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DISPAA
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Application of precision farming with a view to environmental sustainability and productivity

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Role of Nitrogen for Crops Growth and Development

Nitrogen (N) is often the most limiting factor in crop production

Crops advantages:

- higher biomass yield and protein yield
- increased concentration in plant tissue
- affects amino acid composition of protein
- affects leaf area production and leaf area nutritional quality
- in cereals decreases the relative proportion of lysine and threonine
- improves kernel integrity and strength

Optimum, rate of N increases photosynthetic processes, leaf area production, leaf area duration as well as net assimilation rate

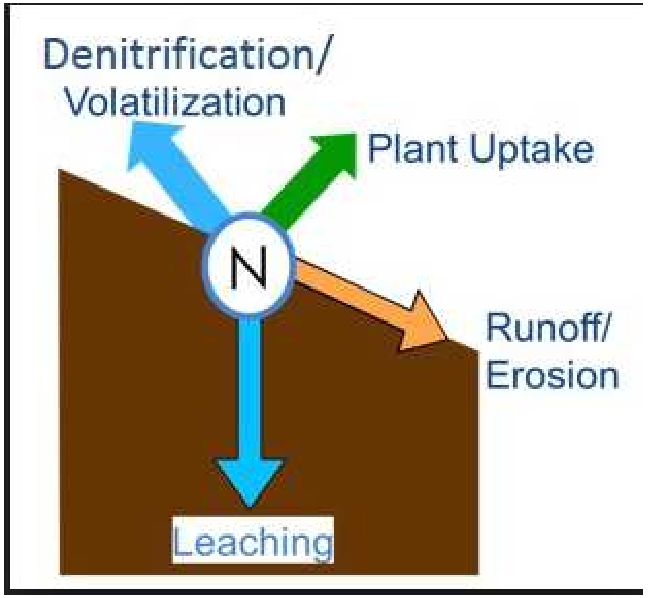
Inappropriate configuration of fertilizer use could increase N losses

ENVIROMENTAL PROBLEMS

Nitrous oxide emission has a very high radiative forcing per unit mass or molecule (296 times higher than the one of CO_2 on a 100 years period)

In agricultural soils and waste management systems (e.g. manure heaps, slurry tanks), they are responsible for 27% of the global annual nitrous oxide budget, but account for 70% of the anthropogenic fraction.

(IPCC,2014)

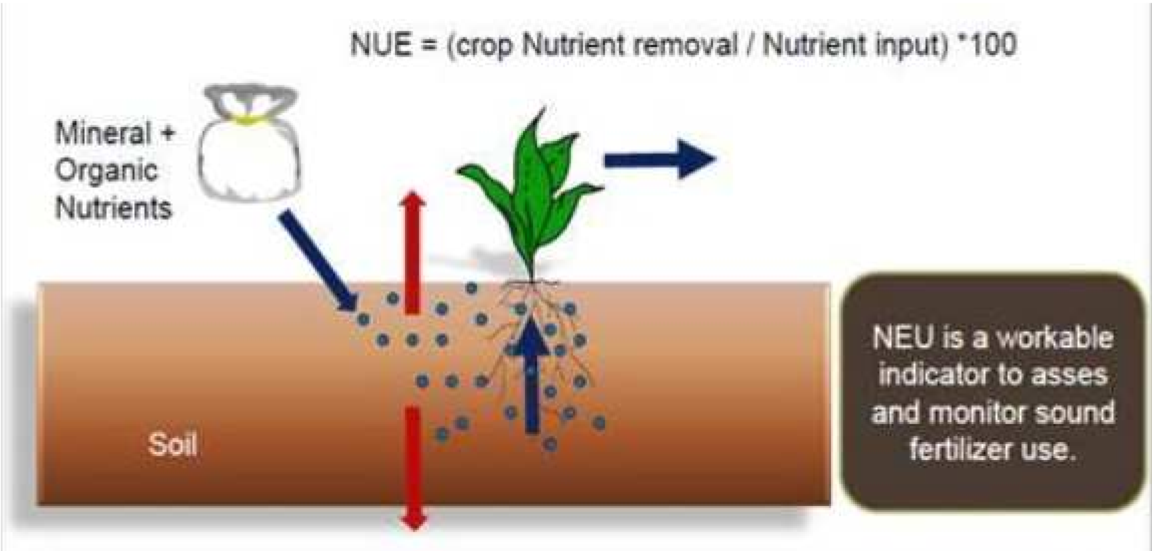


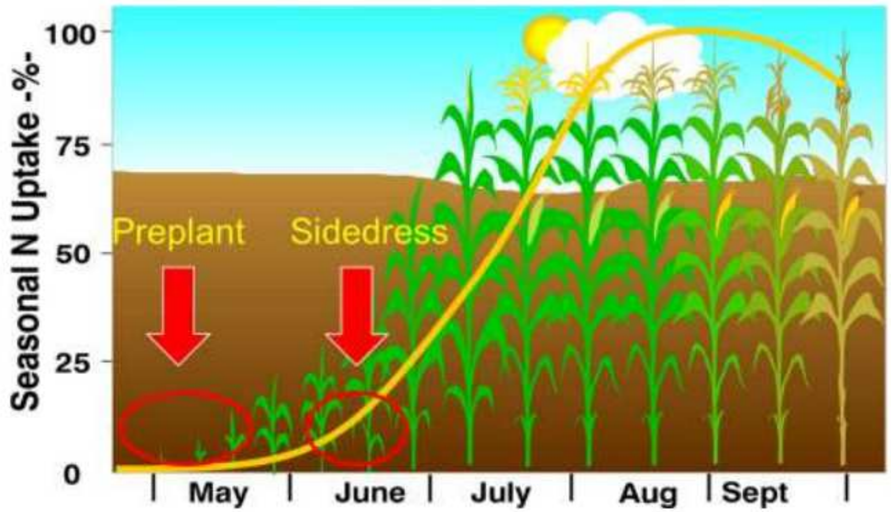
contamination of underground water

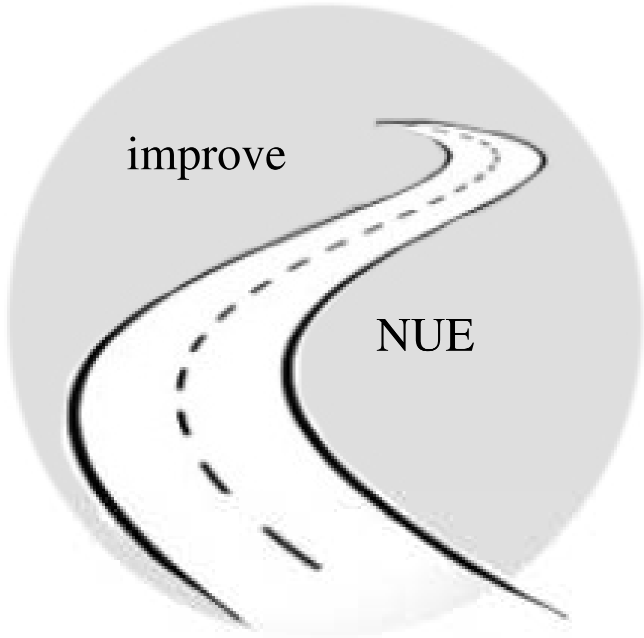
Nitrogen Use Efficiency (NUE)

Crop nutrient uptake and crop yields are the principal factors that determine:
optimal fertilization practices
Therefore, it is very important to apply fertilizers in an efficient way to minimize loss and to improve the nutrient use efficiency

It is the fraction of fertilizer nutrients removed from the field with the crop harvest.







Precision farming

Conventional Agriculture

Uniform management ignores spatial and temporal variability in crop growth, soil or landscape features and denitrification or leaching losses of N

It leads to overuse of farm inputs and environmental losses

Uniform management based on average

Variable rate nitrogen

Response to spatial and seasonal variability: give nitrogen when it is essential (maximum plant intake)

Enviromental and economic benefits

Use of optical sensors mounted on satellites or proximal sensing to measure crop canopy variation throughout the growing season. → Use of vegetative indices: NDVI

Experimental field on Barley

9 preselected tanks:

3 control (no nitrogen)
3 conventional nitrogen dose
3 variable rate nitrogen dose

Study area:
ITA (Istituto Tecnico Agrario), Italy

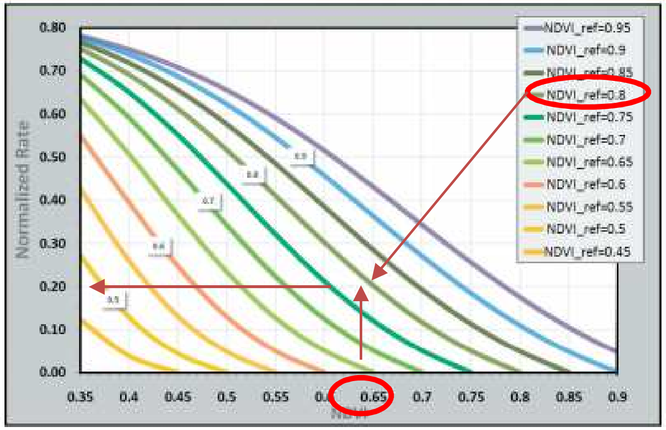
Methods

Conventional Treatment (CT): 75 kg N/ha +75 kg N/ha
sowing top dressing

Variable Rate Treatment: 25% of CT + VRN side-dressed based on NDVI with Greenseeker

Nitrogen Dose	1° time Kg/ha	2° time Kg/ha
CT	75	75
VRT	37	40

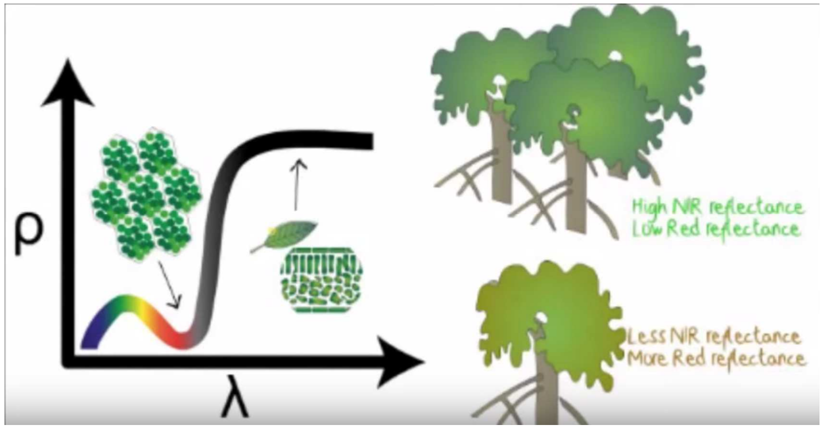
Variable Rate N Fertilizer Recommendations Based on Greenseeker® NDVI



Crop	%N	lb/bu	Maximum yield (bu/ac)											
			15	25	50	75	100	125	150	175	200	225	250	275
Spring wheat	2.45	60		66.8	134	200	267	334	401	468				
Winter wheat	2.30	60	37.6	62.7	125	188	251	314	376	439				
Dryland corn	1.30	56				99.3	132	165	199	232	265	298	331	
Irrigated corn	1.25	56					127	159	191	223	255	286	318	350
Barley	1.70	48	22.3	37.1	74.2	111	148	185	223	260				
Triticale	2.10	54	30.9	51.5	103	155	206	258	309	361				
Sorghum	1.34	56				102	136	171	205	239	273	307		
Canola	3.10	50	42.3	70.5	141	211	282							

Uses NUE = 0.55 and $NDVI_{soil}$ = 0.15

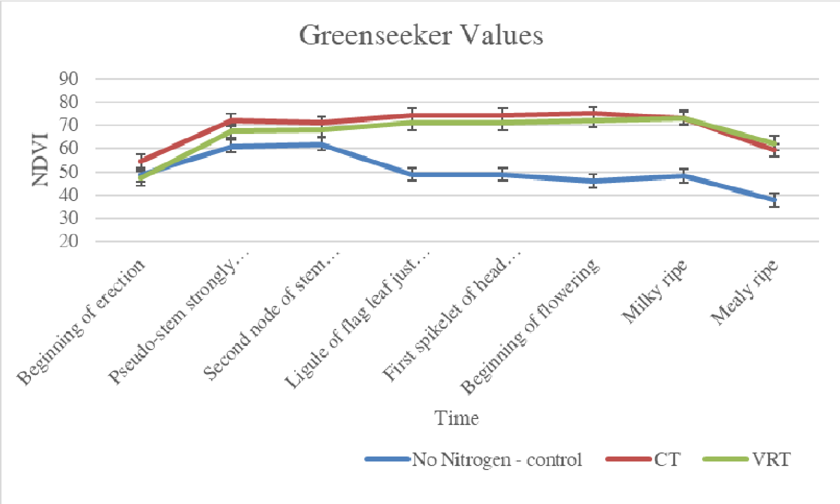
$$NDVI = (NIR-R)/(NIR+R)$$

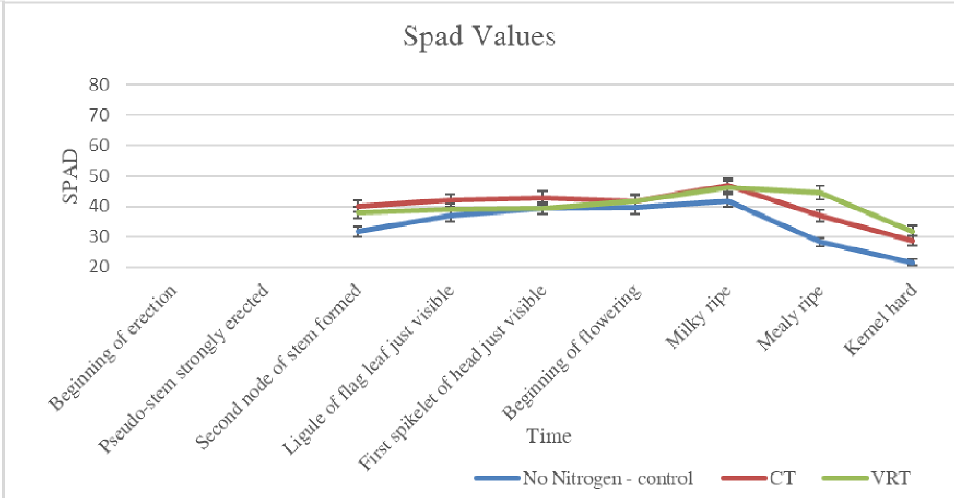


Measurements

		Data Collection		
Stage	**Description**	**Greenseeker**	**Spad**	**ASD Field**
Feekes 3	Beginning of the erection of the pseudo-stem	×		
Feekes 5	Pseudo - stem (formed by sheaths of leaves) strongly erected	×		×
Feekes 7	Second node of stem formed; next to last leaf just visible	×	×	×
Feekes 9	Ligule of flag leaf just visible	×	×	
Feekes 10.1	First spikelet of head just visible	×	×	
Feekes 10.5	Half of heading process completed	×	×	
Feekes 11.1	Milky ripe	×	×	
Feekes 11.3	Kernel hard	×	×	×

Preliminary Results – Greenseeker measurements





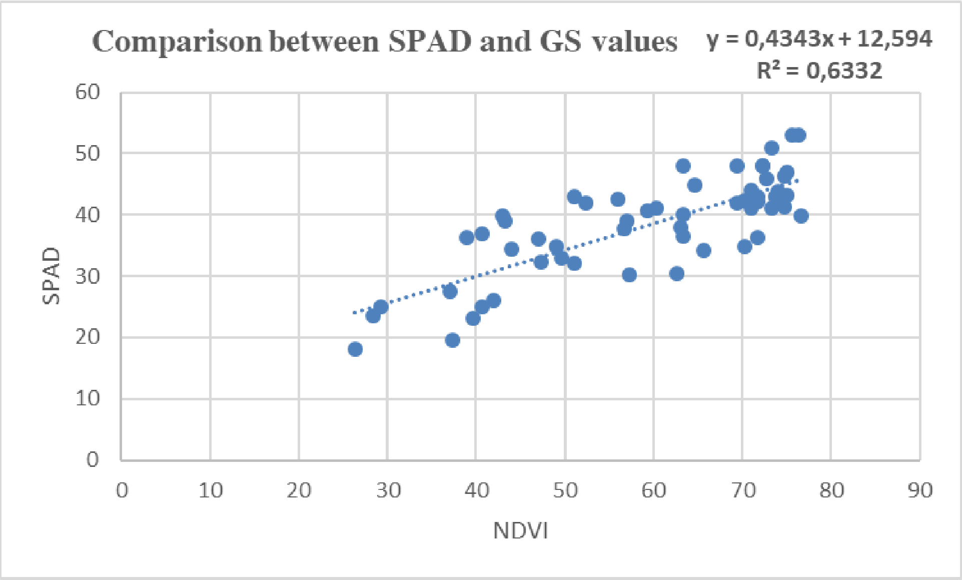
<u>- No evident NDVI differences</u> between CT & VCT

- **NDVI increase through time until milky ripe: it depends on the crop maturity level (beginning leaf yellowing).**

- No Nitrogen tanks present the lowest NDVI value (it starts to decline early).

- **Chlorophyll content is similar for every tratment at the first time.**
- **VCT has the highest value at the first time but from milky ripe it decreases.**
- **No nitrogen tanks have the lowest SPAD value**

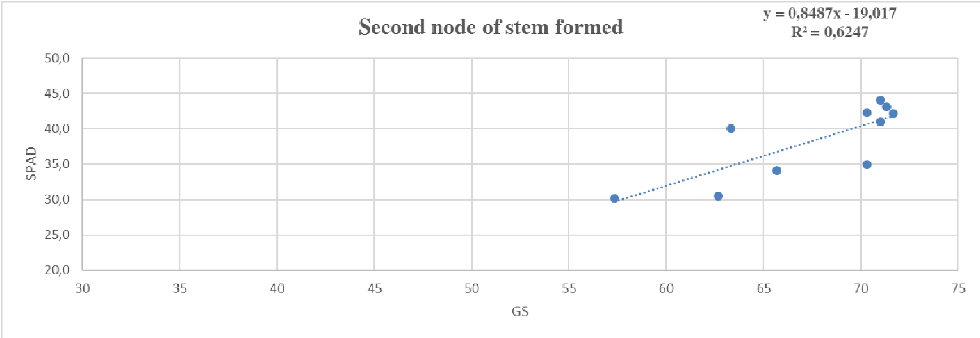
Preliminary Results

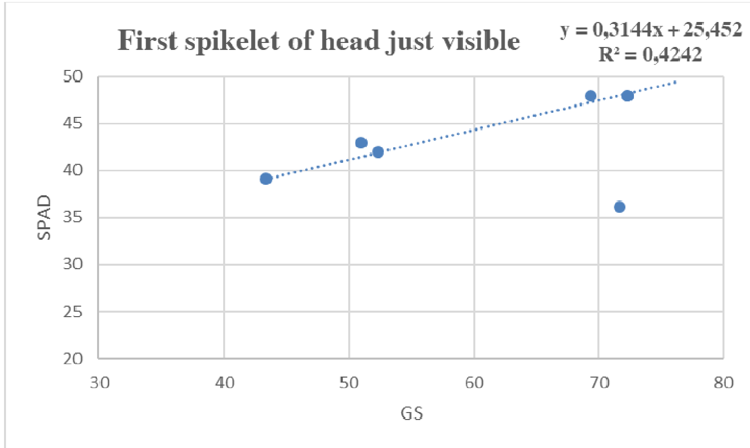


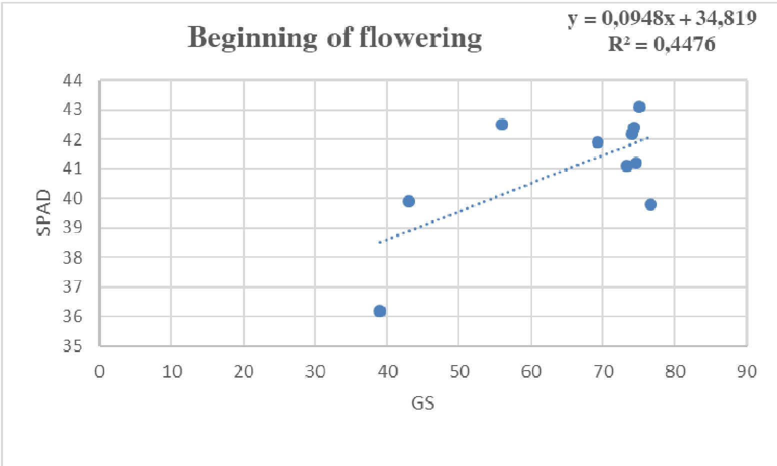
- There is a good general correlation between instruments

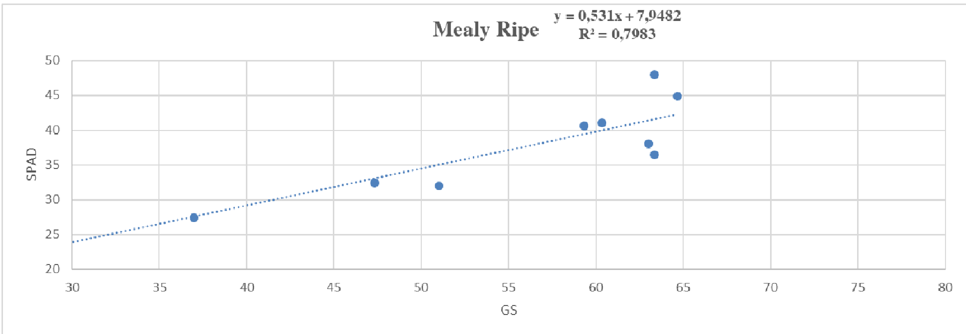
- This is because NDVI is a greeness index – so it is strongly influenced by the presence of chlorophyll

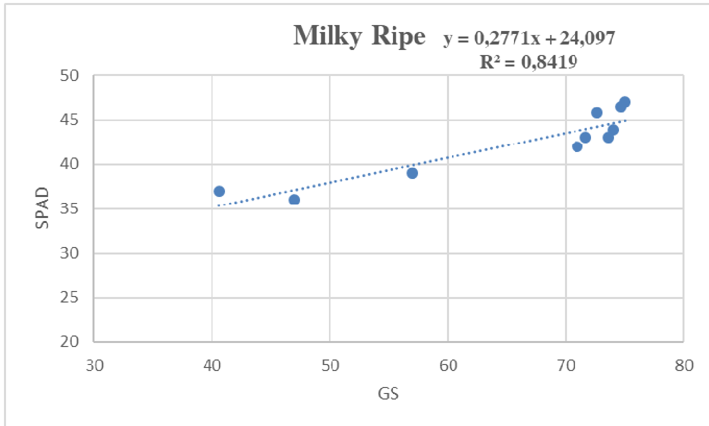
- There are higher correlations in the literature between instruments

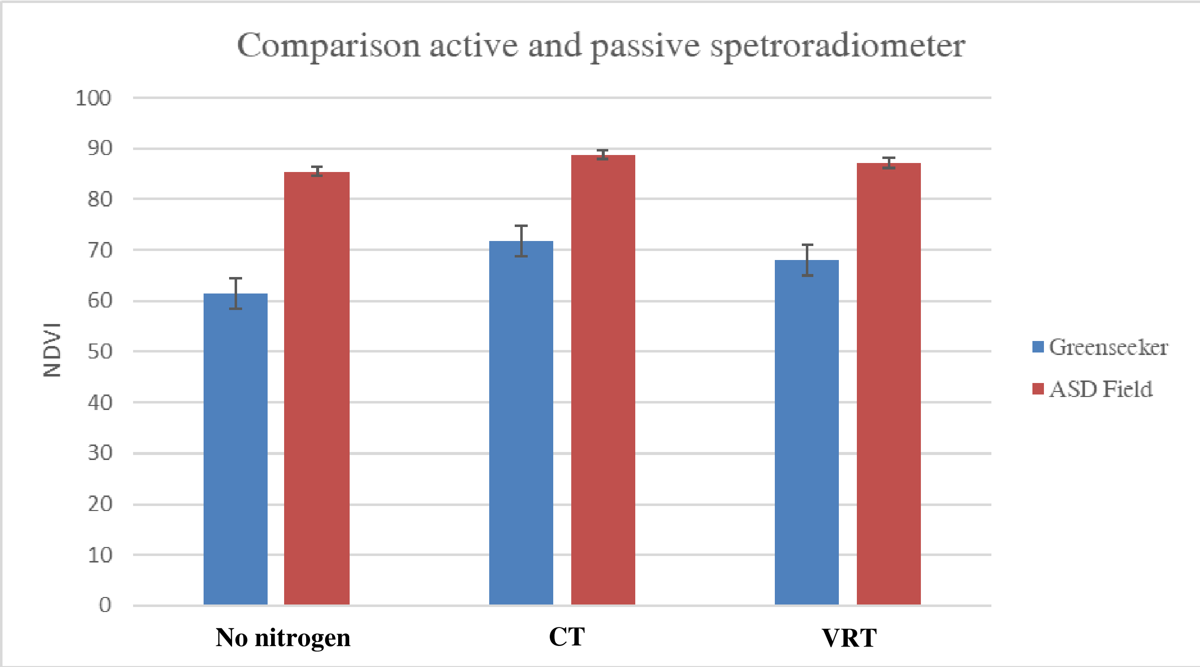

Second node of stem formed
y = 0,8487x - 19,017
R² = 0,6247
SPAD
GS


First spikelet of head just visible
y = 0,3144x + 25,452
R² = 0,4242
SPAD
GS


Beginning of flowering
y = 0,0948x + 34,819
R² = 0,4476
SPAD
GS


Mealy Ripe
y = 0,531x + 7,9482
R² = 0,7983
SPAD
GS


Milky Ripe
y = 0,2771x + 24,097
R² = 0,8419
SPAD
GS



	Greenseeker 1° time	ASD Field 1° time	Greenseeker 2° time	ASD Field 2° time
No Nitrogen	61	86	62	85
CT	72	88	71	90
VCT	68	87	68	88

- **Some differences between NDVI values of two instruments (ASD & GS)**
- **Both measurements respect the trend (high NDVI – high nitrogen level**
  low NDVI – no nitrogen)
- **No obvious differences in the NDVI values of ASD field spectroradiometer**

Conclusions and future research

Conclusion of the experiments to evaluate results:

- Yield estimation
- Nitrogen content evaluation
- Emission and leaching evaluation (enviromental impact)
- Comparison between values measured by instruments

economic
and environmental
advantage

The use of spectroradiometers could be effective to obtain high yields with lower nitrogen

Thank you for your attention

PhD Carolina Fabbri