Grass in Shade is Lower in Sugar

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Photosynthesis is the process by which plants turn water and carbon dioxide to sugar. Because sunlight is the driving force behind photosynthesis, it is easy to understand why grass in the shade should be lower in sugar. Studies have been conducted to measure the nutritional content of grass grown in shade as there is interest in some areas to combine cattle grazing with tree production. These studies show that sugar content is lower in shade and corresponds to tree density and the amount of sunlight that can penetrate the canopy. (Burner and Belesky, 2004)

Some paddocks do not have any shaded grazing areas. In an effort to maximize grazing time for insulin resistant ponies, a system of strip grazing with portable fencing was initiated, where each days grazing allotment would be covered by plastic tarps the previous day. Replicated samples from both shaded and unshaded areas were analyzed to determine sugar concentration.

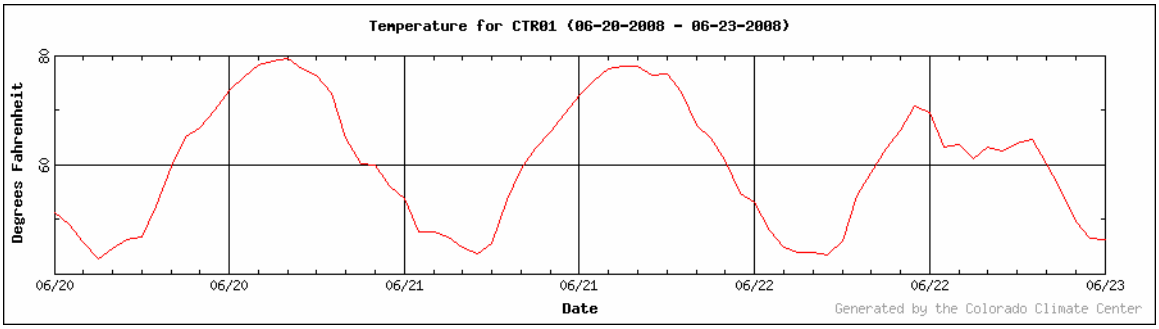
Procedures

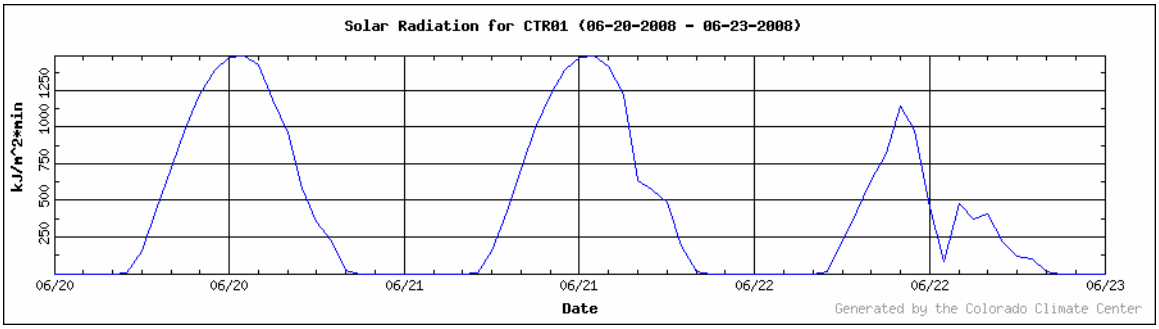
The test site is a well established, straight grass paddock in a high mountain valley in Colorado. Altitude is 7,600 feet and the soil is a cobbley, loamy sand with less than 1% organic matter. Grass species are all 'improved' varieties recommended for maximum production and nutrient content, consisting primarily of Garrison meadow foxtail (*Alopecurus arundinaceus*) and Paddock meadow brome (*Bromus biebersteinii)* A failure in the irrigation system caused the paddock to stay dormant until first irrigation first week of June, which is 6 weeks later than usual. The stand was weakened and quite thin at the time of this study, although it did recover well over the course of the summer. Four sections of grass within the tarped area were designated as replications, with corresponding areas designated by flags adjacent to the tarps but in full sun. Samples were gathered randomly within each area, cut with clippers 1-2 inches from soil surface to simulate grazing by horses. All samples were frozen immediately. Samples were shipped overnight in insulated boxes with dry ice to Dairy One, Ithaca, NY for analysis.

06/20/08 Blue plastic tarps were placed over the plot 1 from 12:30- 4:30 PM.
06/21/08 All samples taken from 6:00- 6:30 AM
Tarps put on shaded plot 2 from 10 AM to 5 PM.
06/22/08 All samples taken from 6:00- 6:30 AM

Study was terminated due to daily thunderstorm activity and inability to keep tarps in place.

Temperature and Solar Radiation for the test period:

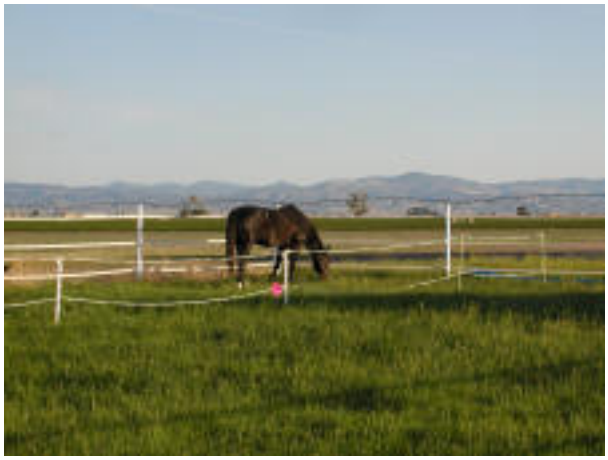




Tarp on plot 1 - 6/21/2008 12:30- 4:30 PM This area became the alley that allowed access to plot 2 the next day.

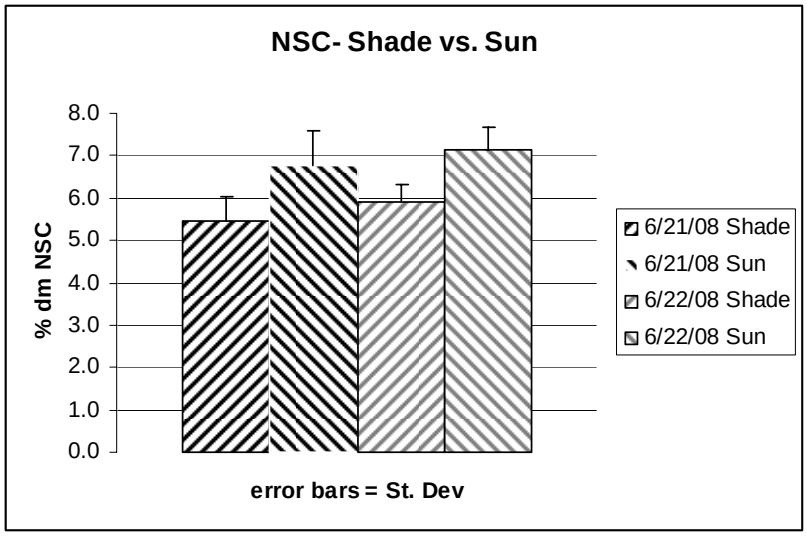
Tarp on plot 2- 6/22/08 10 AM to 5 PM Notice a strip on the end where I ran out of tarp. Foreground is grazed plot 1.

6/23- 6AM- Kali only eats in the narrow alley already grazed that was in full sun yesterday, even though there is far more grass available in the ungrazed portions that were tarped.



6/23 6 AM -Kelcie chooses the area at the very end where I ran out of tarp.

I originally intended to run this study much longer, but I discovered that during the high winds accompanying thunderstorms that started late afternoon of 6/22, one can get beat up pretty bad trying to roll up 6 tarps fastened together. I thought this trial was a bust until the next morning, when I turned out my mares to find that they definitely avoided the areas that had been tarped the day before. When the frozen samples were analyzed, both of the plots that had been shaded for a portion of the previous day were significantly lower in NSC. The shaded portions of Plot 1 and 2 averaged 19 and 17 % lower in NSC, respectively, than the adjacent area in full sun all day.



Four replications of early morning samples averaged significantly lower in NSC when shaded for part of previous day.

Horses being grazed in the plots during the sampling period could detect this difference, preferring the grass grown in full sun.

Discussion

When horses are grazed in pastures with some shade, it can be noted that grass in full sun has the heaviest grazing pressure. The outline of areas shaded by trees for part of the day can be visible as a change in grazing preference in pastures that are grazed

lightly enough that horses still have a choice. Horses prefer grass grown in full sun. The current study confirms that grass in full sun is sweeter than grass grown in shade, which may explain this preference. Many existing pastures have areas that are shaded for part of the day from adjacent woodlots, buildings or windbreak trees. A fenced woodlot may be the perfect turn out area for horses prone to laminitis or obesity. Planting fast growing trees along an east or west edge of a paddock could provide shade to portions of paddocks as well as providing shelter from wind. By utilizing portable electric fencing, areas with some shade could provide obese or insulin resistant horses the opportunity to graze within sight of their herd mates, providing the exercise and social interaction lacking if isolation in a small dry lot or stall is the only option to full time turn-out.

Existing hedges or tree lines create a 'shady lane' for lower sugar grazing. Fenced woodlots might provide the perfect set up to minimize sugar intake for insulin resistant or just plain 'obese' horses.

What other nutrients might be affected by lack of sunlight? In one study looking at the relationship between shade and nutrient concentration, shaded grass was lower in sugar, but higher in concentrations of several minerals and crude protein. (Mayland and Gunes, 1974) This is presumably due to lower dry matter yield under shaded conditions such that the minerals taken up by the roots are not as diluted. Grass in that study, as well as others, shows that shaded grass may be higher in nitrates. There has been little study done on the effect of nitrates on non-pregnant horses. In cattle, rumen bacteria can convert nitrate to the more toxic nitrite form but it is commonly presumed that because horses lack a rumen they will tolerate nitrate better than cattle. Recommendations by universities for tolerable levels of nitrate in forage for horses vary due to lack of real data, but always far exceed those recommended for cattle. There is solid clinical evidence that insulin that results from excess sugar intake causes laminitis, while any role of nitrate being involved in laminitis is only speculative at this point. Avoiding excess applications of nitrogen fertilizers and preventing nitrogen fixing legumes such as clover from taking over the pasture should minimize the possibility that nitrates may accumulate in shaded areas.

The reduction of sugar concentration in this limited study was probably the result of both decreased photosynthesis and increased respiration due to higher temperature underneath the tarps. The long and short term effects of temperature on plant respiration are complex and confounded by other factors, but in general, higher temperature causes sugars to be burned off at a faster rate. (Aktkin and Tjoelke, 2003) Further study is needed to see if this degree of sugar reduction is repeatable in a scenario with shade open to circulating air. Shade every day vs. a single day should increase the difference between shaded areas and those in full sun.

A wide variety of permanent or portable electric fencing is available to keep horses in their designated grazing areas. Setting up a track that utilizes existing shady areas will allow horses to see their herd mates and may alleviate the stress to both horse and owner caused by isolation and separation. Such a system of grazing will encourage self exercise that is vital to the maintenance of insulin resistant horses.

Conclusion

Grazing in shaded areas may offer a practical method of limiting sugar intake for horses.

References

Burner, D. M. and D. P. Belesky (2004) Diurnal Effects on Nutritive Value of Alley-Cropped Orchardgrass Herbage, Crop Sci. 44:1776–1780.

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Atkin, O. K. and M. G. Tjoelke (2003) Thermal acclimation and the dynamic Response of plant respiration to temperature. Trends in Plant Sci. 8: 343-351.
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