Evaluation of methods for estimating winter rye cover crop biomass production

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INTRODUCTION

Winter rye (*Secale cereale* L.) is often used as a cover crop between row crops in the Midwest. However, rye cover crop (RCC) biomass dry matter (DM) production during winter is typically minimal in the upper Midwest. Plant growth is driven by cumulative temperatures, with growth beginning at a base temperature (BT) (Karow *et al.*, 1993). Hence, temperature (growing degree days, GDD) can be used to estimate plant growth (Klepper *et al.*, 1988) and can reflect year to year variations in temperature. A simple approach for predicting RCC DM production could be to use only the number of days (NOD) with an average temperature above BT. Excluding days when the average temperature is above BT during the winter period could also help improve RCC DM production prediction. The objective was to estimate RCC DM production at the time of control in the spring using cumulative GDD and NOD.

MATERIALS AND METHODS

Rye cover crop biomass was sampled following corn (FC) (*Zea mays* L.) and following soybean (FS) [*Glycine max.* (L.) Merr.] in a corn-soybean rotation; with five sites in Iowa, four in 2010 - 2013 and one in 2012 - 2013.

- ✓ RCC seeding dates were between Sept. 17 and Oct. 28 when FC, and between Sept. 19 and Oct. 20 when FS.
- ✓ RCC biomass sampling dates at time of RCC control were between Apr. 23 and May 16 when FC, and between Apr. 06 and Apr. 29 when FS.
- ✓ RCC biomass sampling was by the prior-year N rate (0, 135, and 225 kg N ha^{-1}; hereafter 0N, 135N, and 225N) when FC, and by replicate when FS.
- ✓ Temperatures at 0 and 4 °C were evaluated as BTs for calculating cumulative GDD and determination of NOD.
- ✓ GDD = (Max. temperature + min. temperature)/2 - BT.
- ✓ Cumulative GDD and NOD were determined with and without including days when the average temperature was above BT during the winter period.
- ✓ The approach for deciding when to stop including days in the fall, and to re-start in the spring, was based on having at least two consecutive days (first time in the fall and last time in the spring) with average air temperature below freezing (0 °C) for both BTs (Fig. 1).

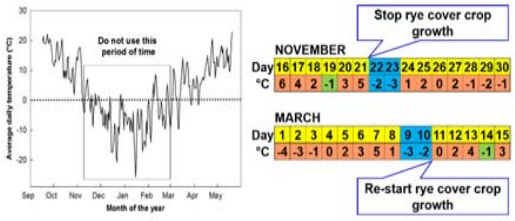
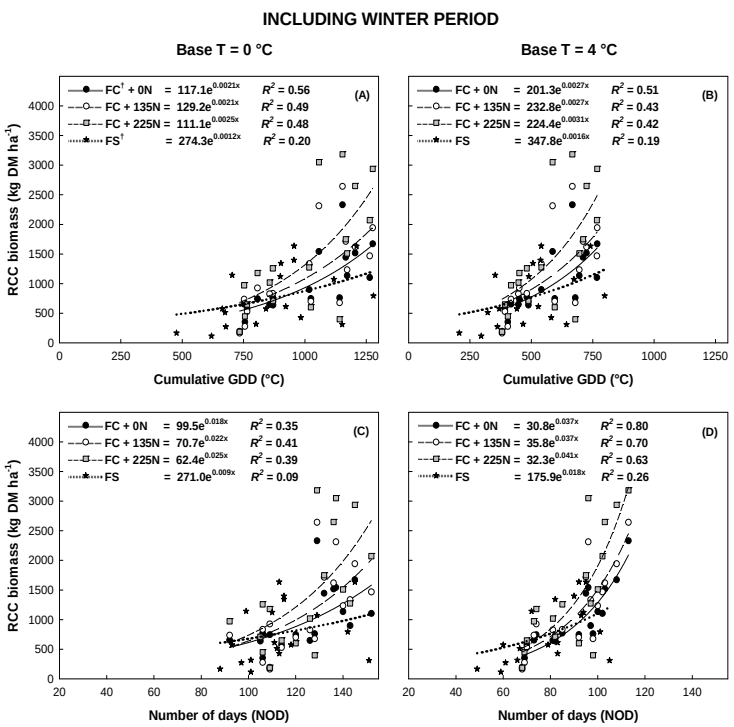
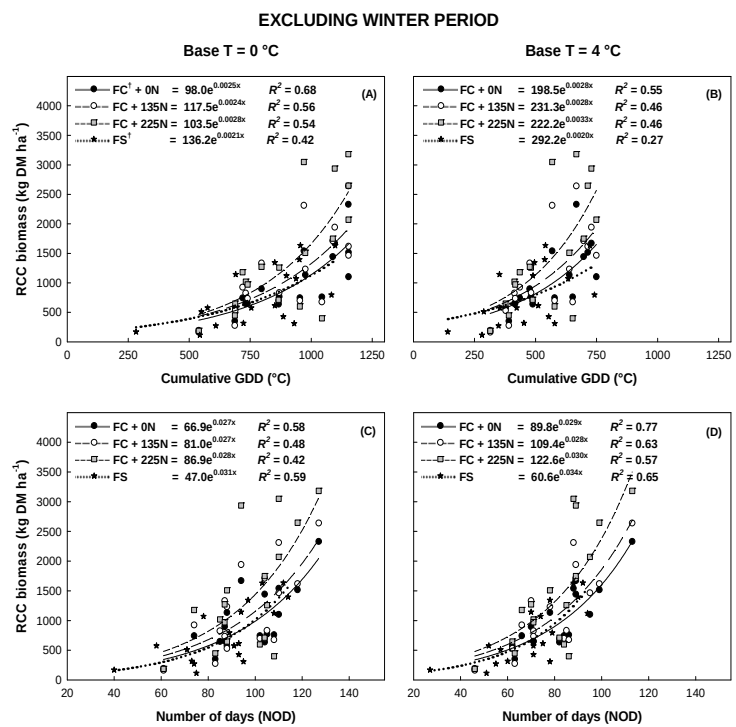


Fig. 1. Example of the approach for not using days with average temperature above the base temperature (BT) during the winter period when calculating growing degree days (GDD) and determining the number of days (NOD) for rye cover crop (RCC) biomass dry matter (DM) production.



† FC, following corn; FS, following soybean.

Fig. 2. Rye cover crop (RCC) biomass dry matter (DM) production with 0 and 4 °C as base temperature (BT) from RCC seeding to control, and including the winter period. Graphs were developed using cumulative growing degree days (GDD) (A and B), and number of days (NOD) (C and D).



† FC, following corn; FS, following soybean.

Fig. 3. Rye cover crop (RCC) biomass dry matter (DM) production with 0 and 4 °C as base temperature (BT) from RCC seeding to control, and excluding the winter period. Graphs were developed using cumulative growing degree days (GDD) (A and B), and number of days (NOD) (C and D).

RESULTS AND DISCUSSION

An exponential model fit the RCC biomass DM production when using cumulative GDD and NOD ($P < 0.10$). Longer spring periods of RCC growth increased RCC DM production with FC and FS. Prior-year N rates applied to corn resulted in differences in DM production, with differences increasing with longer growth periods, such as occurred with delayed control due to wet soil conditions. When including (Fig. 2) or excluding (Fig. 3) the winter period, model fits for predicting RCC DM were reduced when using a BT of 4 °C instead of 0 °C with GDD, but improved with NOD. For most measurements, the NOD better estimated RCC DM production than cumulative GDD. This improvement was greatest when using a BT of 4 °C. Improvements in model fit occurred when using a BT of 4 °C instead of 0 °C for NOD, but not for GDD. This indicates little, if any, RCC DM production occurred below 4 °C. Excluding the winter period resulted in better RCC DM estimation with cumulative GDD and NOD. The NOD method could be a more reliable approach for estimating RCC DM production than using GDD.

CONCLUSIONS

An increase in RCC DM was observed when the spring growth period was extended with FC and FS, and with increasing prior-year N rate when FC. Results show:

- ✓ Improvement in model fits when using 4 °C as BT instead of 0 °C for NOD, but not for cumulative GDD.
- ✓ Exclusion of the winter period increased model fits for predicting RCC DM production.
- ✓ NOD provided a better estimation of RCC DM production than cumulative GDD.
- ✓ The NOD method could be a more reliable approach for estimating RCC DM production than GDD.

REFERENCES

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