12th ECPA CONFERENCE 8 – 11 July, 2019 | Montpellier | France

APPLICATION OF UAV MULTISPECTRAL IMAGES FOR ESTIMATION OF WINTER RAPESEED AGRONOMIC VARIABLES

Pattier P.[1], Nicolas H.[1], Bissuel C.[1], Pinochet X.[2], Laperche A.[1], Kazemipour-Ricci F.[2]

[1]Agrocampus Ouest, Rennes, France, [2] Terres Inovia, Bretenière, France

Introduction

Background : Winter oilseed rape (WOSR) is the second winter arable crop in Europe and France. A whole WOSR cycle lasts around 11 months, from august (sowing) to July of following year (seed harvest) and is divided into four critical periods (figure 1):

Objectives : The aim of this study was to assess the relevance of multi-year and multi-site UAV images to estimate some of agronomic variables for rapeseed crops using vegetation indices (VIs). GLAI (Green Leaf Area Index) and Biomass (dry and fresh) were selected as the most used indicators of crop health and growth.

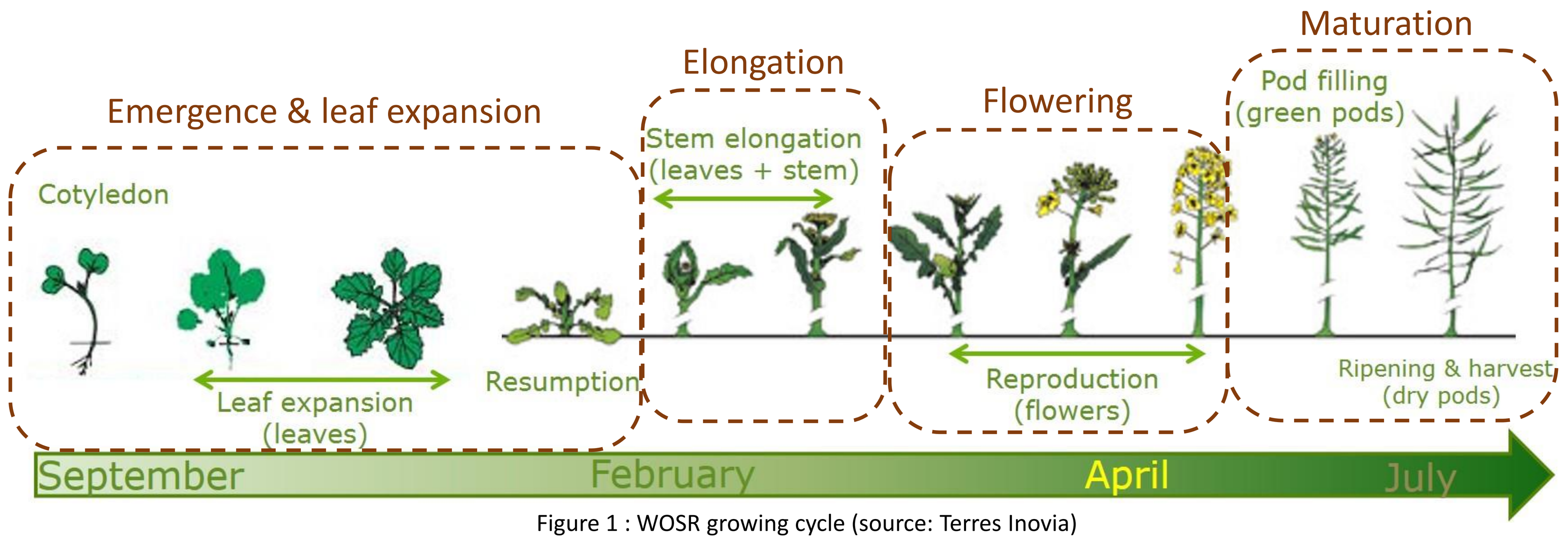


Figure 1 : WOSR growing cycle (source: Terres Inovia)

Materials & Methods

Study site

- Two experiment sites were designed for this study to conduct three WOSR campaigns (2015, 2017 and 2018) in the context of PHENOME-EMPHASIS and RAPSODYN projects.
- The first is located at Bretenière, near Dijon, with two plots in 2015 and one plot in 2017; the second is located at Le Rheu, near Rennes, with one plot in 2017 and one in 2018 (Fig2 and Tab1).

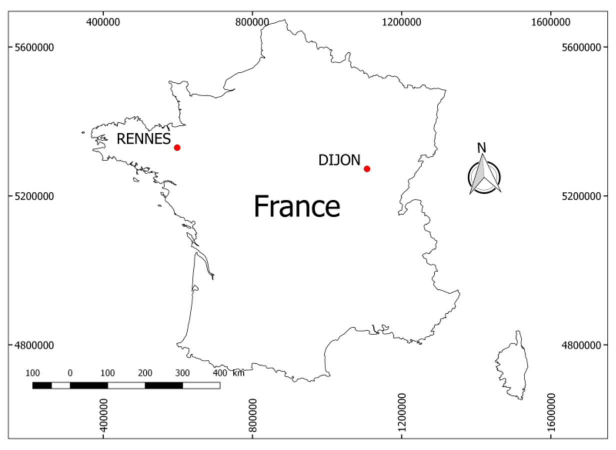


Figure 2 : location of study sites

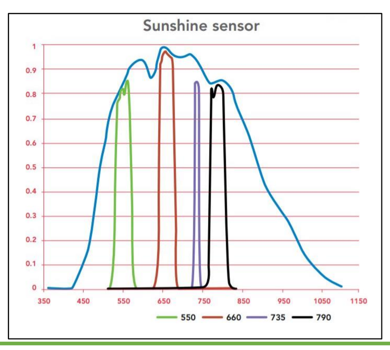
Site-year	Trial	N supply (kg/ha)	Genotype	Subplot	Microplot/date
Bretenière-2015	CAN	0,60,140	8	2	48
Bretenière-2015	PHE	0,40,100,180	1	4	16
Bretenière-2017	CAN	0, 60,140	20	4	120
Le Rheu-2017	CAN	0,40,80	20	3	120
Le Rheu-2018	CAN	0,40,80	10	3	90

Table 1 : Detailed information about each experiment design

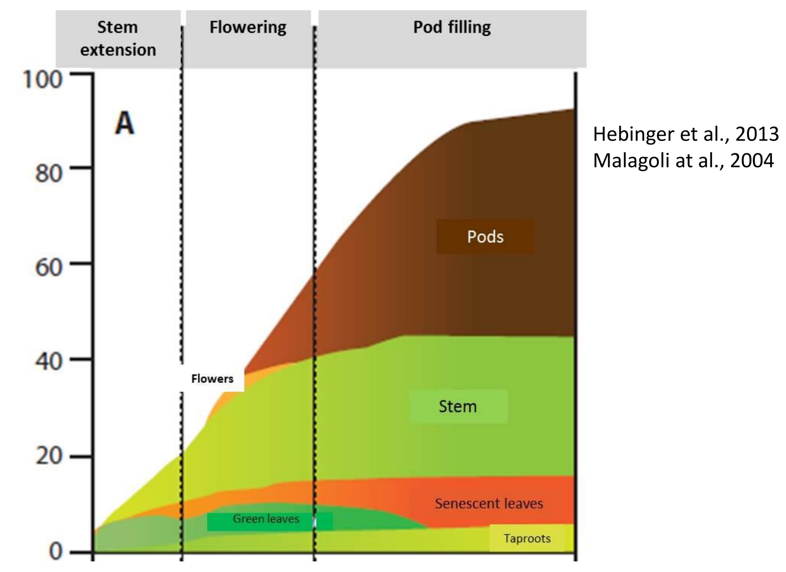
Data acquisition

- UAV (quadrotor and flying wing)

- Multispectral (MS) sensor : Parrot® Sequoia camera + Sunshine sensor for atmospheric calibrations
- Spatial resolution : 5 cm
- 4 spectral bands:

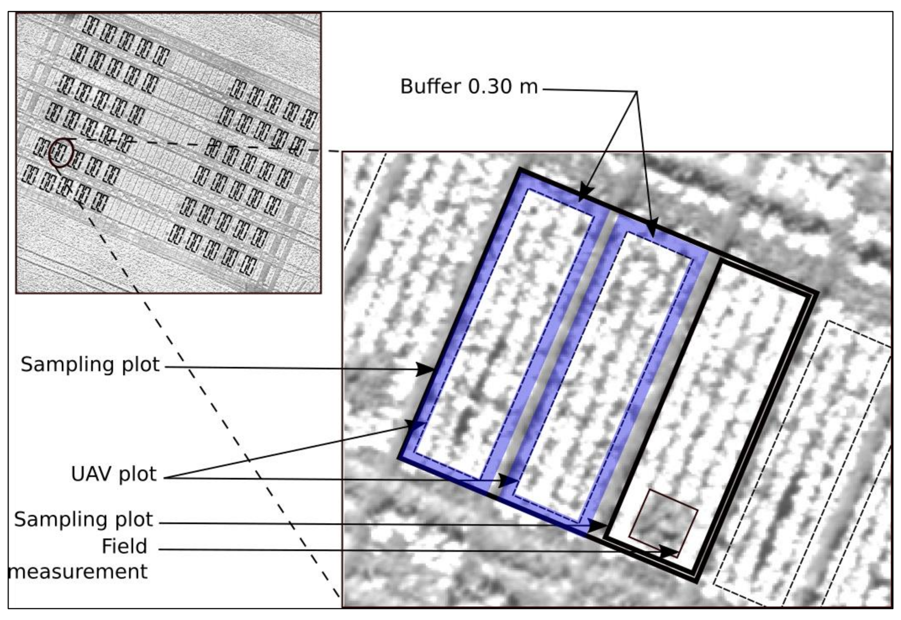


- 2 agronomic variables measured on 0.5-1 m^2 field samples :
  - GLAI : Green Leaf Area Index (planimeter)
  - Fresh Leaf Biomass ($g.m^{-2}$)



Time courses of biomass in rapeseed plants: green leaves present the most massive part until flowering

Data analysis



Extraction of image data for each plot (reflectance ortho-mosaic)

Summary of data-sets: field biomass/GLAI *vs* image VIs

	2014-2015	2016-2017	2017-2018
Rennes		3	3
Dijon	3	2	

- **7 VIs have been tested:**

$NDVI_{log}$: Normalized Difference Vegetation Index logarithmic

MCARI2 : Modified Chlorophyll Absorption Ration Index – Improved

MTVI : Modified Triangular Vegetation Index

NDVI : Normalized Difference Vegetation Index

CIredge : Chlorophyll Red edge

MCARI : Modified Chlorophyll Absorption Ration Index

NDRE : Normalized Difference Red Edge

- **2 selected indices (smallest RMSE)**

$$NDVI_{log} = \frac{\log\frac{1}{R_{790}} - \log\frac{1}{R_{660}}}{\log\frac{1}{R_{790}} + \log\frac{1}{R_{660}}}$$

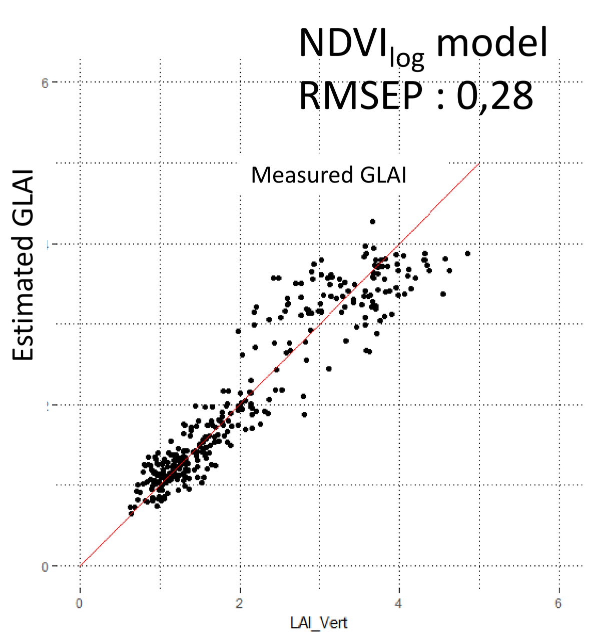
$$MCARI = [(R_{735} - R_{660}) - 0.2(R_{735} - R_{550})] * \frac{R_{735}}{R_{660}}$$

➔Regression between VIs and measured variables

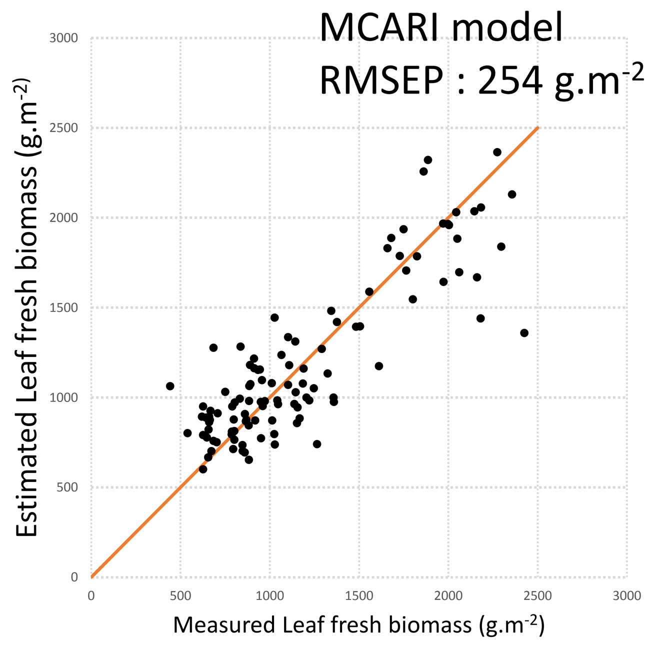
➔Cross validation (75% - 25 %)

Results

Estimation of GLAI and fresh biomass from VIs

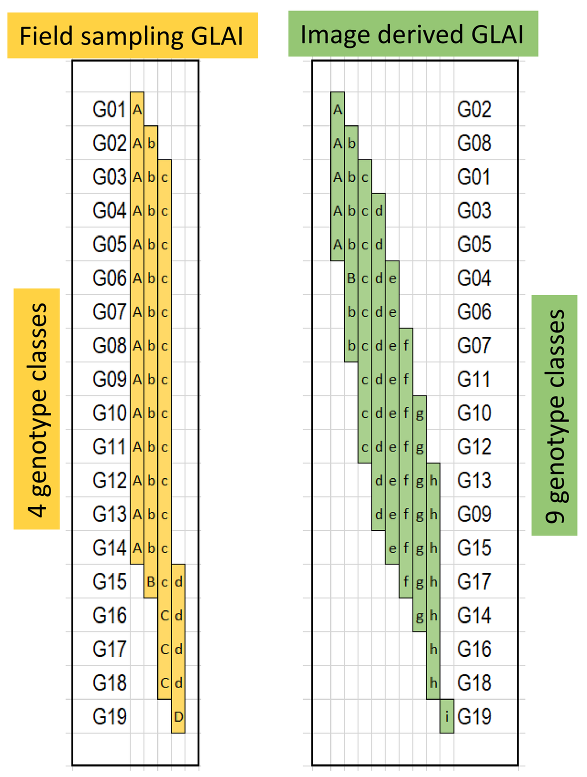


GLAI estimated according to the LAI measured with $NDVI_{log}$ model



Leaf fresh biomass estimated according to the biomass measured with MCARI model

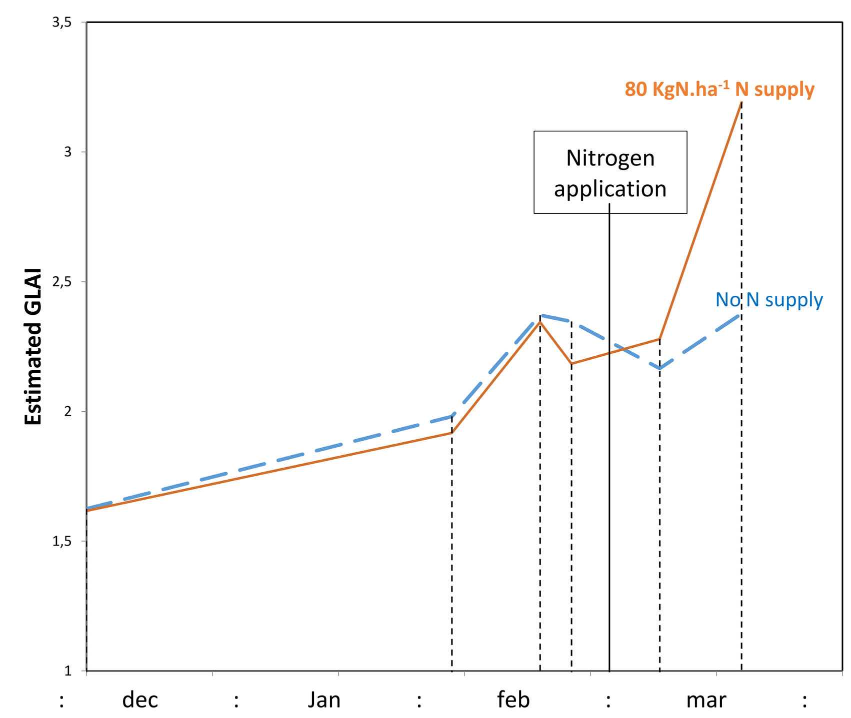
Classification



Classification of genotypes by Tukey test

Kinetics of GLAI

Example of a genotype before the flowering period: significant differences are observed depending on the nitrogen supply



Conclusion and perspectives

- Multispectral UAV images : High frequency data acquisition and synoptic view of whole trials BUT highly dependent on weather conditions
- Multi-sites and multi-years images (2 geographic sites, 3 observation campaigns, several genotypes, nitrogen supply and growing stages)

→ Better discrimination of genotypes than field samples, good estimation of two agronomic variables *(GLAI: RMSEP= 0.28 and Fresh biomass: RMSEP= 254 $g.m^{-2}$)*

Further work:

- New data analysis methods, such as multiple regressions and machine learning
- New data set to reassess model robustness and precision

This work has been partly funded by ANR (French National Agency for research) through PHENOME, RAPSODYN and PHENOL projects and supported by the PLANT2PRO® CARNOT INSTITUT. Both experiments were carried out in Experimental farms of French Agricultural Research Institute (INRA). We would like to thank the experimental teams of INRA and Terres Inovia for field works. We sincerely acknowledge P. Pichelin for operating UAV missions in Rennes and Agridrone/Airinov UAV image services.