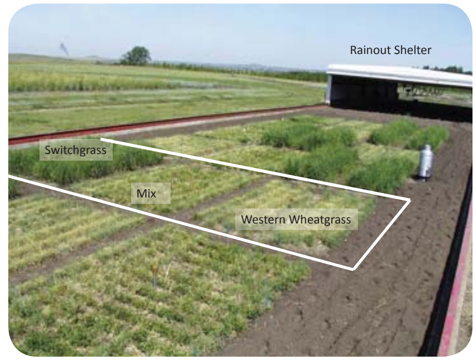
NORTH DAKOTA - Water Use Efficiency for Switchgrass, Western Wheatgrass, and a Western Wheatgrass Alfalfa Mixture

John Hendrickson, Marty Schmer, Matt Sanderson, USDA-ARS



Water and agricultural use of water is becoming a greater concern, especially in the western Great Plains and there are concerns about how biofuel production may affect water quality and quantity. Due to these reasons, it is important to evaluate water use efficiency (WUE) and soil water deficit of potential biofuel crops as well as other forages. At the Northern Great Plains Research Laboratory at Mandan, ND, a rainout shelter was used to evaluate WUE and soil water deficits for switchgrass, western wheatgrass, and a western wheatgrass-alfalfa mixture under an early-season (May-June), a late-season drought (July-August), and a control (normal growing season moisture).

In both drought treatments, approximately 50% of the long-term average May-August precipitation (10.15") was applied as irrigation water. In the early-season drought, only 20% of the 4.5" of the irrigation water applied from May-August was applied in May-June, while the remainder (80%) was applied in July-August. In the late-season drought a similar approach was used. However, in the late-season drought, 80% of the 4.9" irrigation water applied between May-August was applied in May-June, while the remaining 20% was applied in July-August.

Biomass production was measured at the end of the growing season in October. In 2006, switchgrass produced 6.3 tons/ac under the control treatment, 3.8 tons/ac under the early-season drought and 4.8 tons/ac under the late-season drought. Under the early-season drought, switchgrass produced almost three times the biomass as western wheatgrass and under the late-season drought, switchgrass produced four times biomass as western wheatgrass and twice as much as the western wheatgrass-alfalfa mixture.

Water use efficiency was strongly influenced by the amount of forage produced. Switchgrass always produced more biomass than the western wheatgrass monoculture and so the WUE for switchgrass was greater than the western wheatgrass monoculture. The WUE for switchgrass ranged from 0.31-0.41 lbs biomass/inch of water used which was nearly 4-5 times greater than the WUE for western wheatgrass (0.06-0.11 lbs biomass/inch of water). Water use efficiency for the mixture (western wheatgrass and alfalfa) was much more variable. For example, under the early-season drought (May-June), WUE for the mixture was similar to switchgrass. However, for a later drought and the control, WUE for the mixture was similar to western wheatgrass. The year after the drought, WUE for the mixture was similar to switchgrass again.

Soil water deficit was also evaluated in the study. Soil water deficit was calculated as the difference between the month with the greatest soil water and the month with the least soil water. Although switchgrass had the greatest WUE, it also resulted in the greatest soil water deficit while the water deficit for the mixture was usually the lowest except for the control. The water deficit for the western wheatgrass-alfalfa mixture was 31% and 38% lower than the water deficit for the switchgrass for the early- and late-drought stress respectively.

Results suggest switchgrass is an appropriate perennial biofuel to use in drier areas of the northern Great Plains due to its greater WUE. However, its greater soil water deficit suggests switchgrass may deplete the soil water more under a multi-year drought than western wheatgrass or a grass alfalfa mixture. This may be especially crucial if switchgrass was used as a perennial phase in a crop rotation. Researchers and producers need to be aware of the benefits and drawbacks for using switchgrass in dry or drought prone areas.