A non-destructive method to assess changes in biomass of small-grain cereals under field conditions

Dolors Villegas[1], Javier Lozano[2] & Conxita Royo[1]

[1] IRTA (Institute for Food and Agricultural Research and Technology), Field Crops Program, 25198 Lleida, Spain.

[2] Universidad Autónoma Agraria Antonio Narro (Saltillo, Coahuila, Mexico)

Introduction

Destructive sampling for estimation of aboveground biomass is tedious and time-consuming, and reduces the area available for determining final grain yield in research plots. Vegetation indices based on spectral reflectance ratios have been proposed as a suitable method to assess biomass and leaf area index in wheat and to infer changes on growth traits during crop cycle (Royo and Villegas, 2011). The objective of this study was to estimate the curves of aboveground biomass accumulation through growth cycle of triticale and oats cultivars with contrasting biomass production, by using the reflectance spectra captured on crop canopies, and to compare the radiation use efficiency of the two species.

Material and Methods

Two field experiments, including triticale and oats respectively (Table 1), were conducted in Lleida (northeastern Spain) in 2011, under sprinkler irrigation with a total water input of 410 mm (Fig. 1). Each experiment included 30 cultivars and was arranged as randomized complete block design with 3 blocks, and plots of 8.4 m^2 . Biomass production (CDW, crop dry weight) was determined on a plot basis by harvesting the aboveground biomass of the whole plot at the early dough stage of grains. Reflectance spectra were captured five times on each plot at different growth stages, using a FieldSpec UV/VNIR spectroradiometer. The normalized difference vegetation index (NDVI) was calculated from the spectra obtained, according to Peñuelas *et al*. (1993). Daily values of CDW were estimated following Kumar and Monteith (1981). Analyses of variance (ANOVA) were performed independently for each experiment and means were compared according to the Duncan's multiple range test at P=0.05.

Fig. 1. Temperature and water input during the experiments.

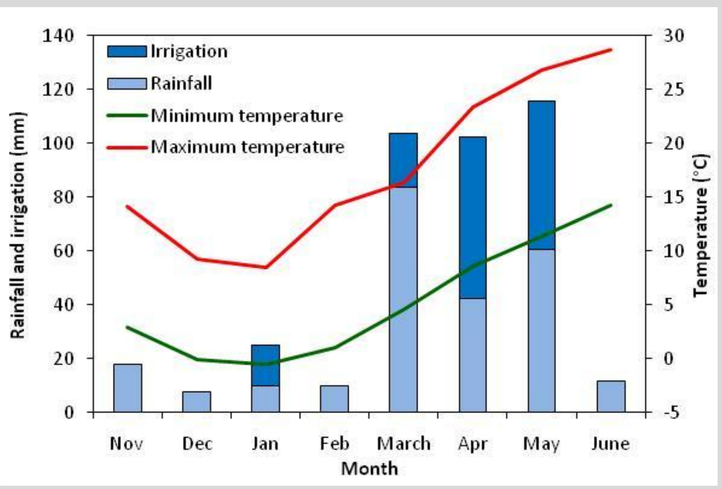


Table 1. Experimental details.

Species	Seed rate (seeds m^{-2})	Sowing date	Harvest date
Triticale	500	28/11/2010	09/06/2011
Oats	450	28/11/2010	15/06/2011

Results and Discussion

Biomass production

Differences in CDW between species were not statistically significant (P<0.05). Triticale cultivars differed in CDW. Average CDW across genotypes was 19,058 kg ha^{-1} (from 16,400 to 21,357 kg ha^{-1}). The cultivar most productive was 'Algoso' and 'Montijano' the least productive. Biomass production of oats ranged from 10,700 kg DM ha^{-1} to 21,007 kg DM ha^{-1} with a mean yield across cultivars of 16,306 kg DM ha^{-1}. The cultivar most productive was 'CHD2316/03' and 'B.I. Maja', the least productive.

Pattern of reflectance spectra

The reflectance spectra of cultivars with high and low biomass production at the early dough stage were compared at different growth stages. Fig. 2 shows differences between species and cultivars. Biomass increased from 3rd node detectable to heading in the most productive triticale, but in the most productive oats the peak of biomass coincided with anthesis.

Estimation of changes in CDW

Triticale and oats cultivars with the highest biomass production showed similar growth curves according with their similar CDW at dough stage (Fig. 3). The curves also reflected differences in final CDW between cultivars of both species.

Fig. 3. Estimation of crop growth curves derived from the NDVI values collected throughout the season.

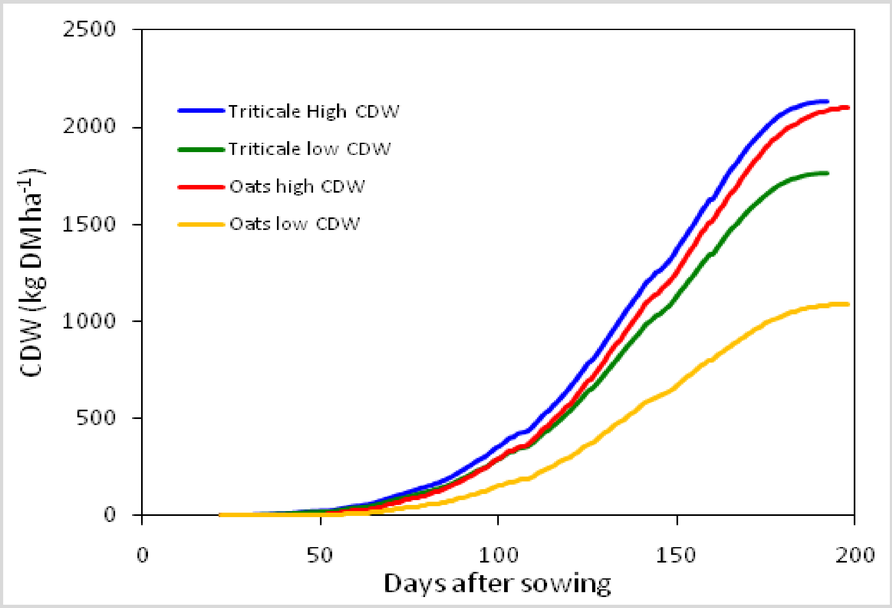
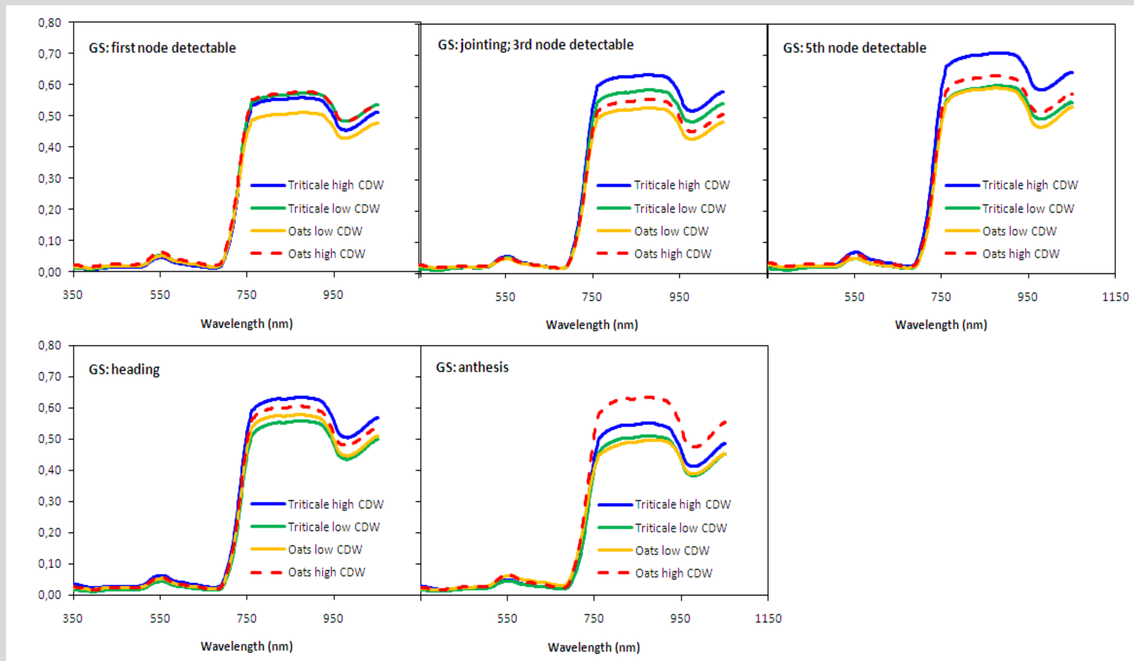


Fig. 2. Reflectance spectra at different growth stages (GS) of triticale and oats cultivars with contrasting biomass production at dough stage. Curves are means of three plots.



Radiation use efficiency (RUE)

The results of the ANOVA for RUE showed significant differences between triticale and oats, and also differences between cultivars within each species. On average, triticale had significantly higher RUE than oats, but the diversity within species was greater in oats than in triticale (Table 2).

Table 2. RUE values ± SD for oats and triticale

RUE (g/MJ)	Triticale	Oats
Mean	2.288 ± 0.143	1.937 ± 0.367
Maximum	2.548	2.478
Minimum	2.024	1.289

References

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Royo C, Villegas D. 2011. In: *Biomass detection, production and usage*. Matovic, D. (ed.). Ed. Intech. Croatia. Pp. 27-52. Available at: http://www.intechopen.com/articles/show/title/field-measurements-of-canopy-spectra-for-biomass-assessment-of-small-grain-cereals

Acknowledgements

This study was conducted within the framework of projects Triti-Mass (Spanish Plan E), AGL2012-37217 and RTA2012-00011. A. J. Lozano is recipient of a grant from CONACYT-México for a sabbatical leave.