to treat 35 percent of our acreage (and re-treat 20 percent of the areas we treat because it rains on the bait) then our cost per acre over all acres will be \$14.70 per acre.
- One farmer used the insecticide hopper on his corn planter to apply slug bait directly behind the planter (dribbled on top of the ground in an area about four to six inches wide directly over the row). His rate was about four pounds per acre. This appeared to work well but we need to try it a few times more. A key concept is that this will not help if the slugs are not active or if it rains shortly after planting. Most years the slugs do not hatch and become active until about May 3-5.
- Farmers and I spread multiple fields that were 30 to 50 acres in size using a spreader mounted on a four wheeler. We were able to get the job done in three to four hours (which likely averaged 10-15 acres per hour). This does not include time driving to the field.

Total Pre-Enrolled Acres (acres we planned to scout prior to the planting season)

Corn	3,420 acres
Soybean	1,420 acres

Pre-Enrolled Acres Approved for Slug Bait (acres where slug damage appeared significant enough to warrant control)

Corn	1,200 acres (35% of total pre-enrolled acres)
Soybean	500 acres (35% of total pre-enrolled acres)

Post-Enrolled Acres Approved for Slug Bait

Corn	312 acres
Soybean	0 acres

Number of Farmers Who Participated in Cost Share Program (both pre- and post-enrolled acres)

15 farmers received \$18,368 cost share dollars in 2012.

Number of Acres that Received Slug Control

This includes both pre- and post- enrolled acres = 1,141 acres.

Soil Nitrate Data from the Northern Shenandoah Valley of Virginia in 2012

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In 2012, there were 292 soil nitrate samples collected in the Northern Shenandoah Valley. The median concentration in 2012 was 20 ppm nitrate-N whereas the median in 2011 was 15 ppm. Recommendations for sidedress N applications are as follows: (1) soil nitrate levels of 0-10 ppm apply a full rate of sidedress N; (2) soil nitrate levels of 10-20 ppm apply a half rate of sidedress N; and (3) soil nitrate readings above 20 ppm no additional N is needed.

Why were soil nitrate levels in 2012 slightly elevated from 2011? In my opinion, there are two primary reasons. First, cornfields did not utilize all of the nitrogen applied in 2011 due to the severe drought (because the drought suppressed yield in most fields). Second, the spring of 2012 was drier than the spring of 2011. More specifically early spring 2011 started dry followed by a severe rainy period. Many farmers applied poultry litter or fertilizer during the dry weather and the ensuing rain likely leached or denitrified the nitrogen. This phenomena did not occur (at least did not occur to the same magnitude) in 2012. Refer to the article about 2011 samples for more perspective:

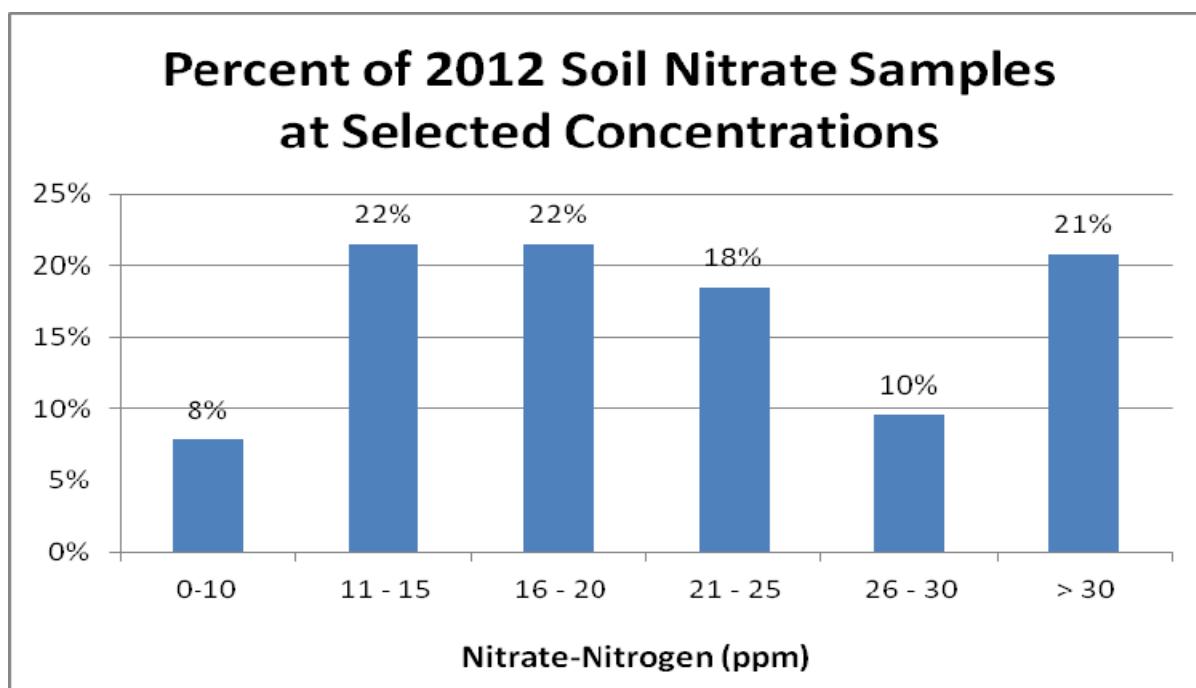
http://offices.ext.vt.edu/shenandoah/programs/anr/Farm_Notes_February_2012.pdf.

Table 1 presents the historic data from the northern area of the Shenandoah Valley of Virginia and Figure 1 below shows the distribution found in the 2012 samples.

Table 1. Historical data (2006 to 2012) for median nitrate nitrogen concentration found in soil nitrate samples collected in the northern Shenandoah Valley of Virginia.

Year	Median Nitrate-N Concentration
2006	30
2007	27
2008	25
2009	18
2010	25
2011	15
2012	20

Figure 1. Percent of 2012 soil nitrate samples falling in various concentration increments. Those at 10 ppm NO₃-N or below would receive a full rate of sidedress N, those between 10 and 20 ppm would receive a half rate of sidedress N, and those above 20 ppm would receive no additional sidedress N fertilizer.



Heifer Mastitis: Subclinical and Clinical Intramammary Gland Infection in Prepartum Dairy Heifers

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Introduction

Mastitis in heifers is defined as intramammary bacterial infection (IMI) leading to temporary or permanent colonization of the mammary secretory tissues with bacteria. Intramammary infections can produce clinically visible disease (clinical mastitis) or no outwardly visible signs of disease associated with bacterial presence in the mammary tissues (subclinical mastitis). Clinical disease is manifest as hot swollen quarters with or without systemic signs of fever, depression and toxemia, and elevated somatic cell counts (SCC). Subclinical disease is detected as elevated SCC in milk from infected quarter or elevated composite SCC in milk across all 4 quarters.

Prepartum intramammary infection in heifers may or may not result in loss of the quarter. However, early infections occurring as calves or at the time of breeding are certainly capable of producing a sustained reduction in intramammary secretory tissue that reduces lifetime productivity and profitability. Intramammary heifer infections can occur as early as 1-9 months of age and have been observed as early as 9 months before parturition (Boddie et al., 1985, Fox et al, 1995, 2009). The prevalence of prepartum intramammary infection in heifers varies considerably across farms but is a common event that may involve as many as 35% of all yearling heifers (Fox et al., 1995).

Heifer mastitis differs from adult cow mastitis in several ways. Heifers more frequently experience a higher incidence of clinical mastitis within the first few days post-partum compared to adult cows. The causal bacteria in heifers differs from those in adult cattle in that minor mastitis pathogens such as coagulase negative Staphylococcal agents like *Staphylococcus epidermidis* typically invade heifer mammary tissues. In contrast, intramammary infections in adult cattle more often occur with major mastitis pathogens such as *Staphylococcus aureus*.

Heifers with intramammary infections prepartum most often manifest the infection as a subclinical problem marked by elevated SCC pre- and postpartum. Many of these prepartum infections are sustained as subclinical mastitis problems with a persistently elevated SCC during the first lactation. Still many other pre-partum infections spontaneously self-cure within the first few test dates. These appear as a return of elevated SCC early in lactation to near normal amounts later in the first lactation.

A lower percent of the subclinical prepartum infections will eventually progress into clinical mastitis in the first lactation. In all cases, first lactation milk yields are reduced and the risk of premature culling is increased. Most importantly, these pools of subclinical, prepartum

infections present an enormous biosecurity threat to the lactating herd in that they serve as a reservoir of contagious mastitis pathogens for the lactating herd with the trends for greater demands for heifer replacement that accompany 30-35% replacement requirements in the commercial herd.

Environmental Pathogens and Heifer Mastitis

Environmental coliforms and the non-agalactae streptococcus, *Streptococcus dysgalactiae* and *Streptococcus uberis* contribute substantially to pre- and post-partum intramammary infections in heifers. For example in one report, *Streptococcus dysgalactiae* was the causal agent in 68% of cases of clinical mastitis occurring in heifers within the first 4 days post calving (Pankey et al., 1996). *Streptococcus uberis* was second to the coagulase negative staphylococcal organisms in causing 15% of the intramammary infections in heifers 27 days prepartum (Parker et al., 2008). The prevalence of intramammary infections increased 3 fold over the pre-calving prevalence within the first 4 days post calving implying a high rate of new intramammary infections occurred with this organism at the time of parturition.

Environmental pathogens are often associated with subclinical intramammary infections in both lactating cows and nonlactating heifers. Prevalence estimates of subclinical intramammary infection in heifers vary quite widely across survey data. Prepartum infections range from 2-10% of quarters and post-partum subclinical infections have been reported to range between 4-13%. In the same review, Fox (2009) compiled data showing environmental bacteria accounted for 9-50% of prepartum and 15-55% of post-partum infections ending in clinical mastitis in heifers. Bacterial agents have been isolated from heifer mammary glands as early as 9 months prepartum and the number of isolations increased as the heifer approaches parturition. However, the prevalence of these environmental pathogens has been shown to change over the prepartum period because of spontaneous self-cures or the acquisition of different intramammary infections.

Coagulase Positive Staphylococcus aureus

Staphylococcus aureus is a major pathogen of intramammary infections in dairy cattle and is the single most important cause of infectious mastitis and long term persistent intramammary infections. *Staphylococcus aureus* can be a prominent cause of clinical mastitis in heifers (Oliver et al., 2005) and in some farms and studies can be the dominant organism associated with prepartum intramammary infections in heifers. Even though it is less commonly isolated in heifer mastitis, the presence of *S. aureus* in heifers should be regarded as a major threat to herd biosecurity because infected replacement heifers transmit intramammary infections to uninfected cattle in the herd.

Strains of *Staphylococcus aureus* found in the mammary gland and streak canals have been shown to be genetically identical to those found in extra mammary sites on a farm. Moreover, they have been shown to be closely related to isolates associated with *S. aureus* induced intramammary infection in the lactating herd. This implies one or more extra mammary pools of *S. aureus* are the resource for intramammary infections of heifers. Extra mammary sources could include lactating cattle, skin of heifers, cattle and farm personnel, bedding, beds, and flies.

Transmission to the prepartum heifer's mammary gland however must by definition be something other than the equipment or milking procedures widely recognized as the major mode of transmission in lactating cattle. Indeed, the horn fly has been implicated as an important mode of transmission in that large numbers of *S. aureus* have been isolated from the horn flies and fly induced wounds on heifer teat ends (Oliver et al., 2005, Gillepsie e al, 2005, Anderson et al., 2012). Moreover, *S. aureus* isolates can colonize horn fly body components for as long as 4 days after flies feed on infected teat end scabs. The genotype of *S. aureus* found in the horn fly was the same genotype found in post-partum colostrum and milk. This observation supports a role of flies in intramammary transmission of *Staphylococcus aureus* in heifers. Recently, approximately half the horn fly and 30% of the nostrils, mouths, and teat ends of heifers yielded *S. aureus* isolates that were genotypically identical to those in the intramammary infections (Anderson et al., 2012) . This affirms the concept that heifer intramammary infections can arise from the extra mammary skin, nostrils, and particularly teat ends in the heifer populations. In the same study, the genotypes of *S. aureus* isolated from milking personnel were not related genotypically to any *S. aureus* isolated from 3-4 day post parturient heifers, lactating cattle, or environmental isolates. This result suggested intramammary infections may also be derived in part from milking personnel.

Consequences of Heifer Mastitis

The status of subclinical intramammary infection has been known to be highly correlated to productivity in lactating cows and heifers. In the heifer, subclinical mastitis is associated with losses in production, diminished herd longevity and increased susceptibility to clinical mastitis. All of this occurs even though prepartum subclinical infection does not result in outward signs of mastitis other than an elevated SCC. Indeed, SCC greater than 200,000-250,000 cells/ml, 4-8 days post-partum is considered evidence of prepartum subclinical heifer mastitis. In fact, some authors believe that use of test day SCC within the first 100 days in milk indicates most intramammary infections originated prior to or at the time of parturition. In that regard however, all producers need be aware the SCC in the first few days post-partum is normally high and not necessarily indicative of intramammary infections. A reasonable measure for producers is to regard SCC > 200,000 cells/ml during the first 100 DIM as indicative of prepartum intramammary infection.

Subclinical mastitis: Because coagulase negative, minor intramammary pathogens cause the majority of heifer mastitis cases, the impact on productivity is often regarded as lower than similar infections with major intramammary pathogens like coagulase positive *Staphylococcus aureus*. Never the less, reductions in milk yields do occur in heifers with minor pathogen infections. The reduction in productivity depends upon SCC levels in subclinical mastitis. For example, first lactation milk production was 14,200, 13,300 and 12,500 lb. milk in groups of animals with SCC less than 100,000, elevated (between 100,000 – 400,000), and increased (over 400,000 cells/ml), respectively in the first test day post-partum (Coffey et al., 1986). Data from a large study showed heifers with a SCC less than 50,000 cells/ml milk on the first test day between 5-14 DIM was 0.5 lb. milk/day and 3.2 lb./day on subsequent test days compared to heifers with SCC between 51,000 - 200,000 and greater than 1,000,000 cells/ml milk, respectively (De Vliegher et al., 2005). The effect of elevated SCC between 5-14 DIM on subsequent test day milk yields decreased with successive 30 day test days across the first

lactation. Self-cure of these infections is the most likely reason for the diminished effect of prepartum intramammary infection on post-partum milk yields later in the first lactation. Self-cure is most likely in first lactation heifers because prepartum infections stem from minor mastitis pathogens, most of whom do not normally establish persistent intramammary infections.

As high as 13% of the prepartum infections may be resolved by self-cure post-partum (Parker et al., 2007). The same cannot be said for prepartum infections with major pathogens such as *Staphylococcus aureus*. However in this study, real reductions in milk yields persisted even as late as test dates around 255 DIM. Interestingly, when elevated SCC are observed in the first test date falling in the first 5-14 DIM, the later in that time period the SCC is observed the greater the reduction in milk yields across the first lactation. Thus, producers can expect greatest reductions in first lactation milk yields to occur in heifers with the highest SCC that also fall later in the 5-14 DIM test date. Altogether, these data indicated elevated SCC very early in lactation from prepartum infections have enduring negative effects on first lactation milk yields in heifers. The earlier in lactation self-cures are accomplished with minor pathogens, the lower the negative impact on first lactation productivity.

The presence of a prepartum intramammary infection, regardless of causal pathogen, is often but not inevitably associated with a 3-4 fold increased risk of post-partum intramammary infection or the onset of clinical mastitis in heifers (Parker et al., 2007). The increased risk of post-partum infection can occur across coagulase negative pathogens, environmental pathogens such as *Streptococcus uberis* or major pathogens like *Staphylococcus aureus*. Other reports showed prepartum intramammary infections, particularly those with minor pathogens, were protective against post-partum infections (Parker et al., 2007). Presumably, the elevated SCC associated with minor pathogen intramammary infections increases antibacterial defenses and therefore protection in the mammary glands (Pankey et al., 1985). The conflicting reports claiming reduced or increased risk of intramammary infection in glands with prepartum minor pathogen infections likely reflects the multiplicity of confounding elements (e.g. environmental, immunologic, anatomic, and pathologic factors affecting streak canal integrity) impacting intramammary infections.

Economic losses associated with mastitis are derived from reduced milk yields, treatment costs, discard milk and premature culling. Very little work exists estimating costs and the economics of heifer mastitis but the losses associated with mastitis in general can serve as a guide for economics of heifer mastitis. De Vliegher et al., (2012) cited work by Huijps et al., (2009) from the Netherlands estimating costs for heifer mastitis at approximately \$40/heifer/year. Cost estimates were also distributed across one of the three possible outcomes for heifers with elevated SCC ($>200,000$ cells/ml) early in lactation (DIM 5-14). Heifer mastitis that self-cured cost \$16; Cost estimates for heifer mastitis that remained subclinical with persistently elevated SCC were \$6-7. Subclinical heifer mastitis that progressed to clinical mastitis cost \$17 per heifer. These costs seem minuscule compared to the \$181 cost estimate of mastitis in parity 2 or greater cows (Huijps et al., 2007) or estimated returns on costs of \$200 for antimicrobial prophylactic therapy in heifer mastitis (Oliver et al., 2003). Estimated costs stemmed from loss of production, increased culling, milk discard, veterinary expenses, medication, and labor. These costs were determined under standard practices and markets of the Netherlands.

Similar estimates of economic costs of heifer mastitis in the U.S.A. do not exist but several models have been developed to estimate costs of mastitis in lactating cattle. In one of the more robust models, Bar et al., (2008) estimated clinical mastitis costs \$71 per cow and \$179 per clinical case of mastitis. Costs were incurred from milk loss, mortality, and treatment. These cost estimates are consistent with those incurred in lactating cows in the Netherlands as well as other models. These include cost estimates of \$83 (Houben et al., 1994) and \$71 (Ostergaard et al., 2005) for clinical mastitis in lactating cattle. Producers should be aware costs depend upon the type of pathogen, individual heifer production abilities or genetic potential, milk prices, and heifer replacement costs. In Bar's model (Bar et al., 2008), the costs of mastitis increased with higher milk prices, heifer replacement costs and lower pregnancy rates, pregnancy status, and cows with high future income generating capacity. Higher prevalence of contagious mastitis in heifer replacements can compromise heifer replacement programs and increase losses associated with contagious mastitis in the older lactating herd. Moreover, estimates of the cost of mastitis in a replacement heifer program cannot be ascribed solely to the individual heifer because controlling mastitis in these animals will directly impact control measures and therefore the incidence, prevalence, and economics of contagious mastitis in 2nd and greater lactation animals across the herd. The later concept should provide strong incentives for producers to make management decisions orchestrating sound mastitis control measures in replacement heifer programs.

Strategies for Control and Prevention of Heifer Mastitis

Management strategies designed to prevent and control heifer mastitis need to target the period prior to and during calving. Moreover, defining the nature of the problem is essential to appropriately target resources that underpin prevention and control measure. One initial, sound and cost effective approach is to simply examine SCC of all first parity animals and restrict that analysis to the first and second test day postpartum. Any primiparous animal with a SCC > 150,000-200,000 cells could be considered a candidate for prepartum intramammary infection. Which SCC threshold one employs to define prepartum intramammary infection is debated but SCC > 150,000 cells could be regarded as highly suspect for infection (Santman-Berends et al., 2012). Since Santman-Berends et al. (2012) observed over half the heifers with high SCC on the first test day reverted the SCC back to normal by the second test day, producers should not interpret these animals in the DHIA test day analysis as non-problems. Rather, these animals likely represent a cohort of the subclinical pre-partum mastitis heifers who spontaneously self-cured. The remaining animals who sustain an elevated SCC through the 2nd and 3rd test dates more than likely represent another cohort of prepartum subclinical mastitis heifers with persistent intramammary infection. Collectively, the presence of both groups in the SCC analysis signal a prepartum heifer mastitis problem. The higher the prevalence of these types of SCC profiles in the primiparous animals, the greater the prepartum heifer mastitis problem.

Characterization of heifer mastitis may require prepartum culture surveillance or surveys to determine the relative contributions of coagulase negative staphylococcus minor pathogens, and major pathogens like *S. uberis* and coagulase positive *S. aureus* in a problem. This always raises the question that prepartum sampling removes keratin plugs predisposing the teat to ascending intramammary infection. In at least two studies where this contention was directly

addressed, prepartum sampling did not appear to increase the prevalence of prepartum intramammary infection (Green et al., 2002, Parker et al., 2008). Producer concerns about loss of keratin plug could also be alleviated by post sampling application of teat sealants and barrier teat dips.

Reduced Heifer and Environmental Risk Factors Predisposing to Heifer Mastitis

A number of common sense factors have been associated with increased risk of heifer mastitis. Since many environmental pathogens cause heifer intramammary infections, dealing with the environmental elements is important. Environmental and heifer risk factors associated with increased prevalence of heifer intramammary infections prepartum have recently been associated with higher prevalence of heifer mastitis. These are dirty, fecal contaminated beds, overcrowding, poor horn fly control, use of saw dust, average herd level SCC > 2000,000 cells/ml milk, heifer contact with the lactating herd prepartum, extensive udder edema prepartum in heifers, dirty udders and lengthy teats, teat leakage, lack of udder hair removal, and an absence of teat dipping pre-partum (Piepers et al., 2011, Waage et al., 2001, Comptin e al., 2007, Fox et al, 2009).

Factors proposed to contribute substantially to contagious pathogen heifer mastitis are an absence of horn fly control, high prevalence of contagious mastitis infection in the lactating herd, heifer exposure to the lactating herd prior to parturition, udder edema, and loss of streak canal plug.

Factor thought to predispose heifers to prepartum intramammary infections with environmental pathogens are those allowing buildup of environmental pathogens on teat sphincters. Accordingly, environmental hygiene, stall hygiene, heifer udder hygiene, and most importantly calving stall hygiene are all important factors.

Lastly, integrity of the streak canal sphincter, keratin plug, and teat conformation are important barrier issues preventing intramammary infection in prepartum heifers. Teat sealants, teat spray disinfectants, and barrier dips may become key elements in controlling the prevalence of prepartum heifer mastitis in many herds.

Prepartum Antimicrobial and Teat Sealant Therapy

A number of field trials have been conducted to evaluate the efficacy of prepartum, intramammary antimicrobial therapy on the ecology of heifer mastitis. Nearly every trial resulted in reduction but not complete eradication of intramammary infections and post-partum clinical mastitis in prepartum and primiparous heifers. In a large study involving 13 dairies, 8 of which experienced a heifer mastitis problem, 185 and 184 heifers were left untreated or infused with antimicrobials 8-10 weeks prior to projected calving date (Sampimon et al., 2009). At the day of calving (day 0), 53% of the quarters from infused heifers were culture negative compared to 42% of the quarters from untreated heifers. At day 10-14 post-partum 76% of the quarters from infused heifers were culture negative compared to 69% of un-infused quarters. Infusion reduced the prevalence of intramammary infections caused by both minor as well as mastitis pathogens. As a result, the risk of clinical mastitis in the infused group was reduced nearly two

fold across the entire duration of the first lactation. The reduction was not trivial because the number of clinical cases across all heifers was 40, 44 and 50 at 0-30, 0-60 and 0-275 DIM, respectively. SCC was reduced (16,000 major cells.ml milk per test date) and milk yields were increased (1.98 lbs. milk per test date) across all test dates in the first lactation although differences were diminished in late lactation test dates. The positive effect on prepartum treatment on post-partum production was attributed to the reduction subclinical mastitis manifest by reduced SCC.

In another study, primiparous heifers infused with antimicrobials 7 days prepartum produced 1000-1160 lb. more milk in the first lactation than control heifers (Oliver et al., 2003). According to the results in this and many other studies, prepartum antimicrobial therapy can be expected to have a sustained effect across the entire first lactation.

In the trial by Oliver (2003), bacterial pathogens were isolated from only 11% of all quarters sampled in the infused heifers compared to 30% of all un-infused heifers. These results reflected the lower average SCC across first lactation test dates in infused compared to un-infused heifers. Net economic benefits to producers from the increased productivity of these heifers were \$200.64 after costs of therapy and testing for antibiotic residues. The authors concluded prepartum therapy would be cost effective so long as the increased milk yields were > 84 lb., per heifer/per lactation.

Collectively, the data all indicate prepartum antimicrobial therapy should be a cost effective approach to reduce the production and economic impact of heifer mastitis. Producers however, need to be aware this therapy is an off label use of antimicrobials and therefore must be performed with the direct knowledge and guidance of the veterinarian. Meticulous monitoring of milk residues would need to become a critical component of any prepartum infusion program.

Use of barrier teat dips and teat sealers to prevent heifer mastitis has not been thoroughly evaluated but could be expected to help. The objective of the approach should be to avoid ingress of intramammary pathogens into the mammary gland. The approach could not be expected to reduce the prevalence of pre-existing intramammary infections prior to sealant application. Indeed, administration of a sealant prepartum reduced by 84% the prevalence of subclinical intramammary mastitis manifest as elevated SCC day 4-10 postpartum in heifers (Parker et al., 2007). Sealant administration was also associated with a 60% reduction in clinical mastitis in post-partum heifers.

In a larger study of >1,000 heifers, use of a teat sealant on heifers 39 days prior to calving reduced post-partum intramammary gland infections by 66%. Teat sealants had no effect on resolving pre-existing intramammary infections prior to sealant administration consistent with the effect being purely barrier protection against new intramammary infections (Parker et al., 2008). There may be one unexpected advantage of teat sealants and barrier dips over antimicrobial therapy in pre-partum heifers. Assuming pre-partum intramammary infections per se signify loss of keratin plug and open teat canals, sealants and barrier dips re-establish a physical barrier to teat canal invasions. Antimicrobial therapy, though curative of intramammary infection, provides no barrier protection to a teat canal that is otherwise open to another episode of bacterial invasion and thus new intramammary infection.

Conclusion

Heifer mastitis is in some ways similar but also very different than mastitis in the lactating cow. Intramammary infection can occur anytime between 9 months to 24 months of age and results in subclinical, clinical mastitis, or complete loss of a quarter. All cases are marked by elevated SCC in early first lactation.

The causal pathogen list is upwards of 40 bacterial types long but the primary problem in most circumstances stems from the set of minor mastitis pathogens. More rarely, the major pathogens are causal but when involved can threaten herd biosecurity.

Culture and sensitivity is the final diagnostic tool of choice, but careful inspection of early test date SCC in DHIA reports can be lead to valuable clinical information. A high prevalence of elevated first test day SCCs that persist into late test day SCCs indicate existence of a heifer mastitis problems. A high prevalence of elevated SCC that is sustained across most if not all first lactation test days is consistent with major pathogen involvement in the heifer infection.

A high prevalence of elevated SCC that appear to resolve as lowered SCC after the first few test dates in the first lactation, suggests minor pathogen involvement in the heifer mastitis problem.

Pre- and early post-partum culture results should confirm the causality and govern management changes designed to orchestrate remediation. Remediation is almost always economically justified given the advantage conferred upon first lactation milk yields. More importantly, remediation is critical to herd biosecurity, lower bulk tank SCC, milk quality, and producer premiums. Strategies for control and prevention have not been universally established but recent field trials and epidemiologic studies suggest best results may emerge from changes in heifer hygiene, heifer environment and housing, fly control, intramammary therapy and teal dipping programs.

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Spring Equine Pasture Management

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Although each year is different, there are some years when hay supplies are so tight that horse owners really need pastures to begin growth as early as possible to provide feed for their animals. Since we know that pasture is the least expensive feed that we can use, encouraging early pasture production is a valuable objective any year. There are a number of steps you can take to help pastures get off to a good start in the spring as well as maintain themselves

throughout the grazing season. The following list of steps should be considered in managing spring pastures, although the sequence may need to be varied some depending on your particular situation.

Management Step #1: Pasture and Feed (Hay) Assessment

Before deciding on your approach to spring pasture management, you should carefully evaluate the current status of your pastures, your hay supply, and the availability and quality of hay supplies within your buying radius. You should keep records of hay availability each year to try to spot trends. Even more critical is to keep accurate records of the status of each pasture so you can determine if the pasture health is declining or improving.

Reasons:

- Spring weather patterns will have a significant impact on when pastures develop enough growth to allow grazing.
- If their needs are not met by pasture, horses require dust-free hay which can be more challenging to buy in early spring as hay supplies dwindle.
- Identification of pastures on the decline can help the manager decide which pastures need the most resources to help improve them.

Process:

- Inventory your hay reserves.
- Evaluate the current supply, quality, and price of hay available for sale and prospects for continued availability until new hay comes on the market (following the first expected hay harvest).
- Individually evaluate each pasture's health and status.
- When buying hay, ask for a forage analysis for that lot of hay as the price will be partially offset by the mineral content (N, P, K, Ca, Mg, S, and micronutrients) of the hay that is excreted or spread on pasture (see the article entitled 'When a Bale Isn't a Bale: Changing the Hay Pricing Paradigm' included in this newsletter). The minerals in the manure are valuable as fertilizer material for growth of plants in the pasture, an added value of the hay beyond just providing nutrients for the horses.

Pasture Status:

- What is the percentage of white clover in the pasture and is it increasing in density from year to year? This is important to assess because if grazing intensity is too great and pasture grasses are grazed too short, the grasses are weakened and can't effectively compete with white clover, thus the amount of clover in the pasture increases over time.
- Is the pasture grass stand thick and vigorous or are large patches of soil visible?
- Are pastures thinning, the amount of desirable pasture species declining, and weeds becoming more and more of a problem in the pasture? Loss of desirable pasture plants and invasion of weeds are a result of mismanagement of the pasture, typically either from lack of proper liming and fertilization and/or overgrazing; often both.
- If the answer to one or more of the above questions on pasture status is yes, then it's time to either reduce the number of horses grazed per acre or recognize that an

expensive pasture renovation or complete reestablishment program will soon be needed.

Management Changes:

- If chronically short of pasture, have you or can you consider rotationally grazing the pasture or pastures by splitting them into multiple paddocks?
- Although even a single split can be helpful, you need a minimum of 4 to 6 paddocks to rotate through to allow each pasture a chance to rest and recover before the next grazing cycle.
- Install sacrifice areas where hay can be fed when periods of inclement weather make grazing pasture unadvisable. Sacrifice areas should also be used when drought slows pasture regrowth to the point that you no longer have enough paddocks available to allow the grass to recover to a proper grazing height during the time from one grazing cycle until the next.
- Have a manure management plan developed that helps you return hay nutrients to pastures.

Management Step #2: Fertilization

Proper fertilization of pastures along with application of limestone to maintain the proper soil pH is the number one key to pasture health. Significant changes can be made in the composition of a pasture just by managing the soil fertility level. For example, grasses with their fibrous root system compete for nitrogen (N) much more efficiently than white clover. The application of N fertilizer at the right time and in the right amount can help grass shade clover and reduce its stand density when pasture clover content reaches an unacceptable level.

Reasons:

- Pasture is your least expensive feed source.
- Horse pastures are dominated by grasses (mostly cool-season grasses).
- Nitrogen promotes grass growth.
- Proper timing can increase the grass's rooting depth, increase tiller or shoot density, and lengthen the grazing season (starting up earlier in the spring and running later in the fall).
- Pasture is good for the environment. Thick grass stands reduces erosion potential from fields and holds nutrients over the winter. Green pastures are also a good public relation tool because who doesn't like to see horses cavorting across green fields).

How to Begin:

- Take soil samples from each pasture or hire a nutrient management consultant to take one for you and then prepare a nutrient management plan for your farm (in many cases this is a legal requirement).
- A single soil test should encompass no more than about 20 acres of land.
- If pastures are different in soil type, are managed differently, are fertilized differently; make each pasture into a separate management zone and sample it separately.
- For established pastures, the sampling depth should be 0 to 4 inches since all nutrient applications will be surface applied. For pastures that will be replanted and the soil worked into a fine, weed-free seedbed before planting the new pasture mix, you should

take a 0 to 8 inch sample since any applied fertilizer can be worked into the plow layer of soil.

- If there is no history of recent lime application or there is a history of frequent, regular N applications, or you suspect the surface soil pH is questionable (i.e. the horses have a corner where urine and fecal matter is deposited or certain weeds such as red sorrel or little bluestem predominate), you should take a 0-2 inch sample and have the soil pH tested separate from the general 0 to 4 inch soil test.

Soil pH and Liming:

- Proper soil pH (between 6 and 7) is crucial for maintaining plant nutrient availability in the soil.
- Surface applied agricultural limestone moves down through the soil neutralizing soil acidity at a very slow rate (approximately one inch per year depending on soil type, rainfall amount, and lime particle size).
- Long-term neglect of liming needs or soil testing can result in acidification of the entire root zone in pastures, necessitating complete pasture reestablishment.
- Successful pasture reestablishment along with complete pH adjustment of the major rooting zone (the top 6 to 8 inches of soil) back to a pH between 6 and 7 is monetarily costly and can cause the pasture to be removed from production for two to three years if properly done.
- Proper soil pH also encourages an active invertebrate population such as earthworms and dung-eating beetles as well as the soil bacteria needed for nutrient and soil organic matter recycling.

When to Apply Nitrogen (N):

- The latest thinking suggests that late summer/early fall and late fall N applications can improve the rooting of cool-season grasses as well as encourage early spring grass growth. This timing replaces the traditional early spring N application which can lead to heavy spring growth that when harvested as hay is difficult to cure properly.
- When fall N application (late-August to mid-September and late-October to early November depending on nutrient management fertilizer application restrictions) does not take place, an early spring (March) N application can encourage rapid spring green-up and pasture growth.
- For cool-season grasses, try to avoid N applications before expected periods of high temperatures (especially high night time temperatures) and/or drought since N promotes growth which can cause injury to the grass during periods of stress.
- For warm-season grasses (such as bermudagrass, teff, and pearl millet), early spring and late fall N applications should be avoided and N applied from May through August when warm-season grasses are growing vigorously.

When to Apply Phosphorus (P_2O_5) and Potash (Potassium— K_2O):

- Phosphorus is very important in maintaining and encouraging root development; and although it can be applied just about any time during the growing season, it does become less available in the soil as iron and aluminum in acid soils or calcium in basic soils bind with the nutrient to form insoluble or only slowly soluble compounds. Since we are

moving to fall N applications to promote root growth, the early-fall period when potash is usually applied may be the best choice of timing to help with root growth.

- Potassium is very important for helping plants through periods of stress such as heat and drought during the summer or freezing and thawing conditions during the winter. The recommendation is generally to split the K₂O application into two applications with one applied in late spring and the other in late summer or early fall.

Management Step #3: Avoid Grazing Too Early and/or Too Close

What is the fastest way to set back your pasture grass all year? Begin grazing animals at the first sign of green in the pasture and keep the animals on the pasture continuously so that the grass is not allowed to reach more than 0.25 to 0.5 inches tall. This management technique is a recipe for creating a winter pasture of white clover and annual bluegrass and a summer pasture of goosegrass and crabgrass.

For horses that can become metabolically challenged with high fructan sugar intake, grazing too close can cause problems. Most grasses store sugars in the lower stems and leaves so that horses that are grazing close obtain forage with higher sugar content. The sugar is being stored by the plant for use during regrowth after top growth is grazed since closely grazed plants may not have enough leaf area to capture the sunlight/energy needed to support growth.

For most cool-season grasses, you should follow the general rule of removing horses when the heavily grazed areas have been grazed so only about 4 inches of top growth remains. Allow the pasture grass to grow to a height of 8 to 12 inches, move horses onto a section of pasture and graze until the remaining forage height is 3 to 4 inches, remove the horses and move them to a new area of pasture to graze, and allow the original pasture to rest and regrow back to 8 to 12 inches tall before returning the horses to graze again. You should keep in mind that the more leaf area that remains after grazing the faster the grass will recover. Pasture grazed to a 2-inch stubble will take much longer, perhaps weeks, to recover than one grazed to a 4-inch stubble.

Pastures grazed very close (< 2-inch stubble) can easily be invaded with white clover or a variety of broadleaf and annual grassy weeds or lose so much grass stand that the soil remains bare. See below under weed evaluation for a pasture assessment fact sheet available online from the Maryland Horse Outreach Workgroup.

Management Step #4: Weed Evaluation

Reasons:

- Some plants if eaten in sufficient quantity can cause toxicity issues.
- Some weeds as well as some pasture species produce seeds or seed pods/heads that have component structures that can cause eye, muzzle, or mouth irritation/discomfort.
- Some weeds such as spiny pigweed (also known as spiny amaranth) inhibit near-by grazing activity and this can limit pasture productivity and encourage further weed encroachment.
- Weeds compete with desirable pasture plants for space, nutrients, sunlight, and water.

Process:

- Learn how to identify the desirable forage grasses and legumes and how to distinguish them from the broadleaf and grassy weeds common to the Mid-Atlantic region. For help with weed identification, try some of the online weed identification web sites. Go to www.extension.udel.edu/ag/weed-science/ for links to a number of state aids.
- Learn about commonly found plants that can be toxic to horses and try to develop the skill to identify these plants (visit the UD Cooperative Extension equine blog at www.extension.udel.edu/equine/ for a soon to be published fact sheet on toxic plants)
- Use the Maryland Horse Outreach Workgroup factsheet on pasture assessment (Vegetative Cover: Is It Grass that's Really Greener on the Other Side of the Fence? and a supporting document, Pasture Vegetative Cover Photo Gallery) found at http://mda2.maryland.gov/resource_conservation/Pages/horse_pasture_manure_info.aspx or have some fun evaluating your pasture by marking the edge of a Frisbee with a small black dot and then walking around the pasture throwing the Frisbee. At each location where the Frisbee lands, look under the black dot and record what's there (pasture grass, broadleaf weed, clover, grassy weed, or bare soil). After 50 throws, total each category, multiply the total by 2, and you'll have an estimate of the percentage of the pasture that is pasture grass, broadleaf weed, clover, grassy weed, or bare soil. This should be done at least twice a year—winter/early spring and summer/early fall. If bare soil is above 30 percent, it's time to renovate the pasture. For weeds, the decision point to renovate is less clearly defined as some weeds are edible and may be nearly as productive as pasture grass so the manager will need to make a subjective decision based on their perception of the pasture's productivity and potential.
- If the manager decides that the weed population is too great, consider your weed control options as available in the following publication: Pasture and Hay Weed Management Guide (PDF) available at www.extension.udel.edu/ag/weed-science/weed-management-guide/
- If the pasture has more than 30 percent bare soil, move to Management Step #6.

Management Step #5: Re-assess Your Pasture Management

Reasons:

- Pasture health or productivity is on the decline.
- White clover density has increased to an undesirable level.
- Hay feeding locations are becoming heavily weed infested.
- Erosion on slopes has begun to form a gully or make pastures unsafe for running horses.

Process:

- Evaluate pasture acreage and horse numbers to see that they are in balance and if there is enough pasture acres available to intensify your management. In general, the suggested stocking rate (acres per horse) is 2 to 3 acres per 1,000 lb horse.
- Reevaluate the amount of time spent on various tasks and decide if there is enough available to spend more time moving horses on and off pasture and changing moveable fences.

- Determine if your hay supply or supplier, finances, barn facilities, and remaining pasture acres can support the operation during the resulting changes to a more intensive pasture management approach.
- Study the various options available for intensive pasture management and try to visit with others who have adopted similar pasture management systems.

Management Step #6: Replenishing Pasture through Overseeding

Reasons:

- Desirable, productive cool-season grass species are being crowded out of the pasture by annual weedy species.
- The stand of a desirable species is too thin.
- A boost to pasture productivity is desired (most often this will be relatively short-term since the species easiest to overseed are less likely to maintain themselves for long periods).
- Areas of a pasture need to be killed with a non-selective herbicide (a herbicide that kills any green plant rather than just grasses or just broadleaf plants) to remove perennial weeds (such as curly dock or Canada thistle invading where hay has been fed).

Process

- Make sure a recent soil test has been taken and shows soil nutrient levels and soil pH are in the optimum range; otherwise adjust soil fertility levels first.
- Check with your local Extension or Soil Conservation District office to see what's new on the market and what might fit best in your pasture.
- If you don't have a no-till forage seeder or other type of forage seeder such as a Brillion seeder available, talk with your farming neighbors, the seed supplier, and the local Conservation District office to see if the equipment is available for rent in your area.
- Obtain fresh certified seed of the forage variety you have selected.
- Avoid the use of prepackaged seed mixtures such as 'Premium Horse Pasture Mix', 'Mid-Atlantic Horse Pasture Mix', and 'Superior Horse Pasture Mix' (all these names are made up but they all will feature 3 to 6 grass species plus 1 to 2 legume species, often including alsike clover that can cause photosensitivity in some horses and timothy which is not very tolerant of grazing).
- If a pasture is not undergoing complete renovation where the old pasture is killed with a non-selective herbicide such as Roundup and an early spring or frost-crack seeding is anticipated, the pasture should be heavily grazed in the fall to weaken the existing plants and remove as much vegetation as possible so that germinating seedlings the next spring are not shaded too quickly by established plants.
- Select species that have very rapid germination and fast establishment characteristics. Species such as perennial or tetraploid ryegrass or the new festuloliums can establish quickly although they may have to be reseeded every few years.
- New seedlings of grasses should be mowed several times before putting horses out to graze. This will encourage the plant stand to thicken as the grasses produce more shoots and leaves and will stimulate the plants to establish a good root system. This usually

means that the new stand must be rested for 6 months to a year before grazing begins again.

When a Bale Isn't a Bale: Changing the Hay Pricing Paradigm

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One of the biggest complaints of hay sellers is someone telephoning around to sellers looking for the least expensive hay and needing the hay right now. The buyer usually only or only stays on the phone long enough to ask the question that's most important in their mind 'How much are you selling your hay for?' It seems that buyers often forget that the weight of a hay bale, the moisture content of a hay bale, and the physical dimensions of a hay bale can vary greatly among hay producers.

I searched the web for information about hay bales and found that the general definition used is that a hay bale is a large bundle of dried plant material bound for storage or transport. There seem to be many types of hay bales including small, medium, and large square bales that aren't really square but vary in dimension as noted below. Other types include compressed bales (often the small square bales that are squeezed length-wise down to half or less of the length), round bales wrapped, not wrapped, netted, nor not netted.

The fixed dimensions (height and width) of the most common small square bale are usually 14 by 18 inches although some of the newer and more expensive small square balers have fixed dimensions of 16 by 18 inches. The length of these bales is a variable dimension that can be set from 12 to 52 inches although the most common bale length is 36 inches which allows bales to be interleaved when stacked to stabilize the stack. The weight of a small square or rectangular bale varies considerably depending on the bale's exact dimensions and the moisture content of the baled hay.

Currently, a number of preservatives are on the market for extending the moisture at which hay can be safely baled. These preservatives allow hay with 15 to 30% moisture to be baled and this allows growers to safely make hay in spring as well as in fall when drying conditions are less than ideal. The use of preservatives such as buffered propionic acid and a new formulation of a

stabilized potassium sorbate (Option-One® water soluble concentrate) also permit growers to save hay from unexpected showers even during the prime hay making June to August period.

Even when hay is near the standard storage moisture of 12%, the weight of hay bales varies greatly depending on the density of the packed bale. The standard small bale weight can vary from the mid-30s to the mid-50s and the longer rectangular bales if tightly packed can weigh as much as 90 lbs. Typically at a bale size of 14"x18"x36", the weight at about 12% moisture varies from 42 to 50 lbs/bale.

A recent introduction into the hay market is the compressed bale which can weigh from 40 lbs to nearly 55 lbs per bale. The compressed bales often are enclosed in plastic which can hold the bale together, offer some protection from rainfall or high humidity, and limit leaf loss when alfalfa or clover is a component of the hay. Dimensions vary based on the equipment and amount of pressure used in compressing the bale. We've observed bales in retail stores that are as small as 12"x17.5"x22" to as large as 9"x16"x28" and ranging in weight from 40 to 52 lbs.

The significant point is that there are no set standards for hay bales with respect to dimensions, weight, packaging, or moisture content. Some locations require state certification of scales for the sale of any product on a weight basis and this is not a viable option for most hay growers and sellers. Since some hay purchases are even made straight out of the field, it is incumbent on the hay buyer to develop a relationship with the supplier so that the buyer can be reasonably sure of bale moisture content and bale weight.

When hay is bought in the equine market, the buyer often thinks of the hay as a supplemental feed whether supplementing pasture or grain or a store-bought prepared ration. The buyer, therefore, looks primarily at color, smell and dustiness to judge the hay's quality. The nutritional content (protein, energy, vitamins, and minerals) may be considered indirectly but often aren't paramount. In certain aspects of the equine market, breeders and owners of high performance horses, the nutritional content becomes the most important consideration; but in this article, we will address the pleasure horse portion of the hay market.

In the pleasure horse hay market, the price per bale as well as the general appearance of the hay is about the only factors considered when making hay purchases, especially via the telephone when looking for new providers. The hay sellers often comment that the first question asked after it is established that there is hay available is "What is your price (the price per bale)?" The buyer upon hearing a price they consider unreasonable will end the conversation immediately. What often aren't determined are the very critical components—average bale weight and hay moisture content. Since hay will be used to supplement pasture during the growing season or replace pastures during the winter months, buyers also should ask for a detailed forage analysis that gives on a dry weight and 'as is' basis the crude protein [divide this number by 6.25 to obtain the nitrogen (N) content of the hay], fiber components (NDF, ADF, cellulose, hemicellulose, etc.), energy content [horse DE (digestible energy), RFV (relative feed value), NEL (net energy of lactation), NEm (net energy for maintenance), NEg (net energy for gain) ME (metabolizable energy)], and mineral content of the hay (please review the article "[Understanding a Hay Analysis Report](#)" by Richard W. Taylor, Les Vough, and Elmer Dengler in the Mid-Atlantic Regional Agronomist Quarterly Newsletter, December 2007, Issue 2, No. 4).

Since the hay analysis report will reveal that there is a lot more to the value of hay than just a feed supplement for the horse to chew on, we wanted to review some of the other values that are derived from hay purchases. The first is the easiest for which to calculate an economic value and is the nutrient content of hay. The nutrient content of the hay in many cases can be considered the same as fertilizer purchases for the farm. In most cases, the manure that is generated by the horse feeding on hay is broken up and spread over the pastures or collected from the barn or sacrifice area and either sold as manure or compost or is spread back over pastures or hay fields. These nutrients can replace store bought fertilizers if carefully handled and then considered by the farm operator.

To evaluate the impact of nutrients on hay value, we looked at three hays bought from a hay supplier who had available forage analyses for the hay. We also purchased three hay products from a local retail outlet that sells to horse owners. Table 1 presents the nutrient analyses for these six hay products.

Table 1. Nutrient content of six hay products based on 12% moisture hay.

Nutrient ⁴	Hay from local hay producer ¹			Hay from retail store		
	Bermudagrass	Tall fescue ²	Mature teff hay	Compressed Alf/grass	Timothy pellets	Hay cubes Alf/timothy
	Second cutting hay		Cut well past optimum	Cutting not stated	First cutting	Cutting not stated
	-----% Percent-----					
CP ³	22.9	18.8	4.35	12.5	8.0	12.5
P	0.31	0.35	0.22	0.31	0.35	0.22
Ca	0.40	0.49	0.31	0.68	0.41	0.59
Mg	0.22	0.21	0.21	0.21	0.21	0.21
S	0.36	0.31	0.30	0.32	0.31	0.32
K	3.91	3.31	1.95	2.91	2.10	2.25
N	3.66	3.01	0.70	2.00	1.28	2.00

¹, Bermudagrass, tall fescue, and teff bales weighed 85 lbs each while from the retail store the compressed alfalfa/grass bale weighted 52 lbs and the bags of timothy pellets and hay cubes weighed 40 lbs per bag.

², Tall fescue hay was the new soft-leaved novel or friendly endophyte Bar Optima Plus E-34 which does not contain the toxic alkaloids normally associated with tall fescue (especially Ky-31 tall fescue).

³, CP is crude protein. Divide CP by 6.25 to obtain percent nitrogen

⁴, Nutrients listed are phosphorus (P but multiply this by 2.29 to obtain percent P₂O₅ which is what fertilizer prices are based on), calcium (Ca), magnesium (Mg), sulfur (S but multiply this by 2.996 to obtain percent SO₄ which is often the form of plant available sulfur in fertilizer), potassium (K but multiply by 1.20 to obtain percent K₂O used for fertilizer grades), and nitrogen (N).

The above nutrient contents were then converted to a value basis using approximate fertilizer costs to the typical horse farm (10 to 35 acres) where large quantity purchases of fertilizer are not the norm. The nutrient cost basis used was \$40/ton for limestone (calcium and magnesium carbonates), \$0.70/lb for N, \$0.65/lb for phosphate (P₂O₅), \$0.75/lb for potash (K₂O) and \$0.80/lb for sulfate (SO₄). Table 2 presents the value in dollars per bale for each of the hay products. Again, keep in mind that the grower bales weighed 85 lbs apiece, the compressed

alfalfa/grass bale weighed 52 lbs, and the bags of timothy pellets and alfalfa/timothy cubes weighed 40 lbs each.

In Table 2, we can see that economically the most important nutrient contributions from the hay selections are potash, nitrogen, sulfur, and phosphate ranked in that order. The total value of fertilizer nutrients in the products ranged from \$6.35/bale for the high quality bermudagrass hay, closely followed by the second cutting E-34 tall fescue hay (\$5.45/bale), and ending with \$1.63 /bag for nutrients in the pelletized timothy. The reader should keep in mind that the relative rankings and absolute value of nutrients will vary based on the bale weight, hay cutting, and fertilizer program used to raise the hay. For producers who breed horses and sell them off farm, a small quantity of the hay imported nutrients will leave with the livestock when sold but this will be only a very small proportion of the nutrient value delivered to the farm as hay.

Table 2. Economic value of the nutrient content of six hay products based on prices in December 2012.

Fertilizer nutrient ³	Hay from local hay producer ¹			Hay from retail store		
	Bermudagrass	Tall fescue ²	Mature teff hay	Compressed Alf/grass	Timothy pellets	Hay cubes Alf/timothy
	Second cutting hay		Cut well past optimum	Cutting not stated	First cutting	Cutting not stated
	\$/bale or bag-					
Phosphate	0.41	0.44	0.28	0.24	0.21	0.13
Ca, Mg from lime	0.04	0.05	0.04	0.04	0.02	0.02
Sulfate S	0.73	0.63	0.61	0.40	0.30	0.31
Potash	2.99	2.54	1.49	1.36	0.76	0.81
N	2.18	1.79	0.42	0.73	0.36	0.56
Total fertilizer value	\$6.35	\$5.45	\$2.85	\$2.77	\$1.63	\$1.83
Hay cost	\$12.00	\$12.00	\$12.00	\$18.99	\$16.99	\$12.00
Original \$/lb hay	\$0.14	\$0.14	\$0.14	\$0.37	\$0.42	\$0.30
Net hay purchase price	\$5.65	\$6.55	\$9.15	\$16.22	\$15.36	\$10.17
Net \$/lb hay	\$0.07	\$0.08	\$0.11	\$0.31	\$0.38	\$0.25

¹, Bermudagrass, tall fescue, and teff bales weighed 85 lbs each while from the retail store the compressed alfalfa/grass bale weighted 52 lbs and the bags of timothy pellets and hay cubes weighed 40 lbs per bag.

², Tall fescue hay was the new soft-leaved novel or friendly endophyte Bar Optima Plus E-34 which does not contain the toxic alkaloids normally associated with tall fescue (especially Ky-31 tall fescue).

³, Nutrients listed are phosphate phosphorus P₂O₅, calcium and magnesium from limestone, sulfate sulfur (SO₄), potash or potassium (K₂O), and nitrogen (N).

Table 2 also indicates that if the value of hay nutrients is subtracted from the purchase price of the hay, the cost per pound of hay as feed is significantly reduced. The original cost of the

hay was \$0.14/lb for the bermudagrass, E-34 tall fescue, and teff hay, \$0.30/lb for the alfalfa/timothy hay cubes, \$0.37 for the compressed alfalfa/grass hay, and \$0.42/lb for the timothy pellets. After subtracting the fertilizer value in the hays, these values changed to \$0.07, \$0.08, \$0.11, \$0.25, \$0.31, and \$0.38/lb, respectively. In a survey of prepared bagged horse diets available at retail stores, we found that the average cost was about \$0.30/lb of feed. Therefore, hay direct from the producer cost about 25 percent of the retail store horse diet after the value of the nutrients in the hay was considered and less than 50 percent of the retail horse diet cost without considering the value to the horse farm of the nutrients imported in the hay.

Fertilizer value is not the only ‘hidden’ benefit in purchased hay. Horses evolved over eons as grazers and foragers. Horses now require long roughage from hay or pasture to maintain normal digestive tract function. Hay, therefore, can reduce the risk of colic and gastric ulcers and help maintain a healthy digestive system that often will translate into reduced veterinary expenses. Actual savings are not easily calculated as dollars per pound of hay consumed but exist nevertheless.

Another advantage of hay is that it can reduce the time horses spend performing stereotypic and undesirable behaviors such as cribbing, weaving; wood chewing, and coprophagy. This again can translate into savings associated with less facility damage or lower maintenance costs.

Finally, quality hay as a feed can supply the protein, minerals, and maintenance energy needed for healthy horses. For example, a 1,000 lb mature horse at maintenance requires 1.25 lbs of daily protein. Horses often are fed about 2 percent of body weight as hay or 20 lbs of hay per day. For the hay products sampled for this article, the crude protein contribution in 20 lbs of hay ranged from 4.6 lbs for bermudagrass (22.9% crude protein) to 1.6 lbs for timothy pellets (8.0% crude protein). Not all of the hay protein was digestible protein but most if not all of the hay products would meet the minimum daily protein requirement of the 1,000 lb maintenance horse. This can possibly save money by reducing the need for prepared diets bought (average price is about \$0.30/lb) at retail stores.

In summary, hay buyers should seriously consider purchasing hay on a weight basis even if they need to weigh a few bales to determine average weight. Buyers also should ask for a hay analysis report so that they will have an estimate of moisture content as well as of the nutritional value (and fertilizer value) of the purchased hay. Knowing bale weight and moisture will help the hay buyer comparison shop more easily; mean less hang-ups for the hay seller when price per bale is mentioned; allow easier access to different bale shapes, sizes, and packaging; help buyers evaluate different hays better; allow the calculation of feed costs more accurately; and allow animals to be fed based on their nutritional requirements as suggested in the National Research Council recommendations.

The hay grower will win as well in that the producer can obtain a fair price for the hay produced and will not be penalized by the misconception of what a hay bale is. The hay grower also must realize the quantity of nutrients moving off his farm that must be replaced at some point to maintain profitability. Both the hay producer and the hay buyer will be able to develop sounder nutrient management plans for their farms.

Notices and Upcoming Events

January 23-24, 2013

Gulke Group's The Executive Program for Producers—Farm Marketing and Financial Workshop, Dover, DE. Contact Jeff Beal at 602-795-5893 or log on to:
<http://theexecutiveprogramforproducers.com/>

January 30, 2013

Kent Count Crop Masters—Delaware Nutrient Management Update, 67 Transportation Circle, Dover, DE. To register, contact Phillip Sylvester by calling 302-730-4000 or by email at Phillip@udel.edu.

February 4-7, 2013

2013 New Jersey Agricultural Convention and Trade Show, Mark Etess Arena Trump Taj Mahal, Atlantic City, NJ. To register, contact Dr. Mel Henninger at 848-932-6332 or 609-203-4184 or email him at henninger@aesop.rutgers.edu.

February 12-15, 2013

Virginia No-Till Alliance Winter Conferences, Rockingham County Farigroundds in Harrisonburg, VA on Feb. 12, at Olde Dominion Agricultural Complex in Chatham, VA on Feb. 13, at Keystone Tractor Works in Colonial Heights, VA on Feb. 14, and at University Hall at University of Mary Washington in Fredericksburg, VA on Feb 15. For more information or to register, contact Matt Yancey at 540-564-3080 or by email at yancey@vt.edu.

February 8, 2013

Grain Marketing Update, Higher Education Center, Chesapeake College, Wye Mills, MD. Cost is \$20.00. To register, call 410-822-1244 or email sdill@umd.edu.

February 14, 2013

Delmarva Dairy Day, Hartley Fire Hall, Hartley, DE. For more information or to register, contact Susan Garey by calling 302730-4000 or by email at Truehart@udel.edu.

February 14-15, 2013

67th Northeastern Corn Improvement Conference, Lord Elgin Hotel, Ottawa, Ontario, Canada. For more information or registration materials contact Dr. Bao-Luo Ma, President, Northeastern Corn Improvement Conference 2013 by phone at 613-759-1521, fax at 613-759-1701 or by email at Baoluo.Ma@agr.gc.ca. The link to the registration site is: The link to the registration site is: <https://cceconferences.wufoo.com/forms/2013-necic-registration/>

February 20, 2013

Kent Count Crop Masters—Pest Management for Agronomic Crops Update, 67 Transportation Circle, Dover, DE. To register, contact Phillip Sylvester by calling 302-730-4000 or by email at Phillip@udel.edu.

February 20, 2013

2013 Bay Area Fruit School, University of Maryland Wye Research and Education center in Queenstown, MD. Registration is \$20. To register or for directions, contact Debby Dant at 410-827-8056 Ext. 115 or by email at ddant@umd.edu or contact Mike Newell at 410-827-7388.

February 27, 2013

Kent Count Crop Masters—Hay Production in Delaware, 67 Transportation Circle, Dover, DE. To register, contact Phillip Sylvester by calling 302-730-4000 or by email at Phillip@udel.edu.

January 30, 2013

Kent Count Crop Masters—2013 Crop Insurance Decisions, 67 Transportation Circle, Dover, DE. To register, contact Phillip Sylvester by calling 302-730-4000 or by email at Phillip@udel.edu.

March 8-9, 2013

2013 Appalachian Grazing Conference, Waterfront Place Hotel, Morgantown, W.Va. To register (\$100/person if by Feb. 6, \$125 thereafter) contact Jim Foster by calling 304-349-4985 or by email at jefoster63@hotmail.com.

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