Association Between Water Spectral Indices and Plant Water Status in Spring Wheat Under Water Stressed Conditions

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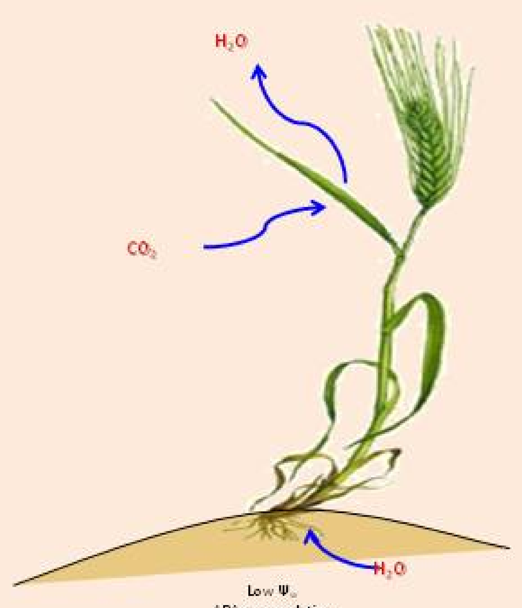
Introduction

The plant water status provides information that can be used to prevent crop water deficit through irrigation, to select genotypes in breeding, and to assess crop growth under drought conditions (Munjal and Dhanda, 2005). Water status can be assessed remotely by measuring canopy reflectance indices (SRI) since they change in response to crop water content (Peñuelas *et al.*, 1993).

The water index (WI, R_{970}/R_{900}) proposed by Peñuelas *et al.* (1993) has been used to estimate water status in diverse plant species because WI has high relationship with water potential). Other normalized water indices (NWIs) based on the WI have been established to screen yield in spring and winter wheat for breeding purposes (Babar *et al.*, 2006; Prasad *et al.*, 2007).

The objective of the present study was to establish the relationship between diverse water indices (WI and NWIs), leaf water potential, (LWP) and canopy temperature in advanced wheat lines under watered stress field conditions.



Methodology

Two types of germplasm developed by the International Maize and Wheat Improvement Center (CIMMYT) were used: a subset of six bread wheat sister lines obtained from the cross Seri-M82/Babax plus the two parents (SBS) and ten synthetic derivative lines (SYNDER) derived from inter-specific hybridization with wild relatives for high grain yield under water stress. The genotypes were planted in NW Mexico (27.3ºN, 109.9ºW 30 masl) in field plots (two beds 5 m long) with 2 repetitions in an alpha lattice design during 2007 and 2008. Leaf water potential (LWP) and canopy temperature were determined close to the canopy reflectance readings. Five water indices (Peñuelas *et al.*, 1993; Babar *et al.*, 2006; Prasad *et al.*, 2007) were determined using a spectrometer (350 to 1100 nm) FieldSpec (ASD, Boulder, CO):

a) $WI=R_{970}/R_{900}$
b) $NWI\text{-}1=[R_{970}-R_{900}]/[R_{970}+R_{900}]$
c) $NWI\text{-}2=[R_{970}-R_{850}]/[R_{970}+R_{850}]$
d) $NWI\text{-}3=[R_{970}-R_{880}]/[R_{970}+R_{880}]$
e) $NWI\text{-}4=[R_{970}-R_{920}]/[R_{970}+R_{920}]$

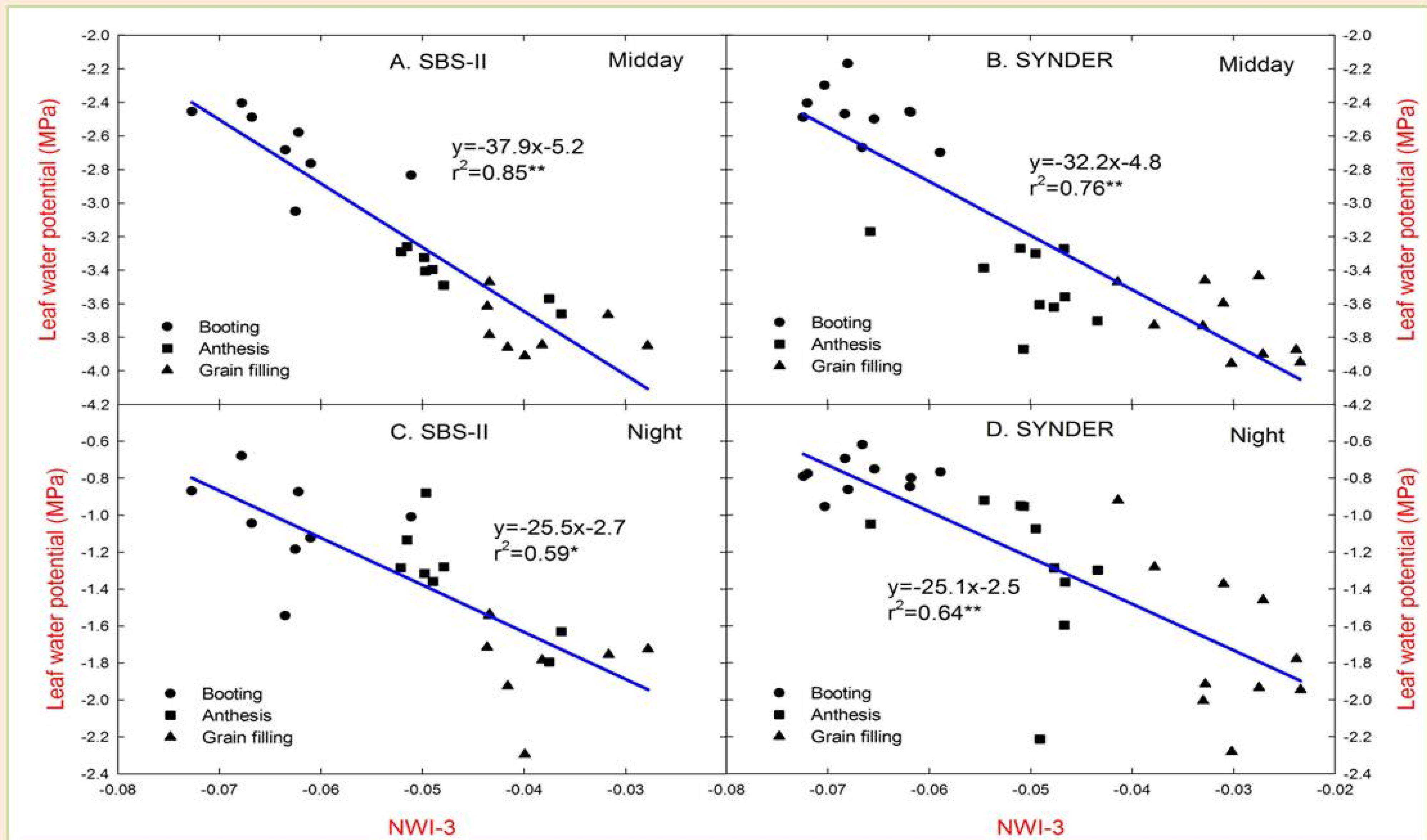


Figure 1. Relationship between the normalized water index three (NWI-3) and leaf water potential determined at mid-day (13:00-15:00 h) and at night (22:00-24:30 h) under water stress conditions.

Results

Table 1. Correlation coefficients between grain yield, normalized water index 3 (NWI-3) and canopy temperature (CT) in advanced wheat lines.

	SBS-II (n=8)		SYNDER (n=10)	
	Grain yield	Biomass	Grain yield	Biomass
NWI-3	-0.95**	-0.96**	-0.68*	-0.64*
CT	-0.95**	-0.94**	-0.68*	-0.76*

*,**Significant at the 0.05 and 0.01 probability level, respectively.

NWI-3 always gave a higher relationship with grain yield compared to other water indices (non sign. differences) across years, especially when heading and grain filling were combined (Fig. 1).

Discussion

NWI-3 showed consistent relationships with LWP, canopy temperature, and yield combining growth stages in SBS and SYNDER (Fig. 1, 2; Table 1). LWP midday determinations with NWI-3 showed stronger associations for SBS ($r^2=0.85$) and SYNDER ($r^2=0.76$) rather than using LWP night determinations across growth stages. (Fig. 1). NWI-3 explain large proportion of LWP variations. Apparently, resistant genotypes with better water content could be detected by using NWI-3 under water stressed environments in a fast, cheap, and easy way.

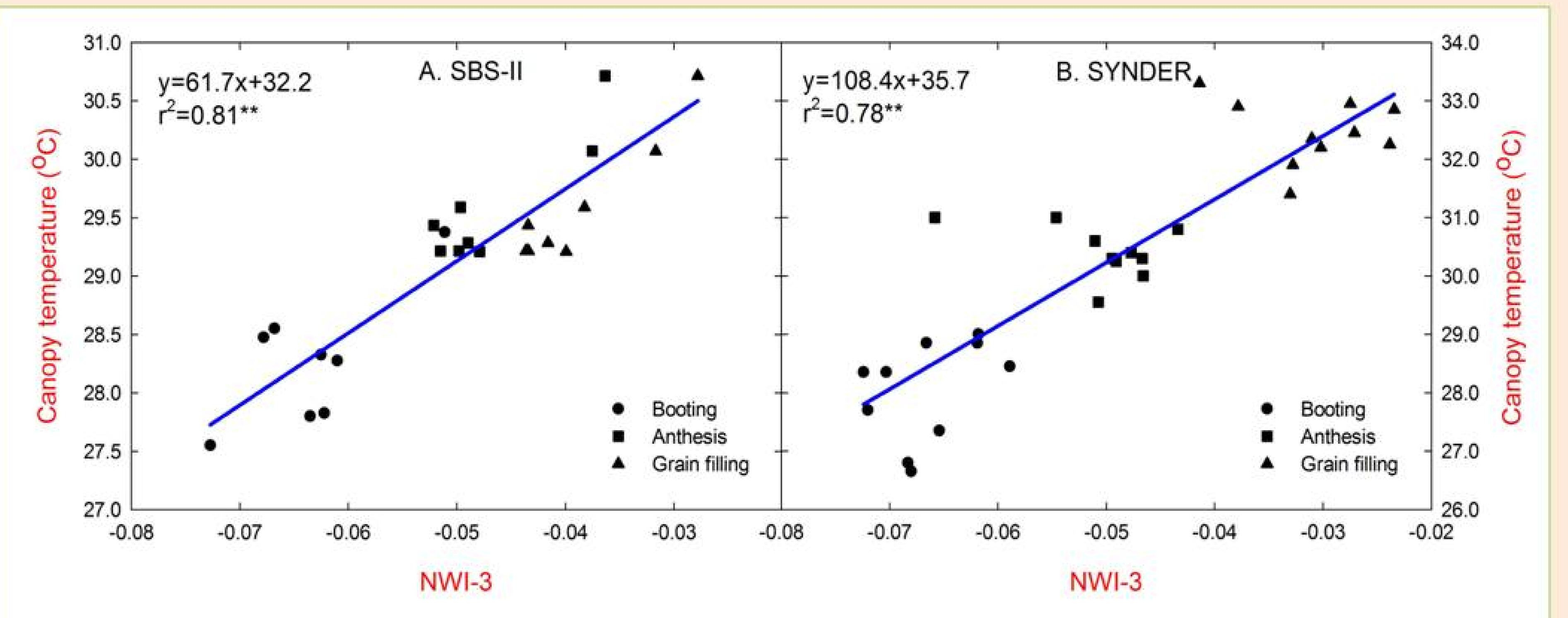


Figure 2. Relationship between the normalized water index three (NWI-3) and canopy temperature

Conclusions

- The relationship between the water indices and LWP was consistent across across growth stages in SBS and SYNDER under water stressed conditions.
- Large proportion of LWP variations were explained by NWI-3.

References

- Babar *et al.*, (2006). *Crop Sci.* 46: 578-588
- Munjal and Dhanda (2005). *Indian J. Gen. Plant Breed.* 65: 307-308
- Peñuelas *et al.* (1993) . *Int. J. Rem. Sens.* 14: 1887-1905
- Prasad et al., (2007). *Crop Sci.* 47: 1416-1425