Management of Livestock Grazing to Fully Activate the Defoliation Resistance Mechanisms in Perennial Grass Plants

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Grass herbage biomass production can be greatly increased with two grazing periods per pasture on three to six pasture rotation systems. The operative processes that make it possible for defoliation by grazing to stimulate herbage production in perennial grasses are collectively known as the Defoliation Resistance Mechanisms. McNaughton (1979, 1983) found compensatory growth in grazed grasses, Coleman et al. (1983) described the relationship between rhizosphere organisms and perennial grasses, and Briske and Richards (1994, 1995) improved the understanding of vegetative reproduction from axillary buds. Manske (1999) has found how and when these beneficial mechanisms can be activated in grazingland grasses.

The rhizosphere organisms are limited by access to simple carbon chains because the microflora trophic levels lack chlorophyll and have low carbon content. Grass plants are known to exudate sugars, amino acids, glycosides, and other compounds through the roots into the soil. Partial defoliation at vegetative growth stages causes greater quantities of grass plant exudates to be released into the narrow zone of soil surrounding living roots. When grass tillers are partially defoliated between the three and a half new leaf stage and the flower stage, the rhizosphere volume increases greatly (236%). The primary producer trophic level in the rhizosphere is comprised of fungi and bacteria. These organisms contain high proportions of nitrogen and they consume relatively large quantities of soil organic matter. The microfauna trophic levels graze on the primary producer organisms. The microfauna organisms excrete the excess nitrogen that they can not use as ammonium, which is nitrified into nitrate, a form of mineral nitrogen, by the rhizosphere fungi. The fungi then moves the mineral nitrogen into the roots of the partially defoliated grass tillers. Thus, with an increase in available carbon from grass plant exudates, the rhizosphere organism biomass and activity levels increase and a greater quantity of organic nitrogen is converted into mineral nitrogen that becomes available for use by the grass tillers.

The compensatory physiological processes within grass tillers are activated following partial defoliation at phenological growth stages between the three and a half new leaf stage and the flower stage. The growth rates of replacement leaves and shoots are increased. These increased compensatory growth processes require increased quantities of carbon and nitrogen. The source of the carbon is not from stored carbohydrates, but from increased photosynthetic capacity of remaining mature leaves and rejuvenated portions of older leaves not completely senescent. The quantity of leaf area required to provide adequate quantities of carbon is 66% to 75% of the predefoliation leaf area. Which means the livestock can remove 25% to 33% of the grass tillers leaf area without detriment during the first grazing period. However, if 50% of the leaf area is removed by livestock during the first grazing period, the amount of remaining leaf surface is insufficient to provide the required quantities of carbon and the increased compensatory growth processes do not occur.

The source of nitrogen for increased compensatory growth of replacement leaves and shoots is not from stored nitrogen but is the mineral nitrogen in the rhizosphere that the microorganisms had converted from organic nitrogen. A threshold quantity of 100 pounds per acre of soil mineral nitrogen needs to be available to the defoliated grass tiller in order for the increased compensatory growth processes to take place.

When 25% of the grass tiller leaf area is removed during the first grazing period, 140% of the leaf weight removed is replaced by the compensatory growth processes. When 50% of the grass tillers leaf area is removed during the first grazing period, only 70% of the leaf weight removed grows back.

There is one axillary bud for each leaf produced on a grass tiller. Most grass species produce six to eight leaves per tiller during the growing season. Development of the axillary buds into secondary tillers is inhibited by the hormone auxin, which is produced in the apical meristem and young developing leaves of grass tillers. Partial defoliation of lead tiller leaf material at growth stages between the three and a half new leaf stage and the flower stage activates vegetative reproduction of secondary tillers from axillary buds by temporarily reducing the quantity of auxin in the lead tiller; this permits the growth hormone cytokinin to stimulate growth of cells in multiple axillary buds. The growth of secondary tillers from axillary buds is dependent on the increased quantities of carbon and nitrogen from the same sources as the compensatory growth processes.

When 25% of the grass tillers leaf area is removed during the first grazing period, the quantity of secondary tillers increases 38% during that same growing season and increases 64% to 173% during the second growing season. When 50% of the grass tiller leaf area is removed during the first grazing period, the quantity of secondary tillers decreases 53% that same growing season and decreases 63% to 144% during the second growing season. Leaving 66% to 75% of the leaf area following grass tiller defoliation during the first grazing period and providing 100 pounds per acre of soil mineral nitrogen by the rhizosphere organisms are essential for the defoliation resistance mechanisms to be fully activated.

Detailed information on full activation of the defoliation resistance mechanisms has been developed that instructs cow-calf producers on how to develop and properly operate a biologically effective management strategy with twice-over rotation grazing on summer pastures in conjunction with a complete 12 month complementary pasture and harvested forage sequence specific for his or her ranch is available at http://www.GrazingHandbook.com and is presented during a 3 day workshop offered every January. These science based management strategies meet the nutrient requirements of livestock during each production period, meet the biological requirements of grass plants and rhizosphere microorganisms, increase the quantity of forage nutrients produced, improve the efficiency of forage nutrient capture, and improve the efficiency of conversion of forage nutrients into saleable animal weight commodities. These biologically effective 12-month management strategies generate greater new wealth from the land natural resources without depleting future production. Workshop information is at http://www.ag.ndsu.edu/dickinso/grassland/12-month.htm.

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