Using Early-Season Dark Green Color Index (DGCI) and SPAD to Predict Corn Yield

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INTRODUCTION

- Crop sensors can help growers manage late-season N applications
- Late-season N applications difficult in rain-fed environments
  - Delay N application further due to rain
  - Lack of moisture may prevent incorporation
- Early detection of N deficiency could help improve N management in rain-fed environments
  - Soil plant analysis development (SPAD) is a non-destructive measure of leaf color (Fig. 1)
  - New technologies using the dark green color index (DGCI) are also available (Fig. 2)
  - Limited field testing of DGCI at early-season growth stages

OBJECTIVES

1. Use DGCI and SPAD to detect different N application rates at multiple growth stages.
2. Measure the relationship between DGCI and yield as well as SPAD and yield at multiple growth stages.

METHODS

Ohio Field Experiments in 2013 and 2014:

- Hoytville (NWARS) and S. Charleston (WARS)
- Five N rates (0-269 kg N ha^{-1})
  - Injected at sidedress (V4) as 28-0-0 UAN
- Measured DGCI and SPAD at V6 and R2

Michigan Field Experiments in 2014:

- Richville (SVREC) and East Lansing (SCFR)
- Six N rates (0-280 kg N ha^{-1})
  - 40% preplant incorporated as 46-0-0 urea
  - 60% surface banded at sidedress (V4) as 46-0-0 urea treated with stabilizer
- Measured DGCI and SPAD at V6 and R1

STATISTICS

Data were analyzed within each site-year using PROC MIXED in SAS 9.4, with means separated using Fisher's Protected LSD (α=0.05). Data were normalized within site-year prior to linear regression analysis (PROC REG).

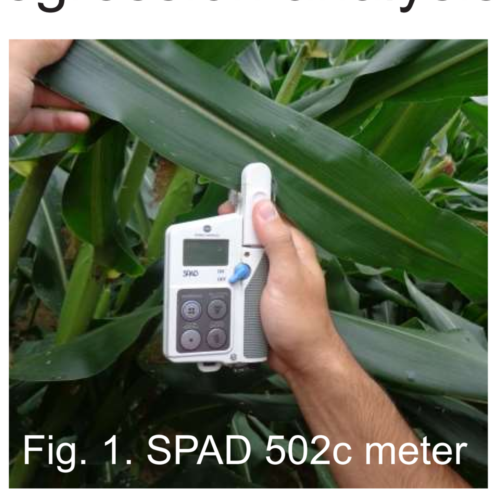

Fig. 1. SPAD 502c meter

Fig. 2. GreenIndex+ app

RESULTS AND DISCUSSION

Table 1. DGCI and SPAD values at each N rate within a site-year at V6. Values followed by the same letter within a column for each site-year similar ($P \leq 0.05$).

N Rate	V6			
kg N ha^{-1}	DGCI	SPAD	DGCI	SPAD
	NWARS, 2013		NWARS, 2014	
0	0.633a	47.7c	0.664a	50.3a
67	0.638a	49.4b	0.696a	50.1a
134	0.632a	50.0b	0.674a	52.2a
202	0.643a	50.5ab	0.674a	51.7a
269	0.651a	51.7a	0.685a	52.5a
	WARS, 2013		WARS, 2014	
0	0.629a	45.7b	0.554b	39.1b
67	0.666a	49.6a	0.618a	44.1a
134	0.646a	49.9a	0.625a	46.4a
202	0.650a	50.6a	0.622a	46.1a
269	0.687a	50.5a	0.641a	47.2a
	SVREC, 2014		SCFR, 2014	
0	0.488c	42.7e	0.651a	43.0a
56	0.515bc	43.0d	0.631a	42.4a
112	0.509bc	45.1c	0.655a	44.6a
157-168	0.530ab	47.0b	0.632a	42.4a
202-224	0.558a	49.6a	0.667a	43.1a
280	0.534ab	45.8bc	0.649a	44.4a

Table 2. DGCI and SPAD values at R1-2 and grain yield at each N rate within a site-year. Values followed by the same letter within a column for each site-year are similar ($P \leq 0.05$).

N Rate	R1-2		Yield	R1-2		Yield
kg N ha^{-1}	DGCI	SPAD	Mg ha^{-1}	DGCI	SPAD	Mg ha^{-1}
	NWARS, 2013			NWARS, 2014		
0	0.399c	28.4d	4.54c	0.582c	37.7d	4.86d
67	0.588b	46.0c	7.76b	0.684b	47.1c	8.33c
134	0.703a	55.1b	10.13a	0.714ab	53.7b	9.95b
202	0.692a	57.9ab	10.94a	0.738ab	56.2a	11.05a
269	0.735a	59.3a	11.09a	0.785a	54.9ab	10.61ab
	WARS, 2013			WARS, 2014		
0	0.616c	45.3c	10.99c	0.542b	35.9c	3.82c
67	0.645bc	53.0b	12.78b	0.771a	51.7b	9.02b
134	0.698ab	57.9a	14.87a	0.757a	56.6a	12.38a
202	0.668abc	55.7ab	14.12ab	0.727a	57.4a	10.90ab
269	0.713a	58.7a	15.19a	0.782a	58.7a	12.50a
	SVREC, 2014			SCFR, 2014		
0	0.525c	39.5d	6.00e	0.525b	41.1c	7.21d
56	0.655b	48.3c	9.30d	0.637a	49.1b	10.27c
112	0.695ab	54.3b	12.32c	0.667a	54.9a	13.25b
157-168	0.735a	55.5b	14.05b	0.645a	53.7a	13.91ab
202-224	0.715a	57.5a	14.35ab	0.667a	56.1a	14.52ab
280	0.716a	55.8ab	14.96a	0.667a	55.6a	14.71a

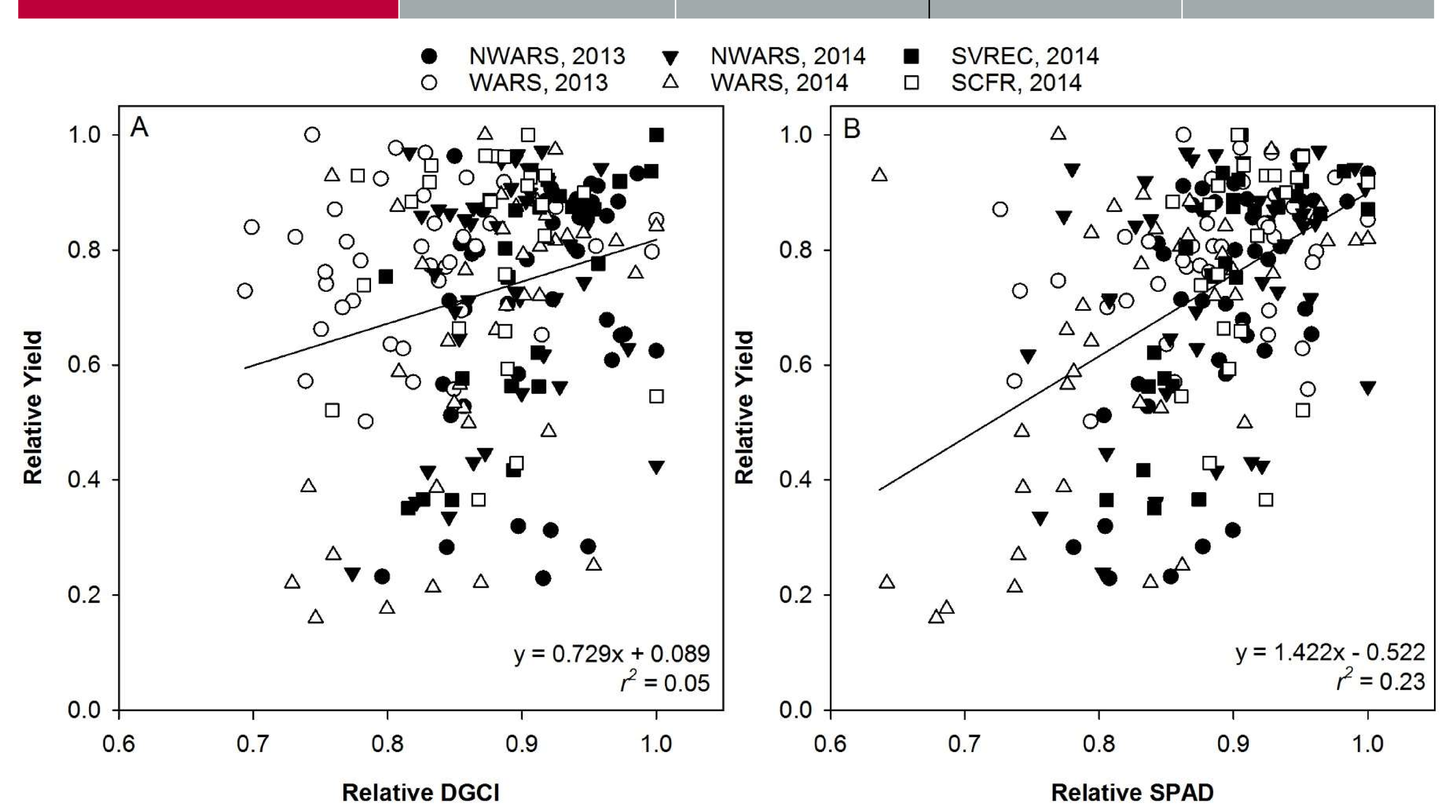

Fig. 3. Relative yield vs. relative DGCI (A) and relative yield vs. relative SPAD (B) at V6. Relationship across site-years was significant ($P \leq 0.01$) for both DGCI and SPAD.

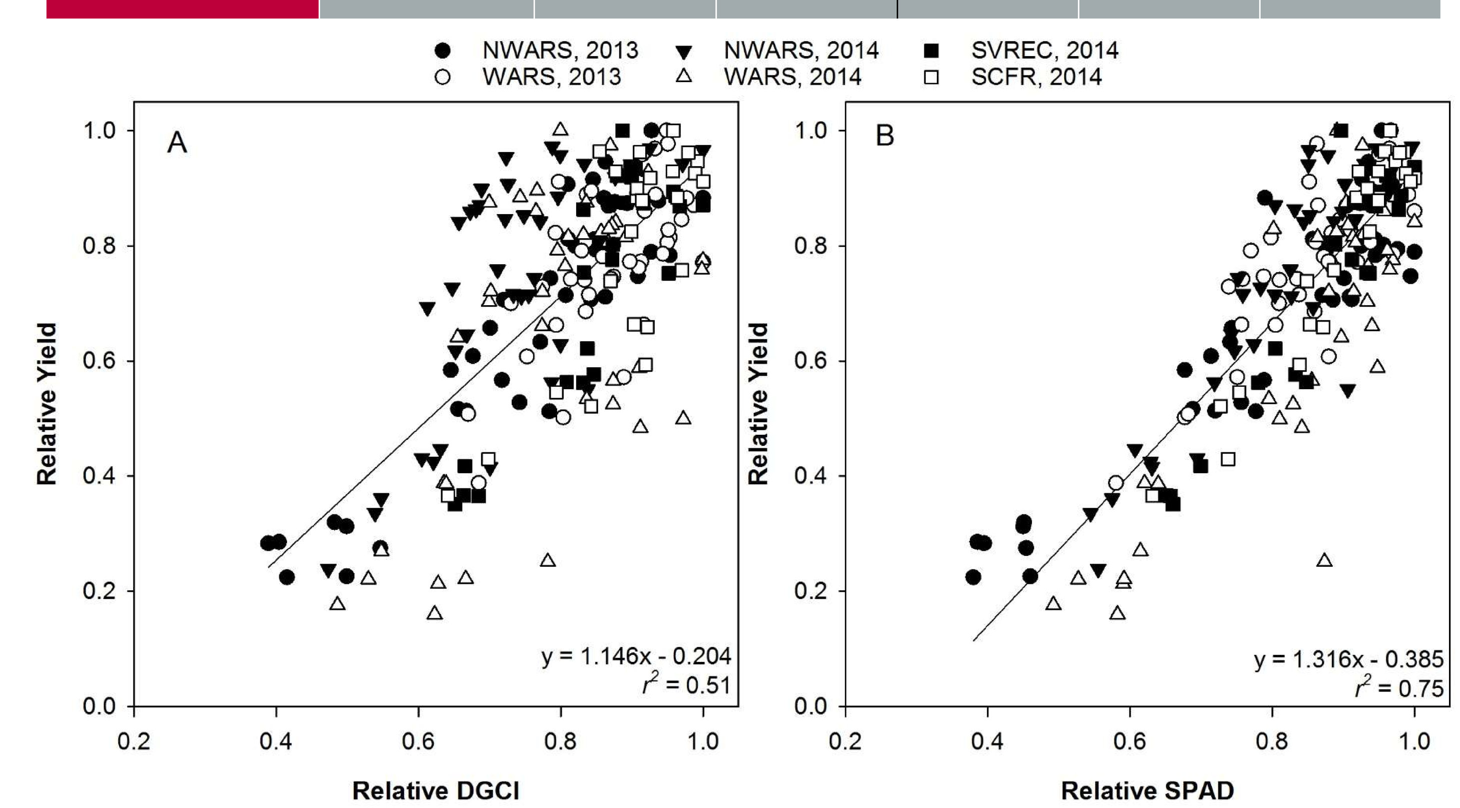

Fig. 4. Relative yield vs. relative DGCI (A) and relative yield vs. relative SPAD (B) at R1-2. Relationship across site-years was significant ($P \leq 0.01$) for both DGCI and SPAD.

V6 Growth Stage (Table 1)

- DGCI detected N application in two site-years
- SPAD detected N application in four site-years

R1-2 Growth Stage (Table 2)

- DGCI detected multiple N rates in four site-years
- SPAD detected multiple N rates in all site-years

Relationship to Grain Yield (Fig. 3 and Fig. 4)

- Related to yield at V6 and R1-2, r^2 greater with SPAD
- Yield separation was similar to SPAD values (Table 2)

CONCLUSIONS

SPAD was more successful at detecting N application rate than DGCI. Detection of differences at V6 varied by site-year, but was more consistent at R1-2 for both technologies. Regardless of stage, the r^2 values were 0.18-0.24 greater ($P \leq 0.01$) for SPAD than DGCI when related to yield based on regression analysis performed across site-years.

The Ohio State University

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