The grain fill period begins with successful pollination and initiation of kernel development, and ends approximately 60 days later when the kernels are physiologically mature. During grain fill, the developing kernels will be the primary sink for concurrent photosynthate produced by the corn plant. What this means is that the photosynthate demands of the developing kernels will take precedence over that of much of the rest of the plant. In essence, the plant will do all it can to "pump" dry matter into the kernels, sometimes at the expense of the health and maintenance of other plant parts including the roots and lower stalk.

A stress-free grain fill period can maximize the yield potential of a crop, while severe stress during grain fill can cause kernel abortion or lightweight grain and encourage the development of stalk rot. The health of the upper leaf canopy is particularly important for achieving maximum grain filling capacity.

Kernel development proceeds through several relatively distinct stages that were originally described by Ritchie et al. (1993). This article offers a pictorial tour of the grain filling period of a 109 CRM hybrid planted April 18, 2007 at the Purdue Agronomy Farm in west central Indiana.

Silking Stage (Growth Stage R1)
Some may argue whether silking should be labeled as a kernel growth stage, but nonetheless silk emergence is technically the first identifiable stage of the reproductive period. Silks remain receptive to pollen grain germination up to 10 days after silk emergence (Nielsen, 2007a). Silk receptivity decreases rapidly after 10 days if pollination has not yet occurred. Natural senescence of silk tissue over time results in collapsed tissue that restricts continued growth of the pollen tube. Silk emergence usually occurs in close synchrony with pollen shed (Nielsen, 2007b), so that duration of silk receptivity is normally not a concern. Failure of silks to emerge in the first place (for example, in response to silkbailing or severe drought stress) does not bode well for successful pollination.
Kernel Blister Stage (Growth Stage R2)

About 10 to 14 days after silking, the developing kernels are whitish "blisters" on the cob and contain abundant clear fluid. The ear silks are mostly brown and drying rapidly. Some starch is beginning to accumulate in the endosperm. The radicle root, coleoptile, and first embryonic leaf have formed in the embryo by the blister stage. Severe stress can easily abort kernels at pre-blister and blister stages. Kernel moisture content is approximately 85 percent. For late April to early May plantings in Indiana, the thermal time from blister stage to physiological maturity is approximately 960 growing degree days (GDD) (Brown, 1999).

Silks beginning to dry and turn brown at blister stage (growth stage R2); about 9 days after mid-silk.

Closer view of drying silks at growth stage R2.

Ear with husks removed showing kernels and spent silks at growth stage R2.

Closer view of cob and kernel "blisters" at growth stage R2.

Clear sugary fluid from developing kernel cut with knife at growth stage R2.

Depth of kernels in cross-section of cob at growth stage R2.
Kernel Milk Stage (R3)
About 18 to 22 days after silking, the kernels are mostly yellow and contain "milky" white fluid. The milk stage of development is the infamous "roasting ear" stage, that stage where you will find die-hard corn aficionados standing out in their field nibbling on these delectable morsels. Starch continues to accumulate in the endosperm. Endosperm cell division is nearly complete and continued growth is mostly due to cell expansion and starch accumulation. Severe stress can still abort kernels, although not as easily as at the blister stage. Kernel moisture content is approximately 80 percent. For late-April to early-May plantings in Indiana, the thermal time from milk stage to physiological maturity is approximately 880 GDDs (Brown, 1999).

Silks dry and brown at milk stage (growth stage R3), husks still green; about 16 days after mid-silk.

Kernel Dough Stage (R4)
About 24 to 28 days after silking, the kernel's milky inner fluid is changing to a "doughy" consistency as starch accumulation continues in the endosperm. The shelled cob is now light red or pink. By dough stage, four embryonic leaves have formed and the kernels have reached about 50 percent of their mature dry weight. Kernel moisture content is approximately 70 percent by R4. Kernel abortion is much less likely to occur once kernels have reached early dough stage, but severe stress can continue to affect eventual yield by reducing kernel weight. For late April to early May plantings in Indiana, the thermal time from dough stage to physiological maturity is approximately 670 GDDs (Brown, 1999).

Silks dry and brown at dough stage (growth stage R4), husks still green; about 25 days after mid-silk.
Kernel Dent Stage (R5)

About 35 to 42 days after silking, all or nearly all of the kernels are denting near their crowns. The fifth (and last) embryonic leaf and lateral seminal roots form just prior to the dent stage. Kernel moisture content at the beginning of the dent stage is approximately 55 percent.

A distinct horizontal line appears near the dent end of the kernel and slowly progresses to the tip end of the kernel over the next 3 weeks or so. This line is called the "milk line" and marks the boundary between the liquid (milky) and solid (starchy) areas of the maturing kernels.

For late-April to early-May plantings in Indiana, the thermal time from full dent (kernel milk line barely visible) to physiological maturity is approximately 350 GDDs (Brown, 1999). Thermal time from the half-milkline stage to physiological maturity for similar planting dates is approximately 280 GDDs. One of the consequences of delayed planting is that thermal time from the dent stage to physiological maturity is shortened, though this may simply reflect a premature maturation of the grain caused by the cumulative effects of shorter daylengths and cooler days in early fall or by outright death of the plants by a killing fall freeze.

Severe stress can continue to limit kernel dry weight accumulation between the dent stage and physiological maturity. Estimated yield loss due to total plant death at full dent is about 40%, while total plant death at half-milkline would decrease yield by about 12% (Carter & Hesterman, 1990).
Physiological Maturity (R6)
About 55 to 65 days after silking, kernel dry weight usually reaches its maximum and kernels are said to be physiologically mature and safe from frost. Physiological maturity occurs shortly after the kernel milk line disappears and just before the kernel black layer forms at the tip of the kernels. Severe stress after physiological maturity has little effect on grain yield, unless the integrity of the stalk or ear is compromised (e.g., damage from European corn borer or stalk rots). Kernel moisture content at physiological maturity averages 30 percent, but can vary from 25 to 40 percent grain moisture.
Harvest Maturity
While not strictly a stage of grain development, harvest maturity is often defined as the grain moisture content where harvest can occur with minimal kernel damage and mechanical harvest loss. Harvest maturity is usually considered to be near 25 percent grain moisture.

FOCUS ON WEATHER AND CROP SIZE

**Dr. Darrel Good, Agricultural Economist, University of Illinois**

Corn and soybean prices managed an impressive rally during the first half of July. That rally was initiated by smaller than expected June inventories and smaller than expected corn acreage revealed in USDA’s June 30 reports. The rally was supported by strength in wheat prices that reflected declining wheat crop prospects in a number of important production areas.

Strength in corn and soybean prices late last week reflected concerns about the potential impact of the forecast for widespread and lingering high temperatures across the U.S. Updated forecasts for more widespread and abundant precipitation this week moderated some of last week’s yield concerns. Most of the crop concern is centered on corn due to prospects for relatively small stocks at the end of the current marketing year and prospects for a continuation of a high rate of consumption during the 2010-11 marketing year. Consumption next year is expected to be supported by increasing use of corn for ethanol production, although there is some concern about reaching the blend wall in early 2011. Most remain optimistic that the Environmental Protection Agency will approve a higher ethanol blend, at least for some vehicles, that would expand the potential market for mid-level blends. There is also concern that the $.45 per gallon blender’s tax credit for ethanol which expires at the end of this year will not be renewed, or more likely, will be renewed at a lower rate. Current price...
relationships in the ethanol and gasoline markets suggest that a lower tax credit rate would not reduce the incentive for blending. The concern would be that the price relationships would change so that a lower tax credit rate would reduce those incentives. A case might be made for a variable tax credit rate that reflects changing price relationships and blending economics.

The other sectors of the corn market are expected to experience stable consumption patterns. The USDA currently forecasts non-ethanol processing uses of corn during the year ahead at 1.36 billion bushels, only 20 million bushels above the forecast for this year. Feed and residual use is projected at 5.35 billion bushels, 175 million less than the inflated projection for the current year resulting from the small estimate of June 1 inventories. U.S. corn exports during the year ahead are forecast at 1.95 billion bushels, equal to the forecast for the current year.

There is a fair amount of uncertainty about export demand for U.S. corn. Through July 15, the USDA reports cumulative export inspection during the current marketing year at 1.608 billion bushels. Through May, cumulative Census Bureau export estimates exceeded inspections by 77.7 million bushels. If that margin has been maintained, exports during the last 6.7 weeks of the year need to total 264 million bushels, an average of 39.4 million bushels per week, to reach the USDA projection of 1.95 billion bushels. Inspections over the 11 weeks ended July 15 averaged 40.8 million per week. It appears that shipments are on pace to reach the projection. Unshipped sales of U.S. corn for delivery during the current marketing year stood at 373.8 million bushels on July 8, well above that needed to reach the USDA projection. Export sales for delivery during the 2010-11 marketing year stood at a relatively small 101 million bushels as of July 8, including only 2.4 million bushels to China. Export sales for next year, however, could accelerate if world wheat production prospects continue to decline.

There is a little less concern about the U.S. soybean crop even with small inventories due to prospects for reduced consumption of U.S. soybeans during the year ahead and the 1.4 million acre increase in U.S. planted acreage this year. With a trend yield in 2010, the USDA expects 2010-11 marketing year ending stocks of U.S. soybeans to reach a four-year high of 360 million bushels. An average yield slightly below trend would still leave expected stocks at a relatively high level.

In general, expectations for the U.S. average corn yield this year have declined slightly, but are still relatively high. The wide range of yield expectations reflects the differing assessments of the impact of weather conditions to date and uncertainty about upcoming weather. Record or near record June rainfall in much of the Midwest may have had a negative impact on yield potential, but that is not accepted by all analysts. Even more subtle is the likely net impact of July temperatures slightly above average this year compared to the record or near record low temperatures of 2009. The USDA will release the first forecast of yields based on surveys and field observations on August 12. The price impact of that forecast could be significant.

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New Concepts and Developments in Hay and Pasture

Dr. Lester Vough, Emeritus Forage Crop Specialist

Some exciting new forage developments are underway in Maryland and Delaware. One is the evaluation of bermudagrass types and varieties for heavy use areas, such as sacrifice and loafing lots, winter feeding areas, and laneways. While bermudagrass has historically been a species adapted to the South, varieties have recently been developed with more winter hardiness that might possibly overwinter in much of Maryland and Delaware.

NRCS began looking at the vegetatively propagated variety, 'Quickstand', six to eight years ago in Southern Maryland and on the Lower Eastern Shore. Early results were mixed, as no one had experience growing it in Maryland. Those involved in this effort had to learn the proper procedures for planting and management during the establishment phase. In spite of difficulties and some establishment failures, there were enough successes to keep going.

One of the successful plantings was on two winter feeding areas on a large beef operation on the Eastern Shore. In spite of an extremely dry summer after the areas were sprigged and being beat up over the following winter, the bermudagrass revegated the areas the following summer. The cover of bermudagrass was thick enough to even suppress spiny amaranth. The fact that it survived the dry weather after planting, endured winter feeding traffic and abuse, and then came back strong enough to suppress spiny amaranth the following summer made a believer out of me on the potential benefits of using bermudagrass for vegetative cover of heavy use areas in Maryland!

Quickstand establishes quickly (as its name implies), but is low growing (5-6 inches), making it better suited for turf purposes and grazing than for hay. It stands out for its vigorous growth, extreme winter hardiness and thick turf
establishment. It has a very vigorous lateral growth rate which allows quick recovery from damage, making it an excellent grass for athletic fields, golf courses and we think for heavy use areas. It is also much more drought and heat tolerant than our common cool-season grasses.

The primary drawback to using Quickstand and other vegetatively propagated forage varieties of bermudagrass in this area is first of all the lack of local sources of sprigs (planting material). Thus we have turned to turf-type varieties and up to this time limited the plantings mostly to heavy use areas where ground cover is the primary consideration and forage production is a secondary consideration. Sprigs of some turf-type varieties are available on the Lower Eastern Shore.

The second drawback is the lack of specialized equipment in the Mid-Atlantic area for field planting of sprigs. These two drawbacks led to a considerable effort to evaluate seeded varieties. A bermudagrass variety evaluation trial was established at the NRCS National Plant Materials Center at Beltsville in 2008. This trial included both sprigged and seeded varieties. In addition to this trial, numerous demonstration seedings were made throughout much of Maryland to look at the performance of several seeded varieties under various conditions. The results of the demonstration seedings were disappointing. While these seedings produced good stands and considerable growth during the establishment summer, many of them failed to overwinter. Thus at this point we are not recommending the planting of seeded varieties.

A couple of newer, more winter hardy, vegetatively propagated forage-type varieties are being planted this year in several locations to be evaluated for hay and pasture production. If these plantings are successful, these varieties might offer an alternative forage species on sites where orchardgrass, timothy, etc. are poorly adapted. There is also interest in bermudagrass hay for the horse hay market in cases where the sugar content of cool-season grasses is of concern. Bermudagrass is thought to possibly contain lower levels of nonstructural carbohydrates than orchardgrass, tall fescue, Kentucky bluegrass, etc., but further testing is needed to determine if that is actually true.

Other warm-season perennial grasses are being evaluated in research trials for possible forage use. Florida paspalum looks very promising from the standpoints of yield and leaf:stem ratio but very little information is available on palatability to livestock. The NRCS National Plant Materials Center, in cooperation with the USDA Beltsville Agricultural Research Center and the University of Maryland Wye Research and Education Center, is establishing trials to assess palatability of this grass with beef cattle.

These are just a couple of the new forage developments to keep an eye out for in the future. If you are interested in more information, you can contact me at 301-405-1322 or vough@umd.edu.

**Crop Reports**

**Central**

Scattered thunderstorms have provided some relief in most areas. Early corn was hard hit by the dry hot conditions during pollination. Late planted corn continues to show drought stress, but not as severe as several weeks ago. Soybeans are holding on, but some producers have chosen not to plant late beans as they were waiting for moisture. Pastures continue to be in poor condition. Second and third cutting alfalfa has been very short.

**North East**

During the period of July 10 to 14 the area received about three inches of very needed rain. It helped pasture, hay and soybeans. Much of the corn has recovered, but the drought has affected plant size, and the drought along with high temperatures has possibility reduced pollination. Spotty rain showers during the week of July 19 have been a help but too sporadic.

**Southern**

Showers starting on June 11 brought some critically needed relief to crops. Rain has been isolated and intermittent with some areas receiving less than ½ inch and others over 4 inches. Corn foliage has greened up but most damage is already done. Most corn failed to pollinate or was stressed to the point of making no ear at all. Due to the poor pollination and lack of ear development, corn has little to no chance of rebounding, even if rains come later this summer. Soybeans still have potential. Most fields have poor pod set but are flowering once again. Spider mite populations are exploding in many areas - farmers are scouting and have or are planning sprays this week. Double-crop beans look better than expected. Now is the time to review contract obligations and begin discussing options with the elevator.
Upper Eastern Shore
The region has received 6-10 inches of rain since the last report. Corn looks much better, but some of the early fields have poor pollination and the rain was too late to help the corn fully recover. At least there is moisture to fill out the kernals that did pollinate! There is some gray leaf spot showing up in corn. Full-season soybeans have recovered also, but many of them have spidermites. Double-crop beans look good and are growing well. 2nd cutting hay yields were poor, but current growth is better. Sweet corn and other vegetable harvest is progressing.

Lower Eastern Shore
Dry conditions have improved somewhat due to rains this past week. Corn in the process of tasseling seems to have been affected most by the dry weather and some areas will see a substantial decrease in yields. Soybeans are in fair to good condition. Pasture conditions are improving at this time.

Aronia – Alternative Crop, Field Observations and Twilight Tours
A new alternative fruit crop is being evaluated by the University of Maryland for organic production. The Black Chokeberry or Aronia, to which it is commonly referred, is a northeastern U.S native with a long history of fruit production in Eastern Europe. The species was collected in the early 1900’s in Eastern Europe where varieties were developed for better fruit production. The Aronia fruit is similar to the size of a blueberry and comes in clusters of about 10 to 20 berries, making them relatively easy to pick. A mature plant (about 7 to 8 years) can yield nearly 15 to 20 lbs., but it starts fruiting within two or three growing seasons after being planted with about 4 or 5 lbs. of fruit.

Interestingly, the fruit itself is more closely related to an apple than a berry and is dark purple in color. The color is attributed to high concentrations of flavonoids, including anthocyanins and proanthocyanidins. Due to health-promoting effects, there is great interest in fruits and vegetables containing high concentrations of flavonoids, which are considered potent antioxidants. Recent studies have shown that Aronia has a very high Oxygen Radical Absorbance Capacity (ORAC) compared to other foods, including blueberries. The fruit has potentially strong beneficial properties for health with regards to the function of coronary arteries. Other studies suggest Aronia has antimicrobial properties that may improve urinary health, prevent colon cancer, and aid in the management of diabetes.

These nutraceutical qualities, heightens Aronia’s marketability and sales potential as a value-added product for Maryland farmers. Several food products can be made from the Aronia fruit including juice, juice extracts, jelly, and wine. Some processing of the fruit is necessary to overcome some of the fruit’s bitter qualities which stem from the flavonoid content, but Aronia is far more palatable than cranberries, a very large fruit industry in the Northeast U.S.

In the Midwest, Aronia is becoming more popular as a supplemental crop. However, there are few if any farms that have actively yielding plants in the East. This is a great opportunity for Maryland farmers. There are several varieties of Aronia, but the most popular and easiest to purchase are “Nero” and “Viking” both of which show similar yields.

At the Wye Research and Education Center an active orchard has been maintained and evaluated for over 5 years. Several interesting conclusions have been drawn.
- Aronia can be easily grown organically because there is little pest pressure.
- Plants yield within the second season at densities similar to blueberries.
- Plants tolerate a variety of soil conditions.
- Plants can be easily propagated from cuttings or seed.
- Plants are apomictic, meaning they self pollinate.
- So far, results show that they need less than 25 lbs. N per acre for maximal production.
- Planted densities are similar to blueberry.

An Aronia Twilight Tour will be held at Wye Research and Education Center, 211 Farm Lane, Queenstown MD, 21658 at 5 PM, August 19th 2010. Potential Aronia farmers will see the ripe fruit, ready to be harvested. They will learn different cultural and picking methods and will get to know Aronia as the next major fruit crop of Maryland. This twilight tour is free to all who register. Call Debby Dant at 410 827-8056 ext.115 to register.

Another informative look at Aronia will be held in conjunction with the Pumpkin Twilight Tour September 21st, 4.30 PM at the Wye Research and Education Center, where Aronia food products will be displayed and tasted.

For more information contact Andrew Ristvey at 410 827-8056 or Sudeep Mathew at 410 228-8800.
Syngenta introduces “Pay it forward with Plant Performance”

Syngenta Crop Protection, Inc. has started a program that will donate $0.25/acre to the 4-H county of your choice if grower purchases Quilt Xcel™, Quilt® or Guardis® fungicides between the dates of June 15, 2010 and September 1, 2010. The eligible counties include Caroline, Cecil, Dorchester, Kent, Queen Anne’s, Somerset, Talbot, Wicomico and Worcester. For details see a local Syngenta authorized retailer. No endorsement of these products by University of Maryland Extension is implied or intended.

Soybean weed control and potato field day to be held on July 27th.

University of Maryland Extension in Dorchester County will conduct a field day for growers on Tuesday, July 27th. Two sites will be visited. 1) Soybean Weed Control from 4pm – 5 pm at Piney Hill Rd, Trappe off US 50. 2) Potato Variety Development from 5:30 pm – 6:30 pm at East New Market Rhodesdale Rd, Hwy 14 near North Dorchester High School. Growers will have an opportunity to observe demonstration plots and interact with University of Maryland Extension specialists. Refreshments will be served. Registration is required. Please contact Rhonda Barnhart at (410) 228-8800 or rbarnhar@umd.edu for additional information and/or to register.

Soybean Cyst Nematode Workshop on August 3rd

The University of Delaware will conduct a Soybean Cyst Nematode Workshop on August 3rd from 8.30 am to 1.30 pm at 16684 County Seat Hwy, Georgetown, DE 19947. This workshop will include classroom time and looking at SCN in the field with the purpose of identifying in the field with a hand lens. Registration form and the brochure for the workshop can be found at http://www.rec.udel.edu/Extension/Agriculture/SCN.pdf. The Workshop fee is $10.00 per person. Please make checks payable to the University of Delaware and mail with registration form to: University of Delaware - Carvel Research and Education Center, Attention: Kim Lewis, 16483 County Seat Highway, Georgetown, DE 19947. For more information contact Kim Lewis at (302) 856-7303.

CMREC Upper Marlboro Crops Research Twilight on August 5th

The Central Maryland Research & Education Center, Twilight Tour will be held on Thursday, August 5, 2010 from 4:30 pm to 9 pm. The research farm is located at 2005 Largo Road in Upper Marlboro, Maryland. Twilight Tour highlights will include: specialty vegetable & cut flower production; strip-till and no-till vegetable production systems; vegetable integrated pest management and reduced risk control methods; field crops research updates; fruit research update for apples, peaches, peentos, blueberries and beach plums; and a vineyard research update for wine grapes. A barbecue dinner, including homemade ice cream, will be served at 4:30 pm. The event is free to attend; however, registration is required. Please call (410) 222-6759 to register.

Poultry Farm Management Workshop on September 29th

The University of Maryland Extension is conducting a one-day workshop for new and existing poultry farmers on Delmarva. A variety of topics will be will be addressed including, site management and maintenance, mortality, manure handling, litter management, windbreaks/vegetative environmental buffers, concentrated animal feeding operation regulations, nutrient management, comprehensive nutrient management plans, EPA inspections and emergency preparedness. The workshop will be held at Chesapeake College, Economic Development Center, Room EDC 27, Route 50 & 213, Wye Mills, MD 21679 from 8:00 am to 3:30 pm. Registration cost is $30. It includes refreshments, lunch and materials. Register by September 20th by contacting Jeri Cook at 410-742-1178 or jcook2@umd.edu.
Did You Know

U.S. farmers provide 18% of the world’s food using 10% of its farm land

SIGN-UP TO RECEIVE “AGRONOMY NEWS”

If you would like to receive this newsletter through email, please send an email to Rhonda Barnhart at rbarnhar@umd.edu. The subject line should be: Subscribe Agronomy News 2010.

If you would like a hard copy please contact your local county extension office to sign-up for the mailing list. The list of local county offices can be found at www.extension.umd.edu.