Corn and Velvetleaf (*Abutilon theophrasti*)Transpiration in Response to Drying Soil.

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Rationale

When soil water supply is not sufficient to meet plant demand, transpiration is reduced. Under water limiting conditions, plant growth is reduced in proportion to the reduction in whole plant transpiration rate. Therefore, actual plant growth can be predicted as the product of potential growth under non-water-limiting conditions and the ratio of actual to potential transpiration (T_a/T_p). The response of T_a/T_p of a species to the progressive drying of soil varies little when water content is expressed as fraction of transpirable soil water (FTSW).

Objectives

1. Quantify the relationship between corn and velvetleaf normalized transpiration ratio (NTR) and the fraction of transpirable soil water (FTSW).

2. Determine the critical FTSW at which transpiration begins to decline for each species.

Materials and Methods

Corn and velvetleaf plants were seeded in pots and grown in a greenhouse. Plants were thinned to one plant per pot and watered to saturation daily until the beginning of the experiment, when pots were wrapped in plastic bags so the only water loss was that due to transpiration. Daily transpiration was measured by weighing the pots at the same time each day. For each trial, five plants of each species were maintained at the well watered level by adding back the equivalent water loss each day via sealed access tubes, and five plants were subjected to drought stress by not replacing lost water. Leaf area was measured as leaves senesced and at the culmination of the experiment. Daily transpiration of the drought stressed plants was normalized relative to fully watered control plants (T_a/T_p) to offset any effect of environmental conditions. Soil water content was expressed as the fraction of transpirable soil water (FTSW) and used as a measure of the level of drought stress. The relationship between the normalized transpiration ratio (NTR) and FTSW was described using a logistic function and used to compare water use during drought stress conditions.

Table 1. Least squares means of corn and velvetleaf shoot biomass (DW, g), daily transpiration ratio (DTR) and volumetric soil water content (θ_{pwp}) in dry-down treatments on the final day of each experiment, volumetric water content at saturation (θ_{fc}), and total amount of transpirable soil water (TSW, kg).

Time of sowing	Development stage at treatment initiation	DW		DTR		θ_{pwp}		θ_{fc}		TSW	
		Corn	Velvetleaf	Corn	Velvetleaf	Corn	Velvetleaf	Corn	Velvetleaf	Corn	Velvetleaf
		g	g			v/v	v/v	v/v	v/v	kg	kg
Fall	Early	38.6	22.3*	0.03	0.02*	0.12	0.07*	0.45	0.40*	2.65	2.58
	Late	56.3	42.5*	0.15	0.09*	0.15	0.07*	0.41	0.40	2.00	2.58*
Winter	Early	12.6	10.0*	0.02	0.01	0.06	0.04	0.38	0.38	2.58	2.78
	Late	32.8	34.7	0.05	0.03*	0.05	0.04	0.38	0.38	2.64	2.65
	S.E. (diff)	4.44	3.15	0.012	0.006	0.011	0.014	0.015	0.010	0.150	0.129

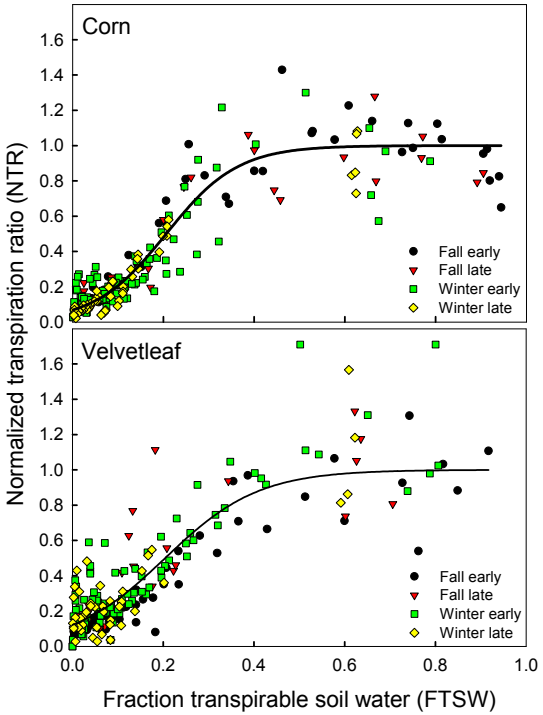

Figure 1. Normalized transpiration ratio (NTR) vs. fraction of transpirable soil water (FTSW). The critical soil water content below which plants begin to close their stomates occurred at $FTSW_{cr}$ = 0.36 ± 0.015 for corn and 0.41 ± 0.018 for velvetleaf.

Figure 2. Corn and velvetleaf 6 d after treatment initiation in the fall early experiment.

Conclusions

- Velvetleaf responded to drought by senescing its oldest leaves, whereas corn mainly maintained its leaf area but with rolled leaves during peak drought stress.
- During a short-term drought, corn should perform better than velvetleaf because it maintains full transpiration to a lower FTSW and keeps its leaves.
- Under long-term drought, velvetleaf will conserve water and increase its chances of survival. Moreover, senescing all but the youngest leaves may ensure at least some seed production.