



Measuring canopy nitrogen nutrition in tobacco plants using hyper spectrum parameters

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Layout

- Background
- Experimental Program
- Experimental Results
- Conclusions

Background

- as real-time, real-field and no-harm diagnostic technology of nitrogen is deficient for flue-cured tobacco production in China.
- Therefore, inefficient use of nitrogen fertilizer has become a common phenomenon, resulting in poor utilization of nitrogen fertilizer and decline of tobacco leaf quality .

- a simple, rapid and non-destructive monitoring method of crop nitrogen is needed for nitrogen precision management.
- As we know, **ground-based remote sensing** has been **widely applied** in crop agronomic parameters monitoring and extraction .
- **Therefore, monitoring tobacco plant nitrogen accumulation by using of canopy reflectance has theoretical significance and practical value.**

Experimental Program

Crop monitored was tobacco, cultivar K326.



Randomized block design was used with nitrogen as variable at **four levels**, namely 0(N0), 105(N1), 150(N2), 195 kg·hm⁻² (N3).



Spectrometry adopted the multispectral field portable radiometer, **MSR-16R**.

Flue-cured tobacco after topping was to be measured under **cloudless** or **less cloud weather**.



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- The total biomass, aboveground weight, root weight, total fresh leaves weight, total dry leaves weight, total leaves area were measured.

the Leaf Nitrogen Accumulation, Plant Nitrogen Accumulation, Root Nitrogen Accumulation were calculated with the following formula.

Experimental Program

Calculation

and

$$R_{RNA} = R_{RNC} \times R_{RDW} \quad \dots \dots \dots \quad (3)$$

L_{JNA} —Leaf Nitrogen Accumulation($\text{g}\cdot\text{N}/\text{m}^2$);

L_{JNC}—Leaf Nitrogen Content(%);

L_{LDW} —Leaf Dry Weight(g/m^2);

P_{PNA}—Plant Nitrogen Accumulation(g/m²);

P_{PNC}—Plant Nitrogen Content(%);

P_{PDW}—Plant Dry Weight(g/m²);

R_{RNA} —Root Nitrogen Accumulation($\text{g}\cdot\text{N}/\text{m}^2$);

R_{RNC} —Root Nitrogen Content(%);

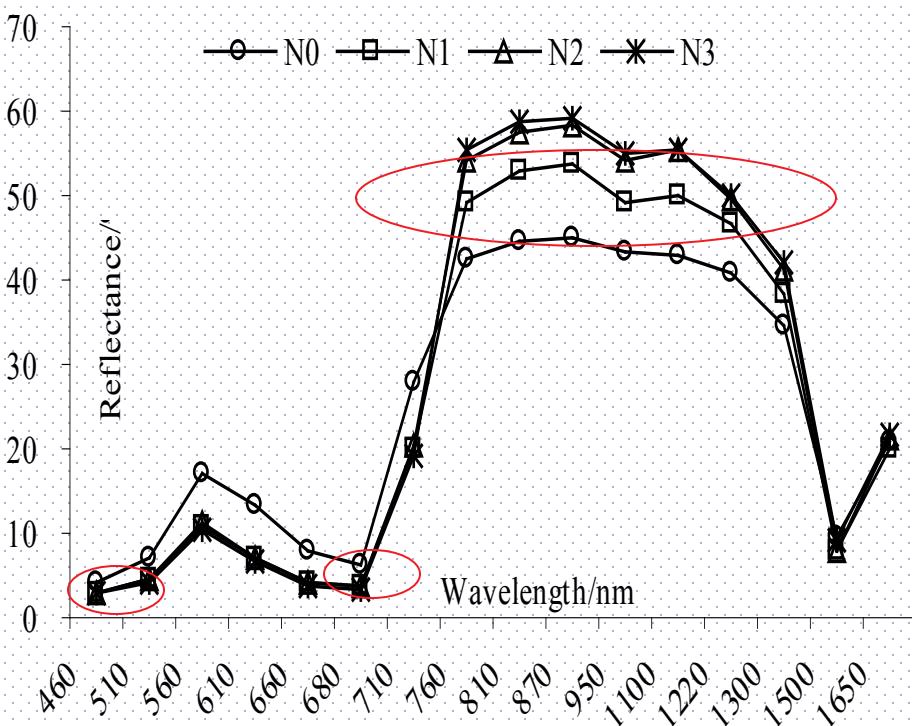
R_{RDW}—Root Dry Weight(g/m²).

Algorithm of different multispectral indices

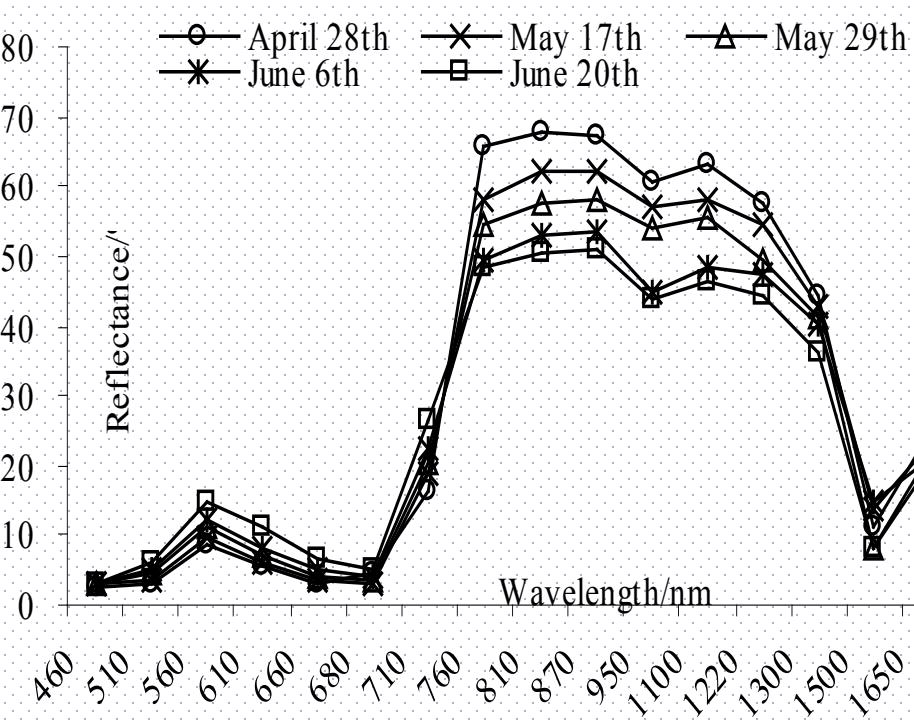
Spectral Parameters	Abbreviation	Calculation Formula
Ratio Vegetation Index	RVI(λ_1, λ_2)	$R_{\lambda_1}/R_{\lambda_2}$
Difference Vegetation Index	DVI(λ_1, λ_2)	$R_{\lambda_1} - R_{\lambda_2}$
Normalized Difference Vegetation Index	NDVI(λ_1, λ_2)	$\frac{R_{\lambda_1} - R_{\lambda_2}}{R_{\lambda_1} + R_{\lambda_2}}$
Enhanced Vegetation Index	EVI	$\frac{2.5(R_{NIR} - R_{680})}{(1 + R_{NIR} + 6R_{680} - 7.5R_{460})}$
Red edge position wavelength	λ_{rep}	$710 + 50 \left[\frac{(R_{810} + R_{660}) / 2 - R_{710}}{R_{760} - R_{710}} \right]$
Soil-adjusted Vegetation Index	SAVI	$\frac{1.5(R_{870} - R_{680})}{R_{870} + R_{680} + 0.5}$
Optimization of Soil Adjusted Vegetation Index	OSAVI	$\frac{1.06(R_{810} - R_{680})}{(R_{810} - R_{680} + 0.16)}$

Results

Original spectrum changes of flue-cured tobacco canopy



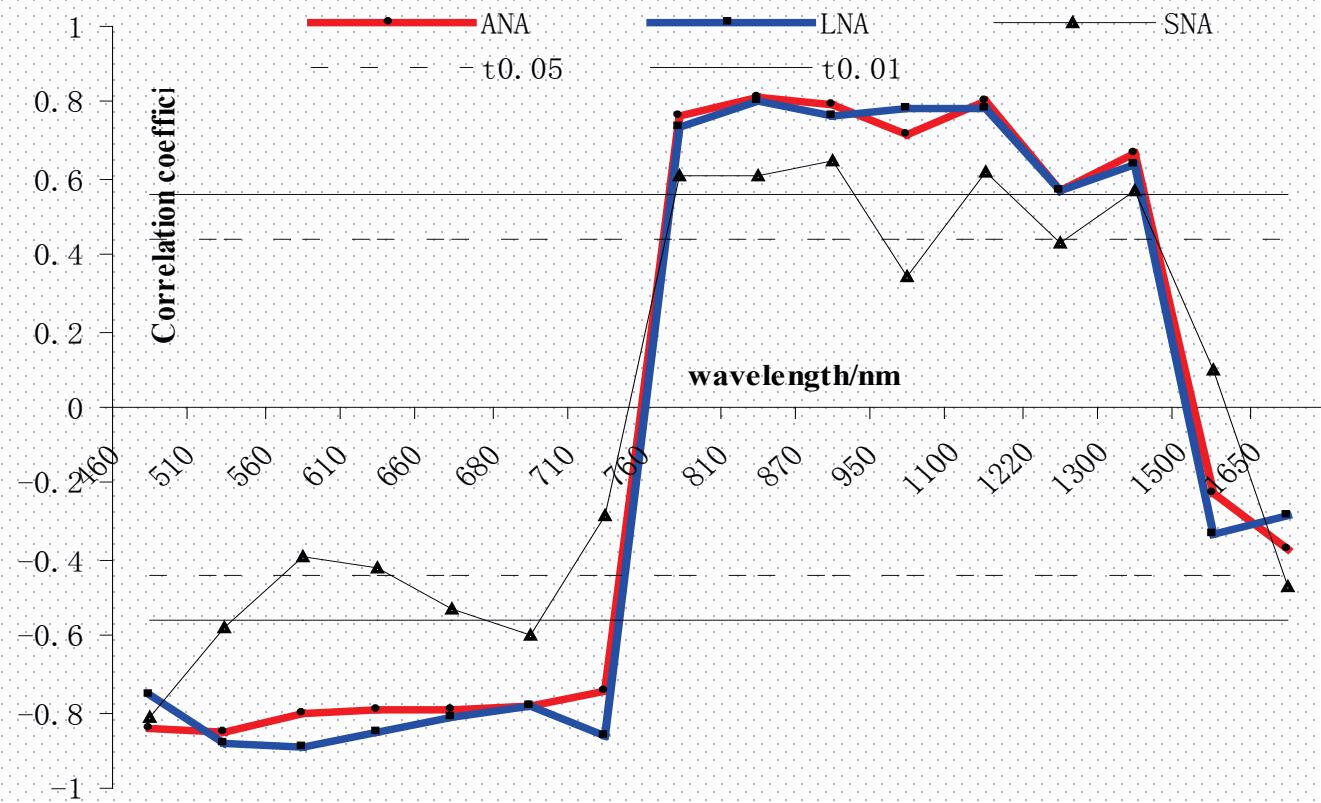
Flue-cured tobacco canopy reflectance under different N fertilization levels



Flue-cured tobacco canopy reflectance in different periods

Results

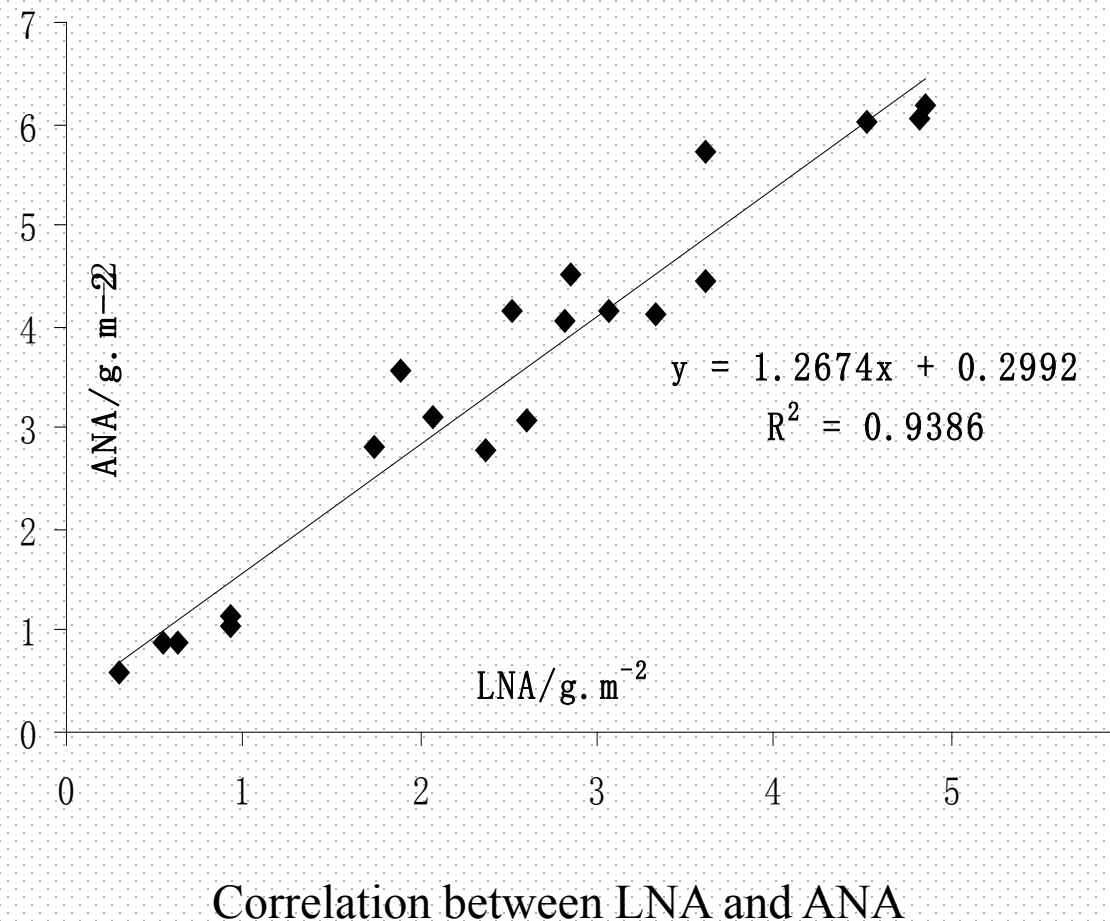
Relating ANA to canopy reflectance



Correlation between ANA and spectra reflectance of flue-cured tobacco

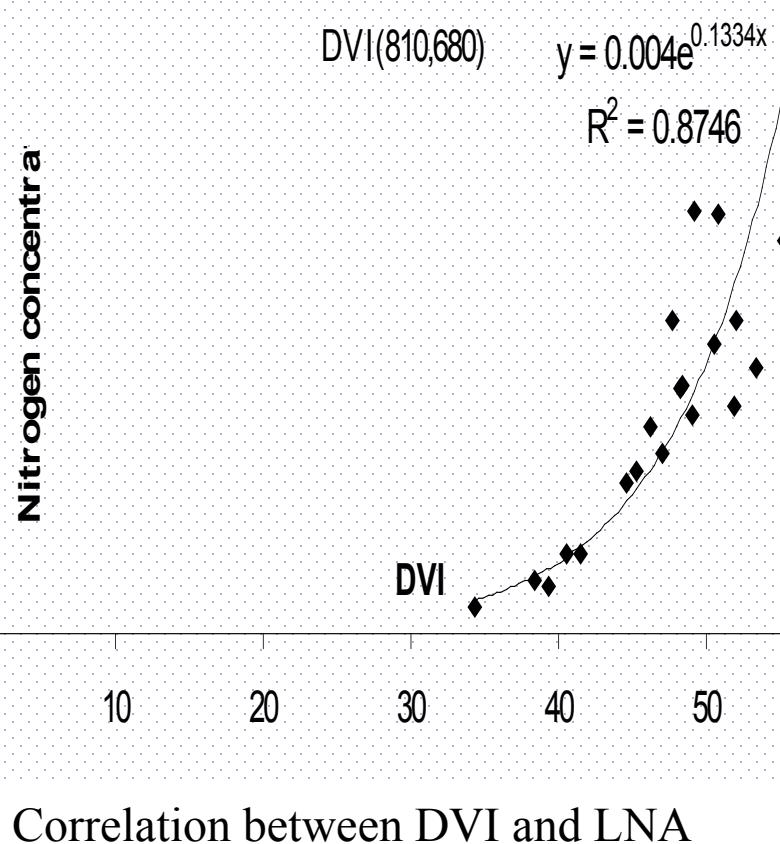
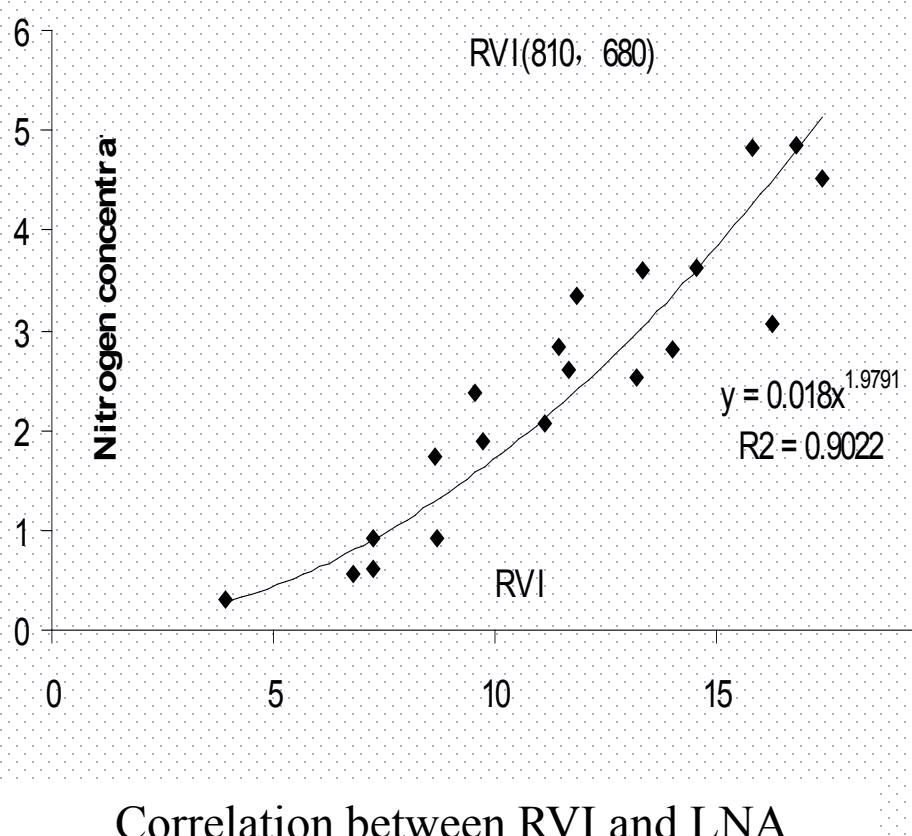
Results

Relating ANA to canopy reflectance



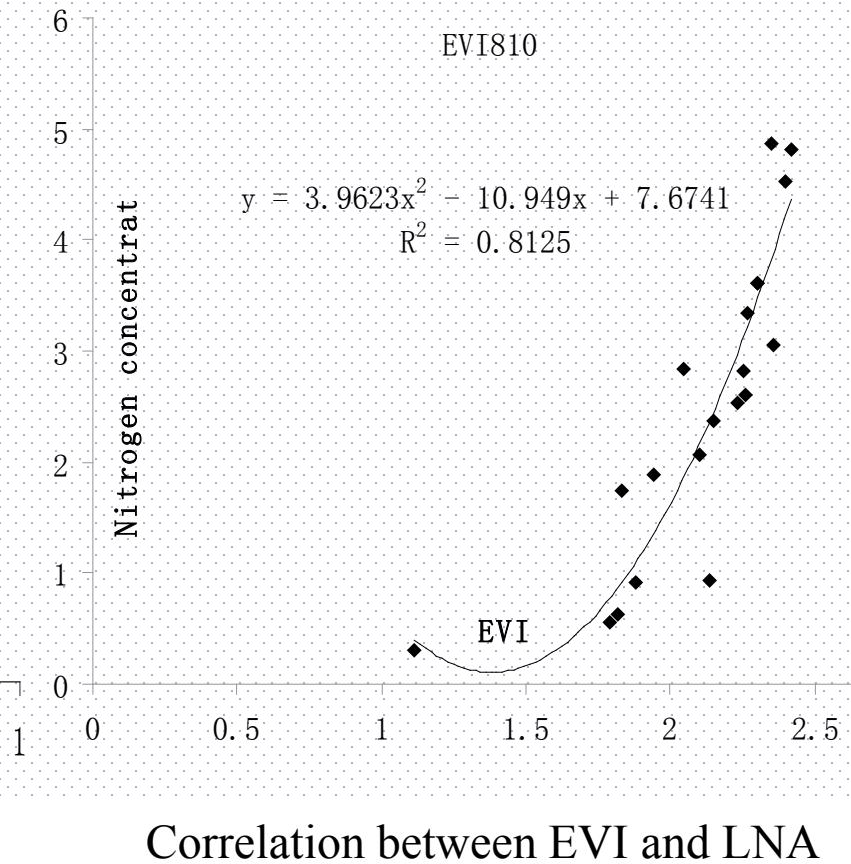
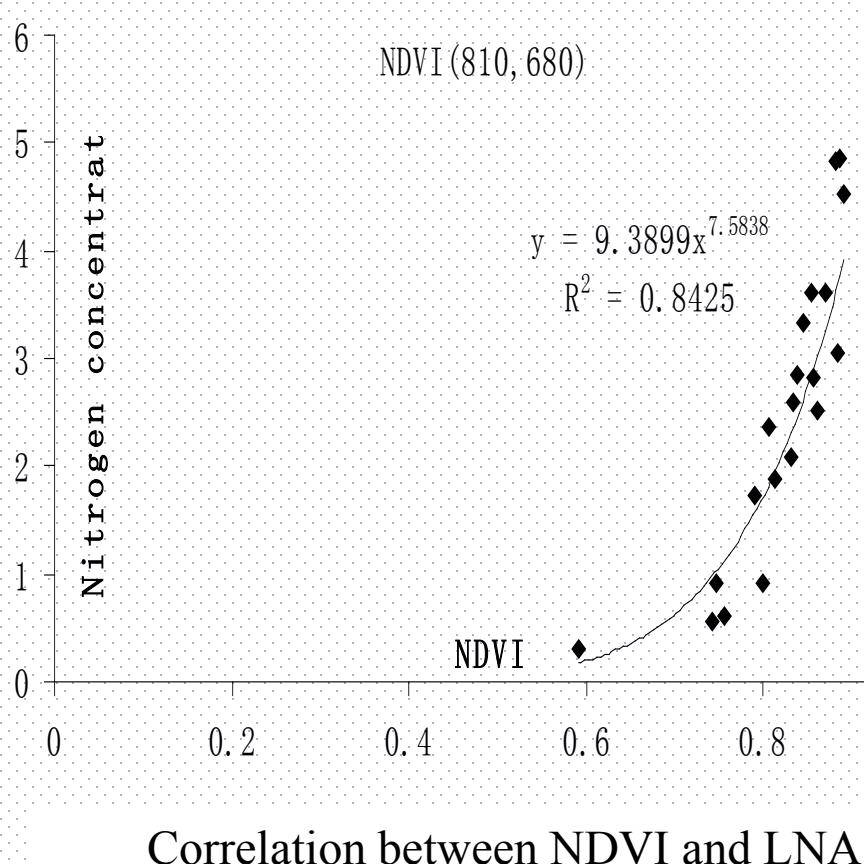
Results

Relating ANA to canopy spectra index



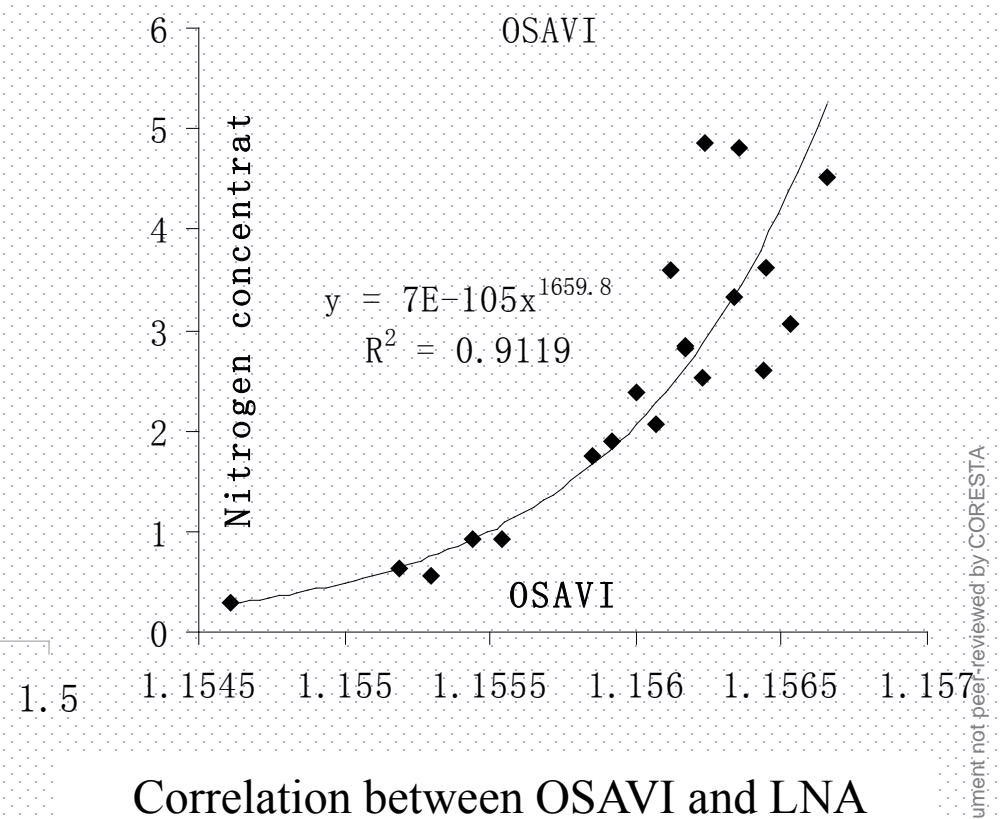
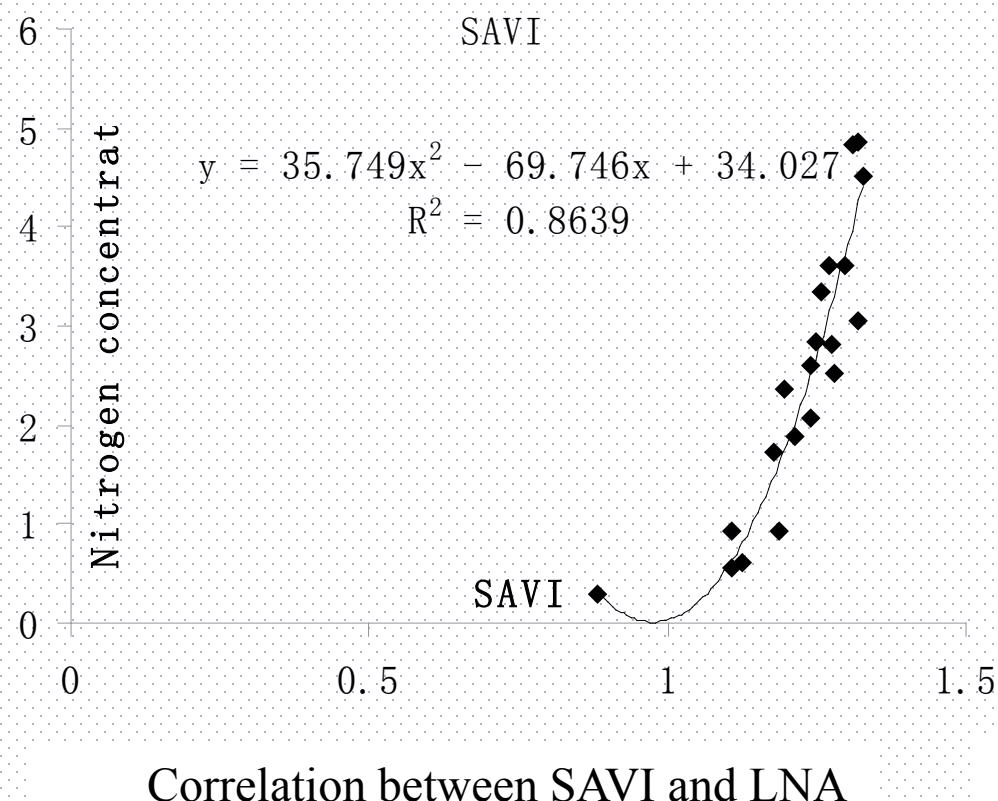
Results

Relating ANA to canopy spectra index



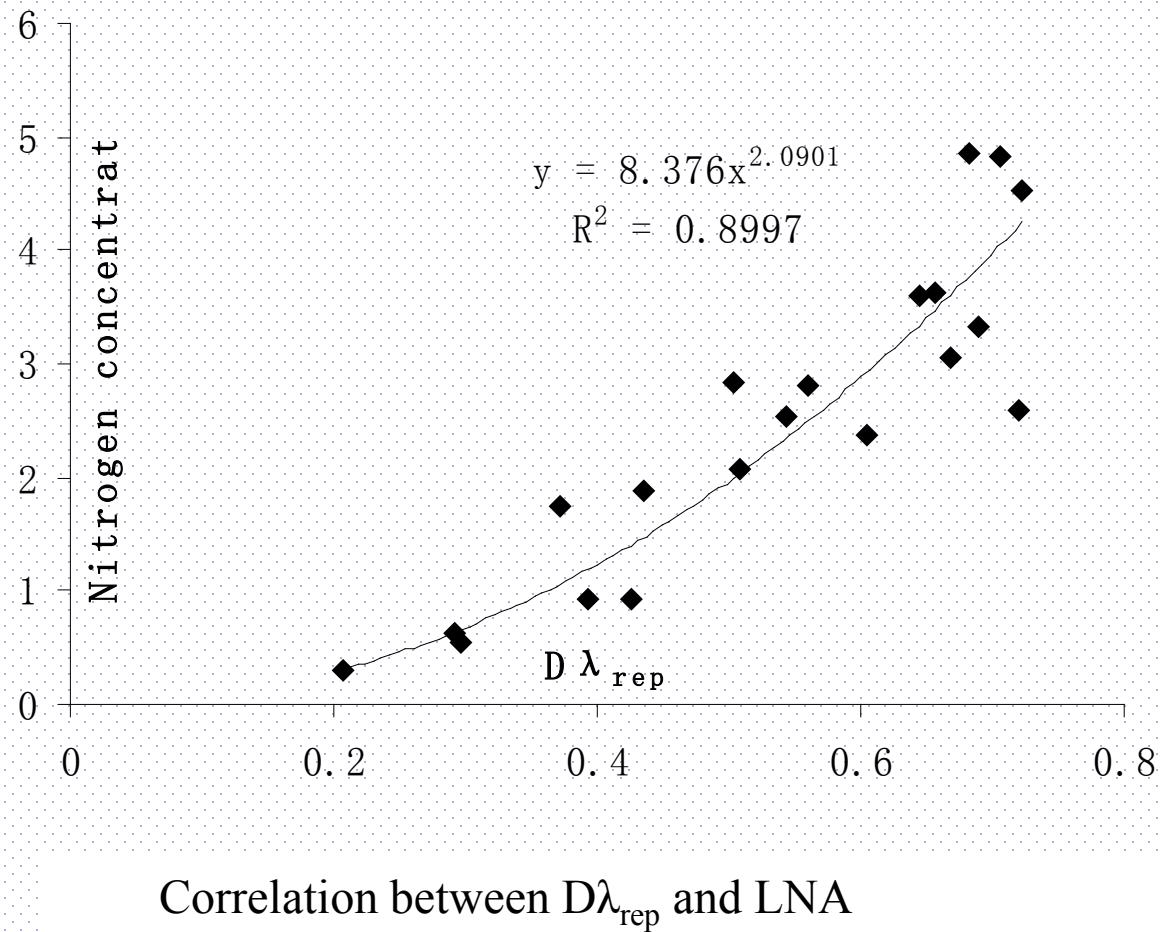
Results

Relating ANA to canopy spectra index



Results

Relating ANA to $D\lambda_{rep}$



Regression models based upon vegetation indices against LNA and its validation

Vegetation Indices	Model Building		Model Verification		RMSE
	Regression Model	Coefficient of Determination	Coefficient of Determination		
<i>RVI</i>	$y = 0.018x^{1.9791}$	0.902**	0.901**		0.264
<i>DVI</i>	$y = 0.004e^{0.1334x}$	0.875**	0.792**		0.245
<i>NDVI</i>	$y = 9.3899x^{7.5838}$	0.843**	0.839**		0.193
<i>EVI</i> ₈₁₀	$y=7.6741+3.9623x^2-10.949x$	0.813**	0.929**		0.188
<i>SAVI</i>	$y=34.027+35.749x^2-69.746x$	0.864**	0.921**		0.202
<i>OSAVI</i>	$y = 7E-105x^{1659.8}$	0.912**	0.930**		0.260
$\Delta\lambda_{rep}$	$y = 8.376x^{2.0901}$	0.900**	0.898**		0.197

Conclusions

- There existed an **absorption valley** in the vicinity of **680 nm** and **460 nm**, a **reflection peak** at about **560 nm** and a **high reflectance platform** in the near infrared region of **810-1100 nm**.
- Canopy spectral **reflectance** of flue-cured tobacco **decreased** in the visible region (**460-710 nm**) and **increased significantly** in the **near-infrared band** (**760-1220 nm**) as nitrogen level increased.

- RVI (680,810), DVI (680,810), NDVI (680,810), EVI₈₁₀, SAVI (680,810) OSAVI (680,810) and Dλ_{Red} all could be used to establish good tobacco nitrogen accumulation regression models, and the EVI₈₁₀ , OSAVI(680,810) and Dλ_{Red} had better fitting effect, which significantly improved the inversion accuracy.
- It could be concluded that ANA in flue-cured tobacco could be monitored effectively by key vegetation indices, especially EVI₈₁₀, OSAVI and DλRed. The regression model were $y=7.6741+3.9623x^2-10.949x$, $y = 7E-105x^{1659.8}$, $y = 8.376x^{2.0901}$ respectively.



Microsoft Excel - WX-CC.RFL

文件(F) 编辑(E) 视图(V) 插入(I) 格式(O) 工具(T) 数据(D) 窗口(W) 帮助(H)

A	B	C	D	E	F	G
1 LOCATION.....	WEN					
2 EXPERIMENT NUMBER.....	1					
3 RAW FILE.....	C:/MSR/WX-CC.MV					
4 PERCENT REFLECTANCE FILE...	C:/MSR/WX-CC.RFL					
5 CORRECTED MILLIVOLT FILE...	C:/MSR/WX-CC.CMV					
6	5					
7						
8 DAT TIME ANG IRR PLOT SS 460						
9						
10 *						
11 8/09/200	10:35:18	31.7	504	1	1	2.94
12 8/09/200	10:35:34	31.7	440	1	2	2.97
13 8/09/200	10:35:51	31.7	415	1	3	3.02
14 8/09/200	10:36:43	31.5	368	1	4	2.28
15 8/09/200	10:36:59	31.5	366	1	5	2.23
16 8/09/200	10:37:14	31.3	367	1	6	2.24
17 8/09/200	10:37:42	31.3	396	1	7	2.64
18 8/09/200	10:38:00	31.1	415	1	8	2.5
19 8/09/200	10:38:16	31.1	425	1	9	2.55
20 8/09/200	10:39:58	31	647	2	1	1.82
21 8/09/200	10:40:16	30.8	641	2	2	1.77
22 8/09/200	10:40:33	30.8	555	2	3	1.81

A close-up photograph of tobacco plants growing in soil. A black irrigation tube is visible in the foreground.



Thank You !