

Is Mutual Shading a Decisive Factor for Differences in Overall Canopy Specific Leaf Area of Wheat?

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Introduction

In crop growth simulators, the daily leaf area growth is often derived from the product of leaf mass growth and specific leaf area (SLA). For wheat overall canopy SLA (cSLA) is usually assumed to be constant or a function of phenology (Van Delden et al. 2000). Under stress cSLA is reduced, but always in conjunction with reduced leaf area. Since for a single leaf, SLA is negatively correlated to light intensity (Rawson et al. 1987), mutual shading might be key factor for cSLA modeling. Our aim was to investigate whether cSLA is primarily a function of growth conditions or light environment.

Hypothesis

Reduced canopy SLA observed under stress is a consequence of reduced mutual shading due to low LAI.

Material and Methods

Field trials in Kiel (northern Germany)

- Three years (2006, 2010, 2011)
- One winter wheat cultivar (Dekan)
- Varying N supply in 2006 (N1:0, N2: 80, N3: 160, N4:240 kg/ha)
- Varying water supply (Rain-Out-Shelter) in 2010, 2011
 - W0: without water supply since spring, W1: ~70-80,
 - W2: >80 % Water holding capacity in rooting zone

Parameters measured (mean of four replications)

- LAI, cSLA (destructive sampling of 0.25 m² sampling area per plot, leaf area determination with LI 3100c leaf area meter)
- Distribution of leaf area and SLA for specific leaf layers with and without drought impact (seven plants each plot, 2010 only).

Results

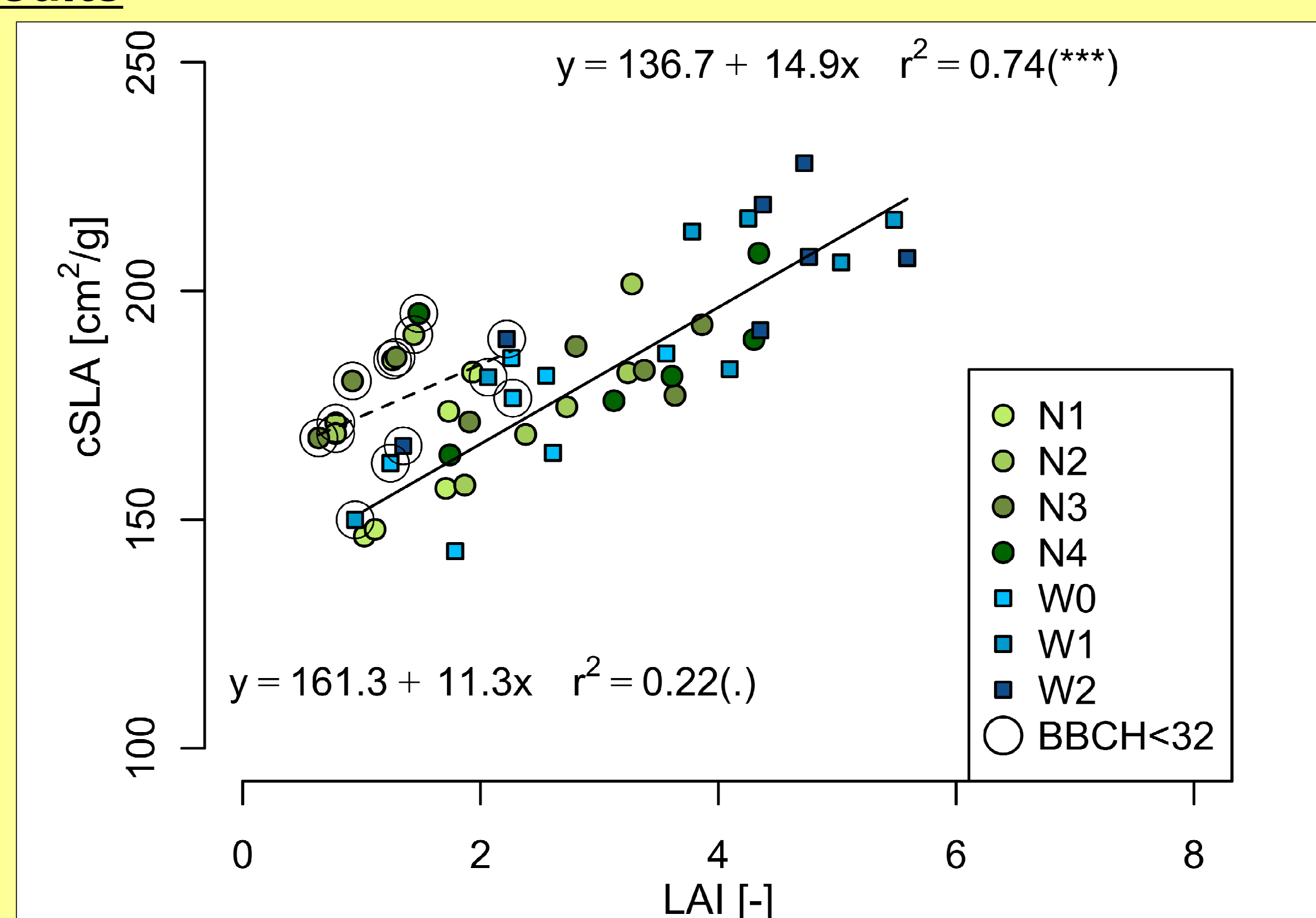


Figure: Linear regression between LAI and cSLA before ($n=14$, encircled data points) and after BBCH 31 ($n=35$) Significant codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1

Table: Leaf area (L) and SLA for leaf layers and flag leaf of main stem (F_{MS}), of irrigated (W2) and drought stress (W0) treatments at anthesis, as well as the difference between treatments (W_0-W_2). ($n=4$, SD in brackets)

Leaf Layer	L [cm ² plant ⁻¹]		
	W ₂	W ₀	W ₀ -W ₂
F_{MS}	25.6 (1.3)	16.4 (1.7)	-9.2
1	61.6 (8.3)	23.8 (3.2)	-37.8
2	65.5 (15.8)	21.7 (3.5)	-43.8
3	43.3 (11.0)	17.7 (3.7)	-25.6
4	13.7 (5.4)	12.1 (3.7)	-1.6
Leaf Layer	SLA [cm ² g ⁻¹]		
	W ₂	W ₀	W ₀ -W ₂
F_{MS}	162.4 (8)	163.0 (23)	+0.7
1	173.0 (11)	166.1 (24)	-6.9
2	191.1 (13)	166.2 (20)	-24.9
3	212.7 (14)	175.5 (16)	-37.1
4	221.8 (29)	186.0 (17)	-35.8

Discussion

We found an significant correlation between LAI and cSLA for the phase after one node stage (BBCH31) (Figure). This relationship is similar for unstressed crops as well as under drought or N limitation.

Due to drought, leaf area was mostly reduced in the upper leaf layers (1-2, see Table). In contrast, the SLA was reduced at lower inserted leaf layers (2-4), but unaffected in the upper layers (F_{MS} , 1). Thus, a direct impact of reduced leaf expansion under drought can not serve as an explanation for differences cSLA. Our results suggest that for wheat a reduced SLA and cSLA under stress is mainly due to differences in light gradient within the canopy.

Conclusion

The hypothesis above seems to be confirmed, therefore shading should be considered for leaf area modeling.

- Literature:**
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 - van Delden, A., Pecios, A., Haverkort, A.J., 2000. Temperature response of early foliar expansion of potato and wheat. Ann. Bot. 86, 355-369.

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