Non-destructive Assessment of Quality and Yield for Grass-Breeding

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Non-destructive assessment of quality and yield for grass-breeding

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Introduction Selection of cultivars has, until now, been based mainly on dry matter (DM) yields because of the high costs of sampling and chemical analysis. Imaging spectroscopy could reduce costs by limiting sampling and harvesting of individual plots to reference samples (Schut *et al*., accepted). In this study, the prediction accuracy of DM yields and chemical composition with imaging spectroscopy is evaluated for cultivar selection purposes.

Materials and methods A total of 13 experiments for cultivar selection were used with 6 experiments in Rilland, 3 experiments in Moerstraten (The Netherlands) and 4 experiments in Aberystwyth (Wales, UK). There were 3 and 4 replicates in experiments in the Netherlands and Wales respectively. Plot sizes varied from 3-5 m^2. From these experiments, the July harvest in Rilland and the July and September harvests in Moerstraten and Aberystwyth were used. The Imspector Mobile was used to record 2D images and hyper-spectral image-lines (Molema *et al*., 2003). This instrument combines a high spatial (1mm^2) and high spectral (9-13nm) resolution with a wavelength range from 450-1680nm. Images were analysed and ground coverage and reflectance spectra of grass leaves were calculated. After screening of the spectra and laboratory data, calibration models were built, with a leave-n-out partial least squares procedure. The root mean squared errors of cross validation were calculated with observations excluded from the calibration set. Q^2 values can be interpreted as the fraction of variation explained by the model. After recording 8-12 images per sensor on each plot, plots were harvested with a Haldrup and samples were taken for laboratory analysis. Samples taken in Wales were gravimetrically and chemically analysed for DM content and for concentrations of water soluble carbohydrate (sugars) and N. The samples taken in the Netherlands were analysed with Near Infrared Spectroscopy for crude protein (CP), total sugars and acid detergent fibre (ADF).

Results In Table 1 prediction results are presented. The statistical models explained a large amount of variation (Q^2 values between 0.55 and 0.91). Q^2 values in the Moerstraten experiments were slightly lower than in the Rilland or Aberystwyth experiments, partly due to limited variation. Relative errors were below 10% for all variables, except for DM yield in Aberystwyth.

Table 1 Mean Q^2 values, root mean squared error of cross validation (SECV) and relative error (RE, calculated as SECV / mean) per harvest, averaged over replicates.

Variable / Location	Rilland (N=130)			Moerstraten (N=214)			Aberystwyth (N=68)		
	Q^2	SECV	RE, %	Q^2	SECV	RE, %	Q^2	SECV	RE, %
DM yield (kg DM/ha)	0.93	146	6.7	0.69	166	7.2	0.86	111	11.5
DM content (%)	0.76	0.94	3.7	0.76	0.79	3.7	0.76	0.94	7.5
CP (g/kg DM)	0.91	8.43	5.5	0.55	6.10	3.9	*	*	*
Sugars (g/kg DM)	0.88	12.1	6.3	0.89	11.1	7.3	*	*	*
ADF (g/kg DM)	0.81	10.1	5.9	0.90	11.4	5.2	-	-	-

*Results of laboratory analysis not yet available.

Conclusions Currently, breeding and evaluation of forage grasses is expensive, largely because of the high costs of sampling for dry matter and chemical analysis of several cuts each year. Imaging spectroscopy may provide a cheaper and much faster means to measure chemical composition and dry matter yield. This study shows that DM yield and CP, sugar and ADF content of ryegrasses can be measured accurately with imaging spectroscopy and confirms results of earlier work (Schut *et al*., accepted). Imaging spectroscopy is a very promising method for selecting candidate varieties based on the productivity and quality of herbage.

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