Predicting mixed stand alfalfa fibre content in New York State

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Abstract

In New York State, most alfalfa (Medicago sativa L.) is grown in mixed stands with grass. The aim of this study was to test the suitability of existing equations for estimating neutral detergent fibre (NDF) of the alfalfa component of mixed stands. Stands of first-cut alfalfa and grass were sampled at two experimental sites and producers’ fields in 19 New York counties during May and June, 2004 and 2005. A range of plant measurements and environmental characteristics were recorded. The applicability of the predictive equations for alfalfa quality (PEAQ) and other models to mixed stand alfalfa NDF estimation was examined. The \( R^2 \) values ranged from 0.80 to 0.87 and RMSE ranged from 20.5 to 25.2 g kg\(^{-1}\). The most biased model was PEAQ, possibly due to the lower cutting height used to generate the PEAQ equation than the cutting height used in this study. Presence of grass did not change the relationship between alfalfa height and NDF, suggesting that the predictive ability of models based on alfalfa height is not affected by the fraction of grass in the sward.

Key Words

Alfalfa, grass, neutral detergent fibre, forages, PEAQ.

Introduction

Although most of the alfalfa in the USA is grown in pure stands, this is not the case in the northeastern USA. In New York State it is estimated that over 80% of the alfalfa land area is seeded with mixtures of alfalfa and grasses (Cherney et al., 2006). Timing of spring forage harvest should be based on NDF (Cherney et al., 2006) and estimation methods for use as a harvest decision aid must be quick, simple, and reasonably accurate. Parsons et al. (2006b) suggested models for estimating total sward NDF of mixed stands, based primarily on alfalfa height and the percentage of grass in the stand. The predictive equations for alfalfa quality (PEAQ) have been tested and recommended for use only with pure stands of alfalfa that contain no grass or weeds (Sulc et al., 1997). Because the equations rely on alfalfa height, if other plants in the sward affect alfalfa height, then the validity of the models is uncertain. As a result, equations for estimation of alfalfa NDF have not been used to estimate the NDF of the alfalfa component of mixed stands. The objective of this study was to test existing alfalfa NDF models for their ability to estimate alfalfa NDF in mixed stands.

Methods

Field Study

Alfalfa-grass mixed stands were sampled in the spring at two experimental sites and 150 producers’ fields in 19 New York counties during May and June 2004 and 2005, as described in Parsons et al. (2006b). Stands were sampled when alfalfa height reached or exceeded 30 cm and a range of plant measurements and environmental characteristics were recorded. A total of 899 samples were collected, separated into alfalfa and grass fractions, oven dried at 60°C, and the percentage of grass in the sample was calculated. Samples were ground to pass through a 1-mm screen and analysed for NDF concentration using the ANKOM (Macedon, NY) fibre analyser with filter bags.

Statistical Analysis

Model validation was performed by regressing actual NDF values on the predicted values. The equations used were the original PEAQ equation (Hintz and Albrecht, 1991), an equation developed by Cherney
and Sulc (1997) based solely on alfalfa height (NYPQ), an equation developed by Parsons et al. (2006a) based solely on alfalfa height (NYHT), and an equation developed by Parsons et al. (2006a) based on alfalfa height and growing degree days (NYGD). The partitioning of mean squared deviation (MSD) into the components of squared bias (SB), nonunity slope (NU), and lack of correlation (LC) was performed to provide further insight into model performance (Gauch et al., 2003). The three components have distinct meanings and simple geometric interpretation, with SB relating to translation, NU relating to rotation, and LC relating to scatter.

Results

The range of values for $R^2$ (0.80 to 0.87) and RMSE (20.5 to 25.2 g kg$^{-1}$) are of comparable magnitude to the PEAQ equations of Hintz and Albrecht (1991). All models had slopes significantly different than 1 and intercepts significantly different from 0, however with the large number of samples this is unsurprising. Figure 1 shows the partitioning of MSD, which helps to clarify the relative strengths and weaknesses of the models. For all models LC is the largest component of MSD. The most striking difference between the models was the high SB value for PEAQ compared with the other models. Figure 2 shows that the PEAQ model appears the most biased in terms of slope and intercept. It is evident that PEAQ deviates from a 1:1 prediction of NDF, particularly at lower values of NDF. The PEAQ equation was developed based on a cutting height of 3.8 cm, compared with 10 cm in this study. Shorter cutting heights would include material of greater NDF near the base of the plant; however, the effect of this extra 6.2 cm would be diluted with increasing plant height. This could account for the observed overestimation of NDF at shorter cutting heights. The other models examined (NYPQ, NYHT, and NYGD) showed less bias than the PEAQ equation, suggesting that these three models adequately estimate the NDF of the alfalfa component of mixed stands.

Conclusion

Existing models for pure-sown alfalfa NDF can be used to estimate the alfalfa component of mixed stands. This is significant for producers in New York and other locations where mixed stands are common. Although equations exist to estimate the total NDF of mixed stands (Parsons et al., 2006b) this finding is still pertinent. Previously, producers have been advised against using the PEAQ equation in fields where alfalfa may be dominant but a small amount of grass is present. PEAQ was originally

Figure 1. Components of mean squared deviation (MSD) of regression models used to estimate the NDF of the alfalfa component of mixed stands.

Figure 2. Comparison of regression models used to estimate the NDF of the alfalfa component of mixed stands.
calibrated and only advocated for pure stands of alfalfa cut at a 3.5-cm stubble height. An issue the results raise is the bias of PEAQ when it is used for alfalfa not cut at this height. In reality, producers cut at varying stubble heights, based on such factors as available machinery and stoniness of the field. Adjusting PEAQ (and other equations) for expected cutting height could help reduce the potential for biased NDF estimates.

References


