Green Leaf Area Decline of the Last Three Leaves of Wheat. Determination of the Relationships with Remote Sensing Green Land Cover

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The proportion of green tissue is an important parameter of crop growth models (Bryson et al., 1997 ; Dimmock and Gooding, 2002 ; Bancal et al., 2007). That's why many attempts to estimate the percentage of green cover surface with remote sensing (RS) tools have been explored (Weiss, 2004). The remote sensing of vegetation includes various non-destructive methods from satellites to platforms in the field (Nilsson, 1995). Unlike the direct methods to estimate the proportion of green leaf area, the remote sensing is not too time and money consuming.
The use of short distance RS estimation methods involving in field platforms is an easy step to implement and allows the identification of a first relationship between a remote sensing method and a reference method of green leaf area estimation. In this field, White (2000) shows that the green coverage of soil obtained from the analysis of images taken at 2.8 m above the ground is statistically identical to that obtained from the analysis of images taken along a vertical transect ranging from 0 to 25m high in an arid ecosystem. The objective of this study is to assess the relationship that can be established between the green coverage of soil obtained from aerial photos taken a few meters above the ground and the green leaf area of the last three leaves of a winter wheat crop.

Methodology

The experiments were conducted in 2007 in experimental plots of winter wheat located in Everlange (Grand Duchy of Luxembourg). The green coverage of soil by the canopy was identified from images taken between 08/05/07 and 03/07/07. The images were taken perpendicular at 3m high above the ground with a Canon PowerShot A620 7.1 Mégapixels. The surface at the height of the canopy covered by the images was 1.10m x 1.40 m. The images were taken once a week on the basis of one photo per plot for each of the 4 replicated plots by variant and the 7 variants (7 variations of variety and fungicide treatment).The image analysis was performed using the software Assess (APS-Press) and Ccover-tool (Guissard, 2005). The results are expressed as a percentage of area covered by green pixels. The green leaf area percentage of the last three leaves was obtained using the leaf area and the green leaf area. The software Assess was used. All the last three leaves were photographed with a non-destructive method using a device allowing a shooting vertical and perpendicular to the leaf at the high of 39 cm. These images were taken 2 to 4 times per month, from the emergence of flag leaf and during 6 to 7 weeks.
A simple regression between the green leaf area percentage and the green soil cover percentage was tested. In a first analysis, all dates for which we have the green leaf area of the last three leaves and the green coverage of soil were used. Next, the same analysis was carried out, but taking into account data acquired at dates when only the last three leaves were still green. Statistical analyses were performed using the Statistica software.

Results

A simple linear model has been established between the green soil surface cover obtained with the two image analysis software and the green surface percentage of the last three leaves such as : "green surface percentage of the last three leaves" = a* "green soil cover" - b. Each model shows a high significance and a coefficient of determination at around 70% (Table 1).

Logiciel analyse d'images	a	b	R	p	RMSEv
ASSESS	1.618	44.727	0.736	0.00001	19.327
Ccover	1.724	15.818.	0.711	0.00001	20.251

Table1 : Statistical characteristics of both simple linear models produced between the percentage of green leaf area and green Cover percentage of soil.

A "Leave-one-out" cross-validation was carried out. The RMSEv (RMSE validation) between the predicted values for each stage of the "Leave-one-out" and observed values give an indication of the robustness of the models obtained (Table1). The RMSEv expressed as a percentage of error of the observed green surface of the last three leaves is predicted by respectively 27% and 28%. This indicates that this type of model can give the percentage of green surface of the last three leaves with a success rate of ~ 73%. If we study this time the relationship between the percentage of green area of the last three leaves and the green coverage percentage of soil using only the data obtained from a measurement date, and this for each measurement date, we get a simple linear relation as the previous ones with each software for each date (not shown). The correlation (R) of these relations is improving(R of 80%) from June 19 (pasty maturity). From this date green leaf area remains only in the last three leaves, except for one variety tested.

Conclusions

There is a linear relationship between the percentage of green soil cover obtained from the analysis of aerial photos and the percentage of green leaf area of winter wheat from the flag leaf emergence to the senescence of the last three leaves. This relationship shows a much better correlation when the number of leaves used (starting from the last appeared) for the percentage of green leaf surface is the number of leaves still green within the crop. The relationship obtained using all available data in the season presents a success of 73% and could most probably be improved with additional data. Improvements in the relationship can also be expected if the following factors are considered: The presence of wind, which increases the values of green soil cover. Second, light intensity which affects the classification of the images pixels. Third, taking into account the leaves that are still green beneath the last three leaves emerged. And Finally, a better discrimination of pixels very shady could afford to exclude these leaves.

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