Orchardgrass die-off

How harvest management and heat stress may be reducing the persistence of orchardgrass hay stands

By Gordon Jones, doctoral degree student, and Ben Tracy, associate professor, Department of Crop & Soil Environmental Sciences, Virginia Tech, Blacksburg
Orchardgrass is one of the most important perennial cool-season forage species in the Mid-Atlantic. While it can be used for pasture, it is frequently grown for hay, which is high quality and desirable for the equine industries in addition to beef and dairy production. Orchardgrass has been grown in Virginia since the 1700s, but over the past several decades, producers have started to notice problems with their orchardgrass stands.

In the past, producers were able to plant a stand of orchardgrass and harvest it two to four times per year with stands lasting 6 to 12 years or more. Stands would thin to a point where farmers would rotate out of orchardgrass for a season or two and then replant their fields. Recently, producers have begun to complain of reduced persistence of orchardgrass fields with stands only lasting about two to four years before they became unproductive and need to be re-established. Producers claimed that they were following the same management practices that they always had, but for some unknown reason, their orchardgrass hay stands would abruptly die.

To try to get a handle on the causes of this problem, the Mid-Atlantic Orchardgrass Task Force was formed in 2008. A 17-member group made up of extension agents, university professors, and industry representatives from Virginia, West Virginia, Maryland, and Pennsylvania met to brainstorm potential causes of reduced orchardgrass persistence and to identify research needs to improve stand longevity. This task force came up with three causes likely responsible for the reduced persistence of orchardgrass. Either individually or some combination of soil fertility issues, new insect pests or diseases, or harvest management problems were likely causing the observed orchardgrass decline. The group concluded that more research was needed to better narrow down this list of potential causes and provide recommendations to producers.

In 2013, we began developing projects for the first author’s doctoral dissertation at Virginia Tech to study orchardgrass persistence problems. We began to work through the list of potential causes by establishing several field experiments and conducting a regional survey of orchardgrass stands. As we began to see preliminary results of our experiments and the survey, and with continued review of the previously published literature, it appeared that we were making some progress towards understanding the causes of decreased orchardgrass persistence. Our results showed no systematic nutrient deficiencies in hay stands across the region and no clear evidence that foliar pathogens or insect pests were driving the persistence problems. Because of that, we have recently been focusing our attention on harvest management practices.

One important hypothesis about the orchardgrass persistent problem is that cutting heights for hay harvest are too low. In the 1970s and 1980s, many producers transitioned from a sickle-bar to disc mower. These mowers are both more powerful implements and also allow for lower cutting heights. Thus, producers have a tendency to cut lower now that they have machinery capable of doing so. While lower cutting heights increase yields for a single harvest, this practice, if continued, will likely reduce the longevity of orchardgrass stands.

**Low cutting height and heat stress hypothesis**

We suggest that low cutting height and high temperatures cause highly stressful conditions that suppress the regrowth of orchardgrass during the summer. The inability to restore a closed canopy during midsummer may cause the death of young tillers, leading to the reduced persistence of stands.

In Virginia, we are in the “transition zone” between cool- and warm-season forage production. Cool-season forages grow well during the spring and fall, but growth is suppressed during the midsummer, and warm-season forages grow well during the summer but are inactive in the fall, winter, and spring. Orchardgrass is generally not grown much further south than Virginia because of hot and dry summer conditions. The management used at hay harvest can further stress plants, which are already at the margin of the region to which they are well adapted.

Cutting date is an important variable that determines the yield and quality of hay but also impacts the microclimate for regrowth. We would expect much less heat stress in a hay stand cut on May 1 as compared with June 1. Another factor that impacts the surface microclimate of hayfields is actually the cutting height used. At higher cutting heights, more plant material is left in the field to shade the soil surface while at lower cutting heights, leaf area can be reduced to such an extent that a considerable

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amount of soil is exposed to direct sunlight. For example, a study in Virginia conducted in the 1970s found that the surface temperature under uncut tall fescue in June was 73°F while in tall fescue that had been cut to 2 inches, the surface temperature was 95°F (Stringer et al., 1981). The optimum growth temperature for orchardgrass is between 60 and 80°F, and studies show that growth declines dramatically at higher temperatures (Brown, 1939; Baker and Jung, 1968). Producer choices of the cutting date and cutting height, then, may have important impacts on the abiotic conditions in these swards.

We've diagrammed out the aboveground processes related to harvest management and regrowth in an orchardgrass system in Fig. 1. If cutting height is reduced, less stubble remains in the field. With less stubble, there will be less green leaf area and a smaller quantity of soluble carbohydrate energy reserves in the stem base, both of which can slow regrowth, and with less stubble, less shading is expected at the soil surface. With less shading, surface temperatures will increase, and at high temperatures, maintenance respiration to keep the plant functioning will increase. This will cause the plant to quickly burn through the carbohydrates used for regrowth. As the quantity of carbohydrate energy reserves declines so does the rate of grass regrowth. Without a closed canopy of green leaf area, less photosynthesis occurs and less shading causes reduced energy for regrowth and further increases surface temperature. This causes the sward to enter a feedback loop where high temperatures and limited carbohydrate reserves suppress regrowth and may be driving decreased persistence.

To add a little bit of further complexity to this, we can step back and ask how weather and climate has changed over recent decades and consider how that might impact orchardgrass and potential summer heat stress. Looking at temperature trends in Blacksburg, VA for the months of May, June, and July since 1970, it can be seen that average high temperatures have increased somewhat, but there has been a greater increase in average low or nighttime temperatures over that period (Fig. 2). It has been shown with other cool-season crops that warmer nighttime temperatures are associated with lower yields because of the increased maintenance respiration demand. The same phenomenon is expected for orchardgrass as well.

Another way that the warming climate may be impacting orchardgrass is by shifting its phenology or the timing of events like flowering. A study from Poland found that warmer temperatures caused the date of flowering of many varieties of orchardgrass to advance by about 10 days between 1972 and 2002 (Grzegorz, 2011).

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**Fig. 1.** A simplified causal loop diagram of aboveground orchardgrass regrowth processes. As cutting height is reduced so is the regrowth rate, carbohydrate energy reserve, and the amount of shading. Slow regrowth limits biomass accumulation, which further limits shading to the soil surface. The feedback loop is shown in bold.
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While timing of flowering of orchardgrass has not been studied in the Mid-Atlantic, we assume that a similar trend has occurred here. If producers have not advanced the date of first cutting, then harvest could be occurring at a later maturity stage, and there is evidence that regrowth can be slowed by late first cutting.

We are working now to gather more evidence to back up our hypothesis. Experiments in climate-controlled growth chambers will monitor orchardgrass regrowth from 1- and 3-inch cutting heights in cool (70°F) and hot (90°F) environments. We’re expecting that low cutting height and high temperature treatment should fail the worst. We are also planning to put a multi-site field experiment into place to look at interactions between cutting date and cutting height on orchardgrass regrowth. We will track soil, surface, and air temperature and soil moisture and relate these factors to orchardgrass regrowth rate and soluble carbohydrate concentrations.

**Preliminary recommendations for improved persistence**

While we will need to wait to see what the results of these experiments hold to determine our final recommendations to producers, based on previous literature, we can make some preliminary recommendations for improved orchardgrass persistence. It is important to ensure proper soil fertility based on soil test results and local extension recommendations. Adequate potassium fertilization has been shown to help orchardgrass overcome the stress of close cutting. Cutting heights should be 3 to 4 inches for orchardgrass such that some green leaf area remains on the stubble.

Given the cool-season growth pattern of orchardgrass, earlier first cutting will almost always result in better aftermath regrowth compared with late first cuttings. Use of crop rotation prior to replanting orchardgrass is important for disease management, and rotating out of cool-season grass crops will help to reduce the hosts of many orchardgrass diseases.

Orchardgrass is a valuable crop in the Mid-Atlantic, and its hay is sought after by many livestock producers. Our overarching goal through this research program is to provide more specific management recommendations to growers to improve the longevity of their orchardgrass stands. Although farmers have been growing orchardgrass in this region for more than two centuries, certain management practices and a changing climate may be interacting to cause the persistence problems we are seeing today. Unless we can get a better grip on relationships between hay management and heat stress in orchardgrass, continuing to grow this important crop in the Mid-Atlantic may continue to become increasingly unsustainable in the coming years.

**References**


