Assessment of Botanical Composition of Cool-Season Pastures via Near-infrared Reflectance Spectroscopy

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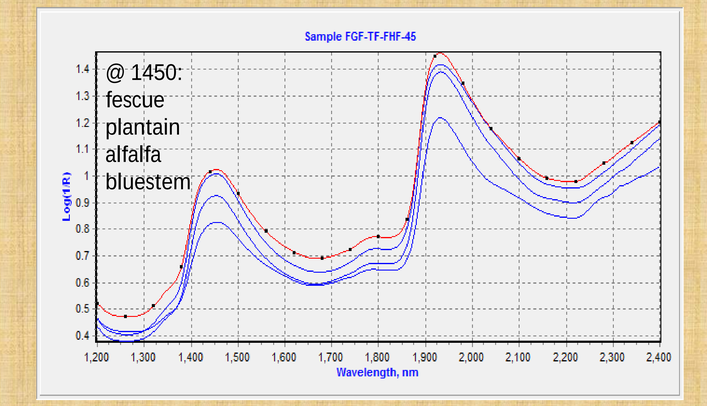
Introduction and objectives. Botanical composition varies within pastures under fluctuating environmental and management conditions. Knowledge of grass and forb (herbaceous broadleaf plant) proportions can support nutrient and grazing management planning and prediction of grassland and animal performance. Proportions of species or functional groups in sample dry matter (DM) can be determined via visual estimation; clipping, sorting, and weighing; and laboratory chemical and spectral analyses. Field spectroscopy may offer an effective means of assessing *in situ* pasture botanical composition. Results from laboratory-based near-infrared reflectance spectroscopy (NIRS) analysis of botanical composition of fresh samples may reflect the potential for *in situ* determinations via field spectroscopy. Our objective was to evaluate the accuracy of NIRS analysis of botanical composition of clipped samples from mixed pastures, relative to independent validation samples of known composition.

Methods. Spectra (1200-2400 nm wavelength) of i) fresh, coarsely-chopped (0.2-0.3 [DM], 2-5 cm particles); and ii) dried, ground (60° C, 1-mm particles) samples were obtained from 12 species encompassing C_3 and C_4 perennial grasses, legumes, and non-leguminous forbs from a range of environmental conditions and growth stages in northern West Virginia. Genera included *Andropogon, Dactylis, Digitaria, Holcus, Medicago, Panicum, Plantago, Poa, Rumex, Schedonorus, and Trifolium*. Chemometrics software (Ucal 2.0, Unity Scientific, LLC, Brookfield, CT) was used for end-point calibration (modified partial least squares regression, math treatment 1, 8, 8) of botanical composition of pure samples of each species (compositional values were 0.01 or 99.9 g/100 g DM). Prediction equations for species classes (Table 1) were applied to mixed fresh/coarse and dried/ground validation samples with known proportions.

Results. Equation development was successful for all botanical classes, with greater precision for dried/ground than for fresh/coarse forms (Table 1). Precision of estimation was lower for C_3 and C_4 grasses than for other components, but was similar among fresh and dried forms. Performance of equations on validation samples was highly variable, with low precision for many classes of fresh samples, but acceptable precision for many classes of dried/ground samples. Results suggest limitations to applications of field spectroscopy to *in situ* assessment of botanical composition of fresh materials.

Figure 1. Form, handling, and instrumentation for fresh, coarsely-chopped samples.

Figure 2. Typical botanical composition of mixed cool-season grassland.



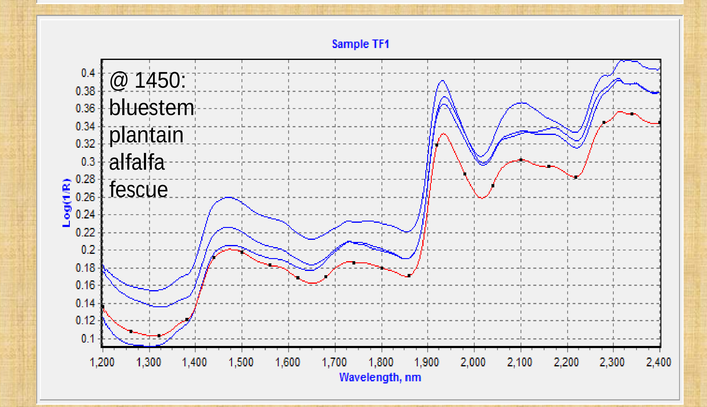


Figure 3. Absorbance spectra for alfalfa, big bluestem, buckhorn plantain, and tall fescue in fresh/coarse (above) and dried/ground (below) forms. Species are indicated in decreasing order of absorbance at 1450 nm.

Table 1. Performance of prediction equations for botanical composition of samples in fresh/coarse and dried/ground forms. Validation sets contained 9 and 20 mixtures with components ranging from 10-90 and 2-50 g/100 g DM, respectively, for fresh and dried forms. SECV=standard error of cross-validation, SEP=standard error of prediction.

	Calibration			Validation	
Species class and components	n	SECV	r^2	SEP	r^2
		g/100 g DM		g/100 g DM	
Fresh grass (2 C_3 + 2 C_4)	544	8.8	0.97	15.2	0.71
Fresh C_3 grass (orchardgrass + tall fescue)	550	11.3	0.93	77.1	0.04
Fresh C_4 grass (big bluestem + crabgrass)	551	12.8	0.91	74.6	0.17
Fresh forb (2 legumes + 2 non-legumes)	544	8.8	0.97	15.2	0.71
Fresh legume (alfalfa + red clover)	539	10.3	0.94	31.9	0.63
Fresh non-legume forb (2 plantain spp.)	544	9.5	0.95	41.0	0.13
Dry grass (as above)	677	4.4	0.99	7.4	0.80
Dry C_3 grass (as above)	676	10.2	0.94	12.5	0.53
Dry C_4 grass (as above)	677	10.0	0.94	9.5	0.47
Dry forb (as above)	677	4.4	0.99	7.4	0.80
Dry legume (as above)	666	5.3	0.98	8.7	0.69
Dry non-legume forb (as above)	676	5.3	0.98	7.0	0.81