Yield and N Uptake of Strip-Intercropped, Rotated Corn in a Ridge-Tillage System

T.K. Iragavarapu, G.W. Randall and M.P. Russelle

Introduction

Strip-intercropping, a practice in which two or more crops are grown simultaneously in contiguous narrow strips, is gaining popularity across the USA. In the Midwest, where continuous corn (*Zea mays* L.) and annual corn-soybean [*Glycine max* (L.) Merr.] rotations predominate, strip-intercropping with an additional small grain crop such as wheat (*Triticum aestivum* L.) provides diversity in both time and space and often improves overall system productivity. Strip-intercropping using a combination of reduced tillage and high levels of surface residue provided by the small grain also should reduce soil losses due to wind and water erosion compared to traditional practices. Ridge tillage may be well adapted to strip-intercropping because crops can be planted in the same rows year after year.

Planting legumes such as alfalfa (*Medicago sativa* L.) or hairy vetch (*Vicia villosa* Roth) either in or after small grains has increased yields and reduced the need for fertilizer N in the subsequent corn crop but is most successful where the autumn growing season is long. There are few reports of the fertilizer N requirement of corn when seeded after legume cover crops in reduced tillage systems in the Midwest and also little information on N requirements of corn in ridge tillage systems. Our objective was to provide such information on a soil common to much of the northern Corn Belt.

Materials and Methods

Field studies were conducted from 1991 through 1994 at Waseca and Freeborn in southern Minnesota on Webster clay loam soils (Typic Haplaquoll) on sites that produced soybean in 1990. Cropping sequences included continuous corn, soybean-corn, soybean-wheat-corn, soybean-wheat/hairy vetch-corn, and soybean-wheat/alfalfa-corn. Hairy vetch was seeded immediately after wheat harvest, whereas alfalfa was companion seeded with wheat. Legume seeds were inoculated with appropriate rhizobia. Sufficient plots were included in the four replicates so each phase of each rotation was present each year of the experiment. Strips of each crop were 4.6-m wide and 36.6-m long, except for continuous corn, which was grown in 9.2-m-wide strips.

Aboveground legume dry matter and N content were determined after the first killing frost each year. Every rotated corn plot was subdivided into four 9.1-m-long plots that received broadcast ammonium nitrate at 0, 45, 90, or 135 kg N/ha, and eight N rates were added to continuous corn plots (0 to 238 kg N/ha). Both grain and stover yields were determined after physiological maturity. Subsamples were analyzed for total N concentration. All data were subjected to either ANOVA (split plot arrangement in a randomized complete block design) or regression analyses.

Results and Discussion

Hairy vetch produced more aboveground dry matter and N than alfalfa in all cases except one site/year, but in no case was herbage N yield greater than 57 kg N/ha. These results are comparable to those for frost-seeded alfalfa into winter wheat in Michigan and for hairy vetch planted in a ridge-till system in Iowa in September, but smaller than N accumulations under milder autumn weather conditions.

Corn grain yield (Fig. 1) and aboveground N uptake (which paralleled yield) were lower in most treatments at the Freeborn site than at Waseca, probably because the former is imperfectly drained, whereas Waseca has parallel drainage tiles. Corn planting was delayed at Freeborn by several days in two of the years because of wet soil. At Freeborn, continuous corn grain yields and N uptake usually were smaller than corn grown after other crops; the soybean-corn rotation provided best yields in two of three years. In contrast, corn grain yields and N uptake generally were similar among rotations at Waseca, with the exception that they were lower following wheat alone in two of three years.

Differences among rotations at Freeborn cannot be explained by N availability because cropping systems generally had similar responses to added fertilizer N. Therefore, differences must be due to some non-N related rotation effects, such as autotoxicity from decomposing plant residues, that affected plant growth

potential. Lack of response to the legumes at Freeborn contrasted with a positive effect at Waseca (relative to wheat alone), but the absence of larger responses was not surprising, given the small N accumulation in legume herbage. When legumes regrew after the mild winter of 1991-1992, they probably competed with corn for limited water and other resources, so corn yield was depressed by 1.5 Mg/ha following wheat plus alfalfa or hairy vetch at Freeborn. Effective control of interseeded legumes may require well timed use of herbicides under ridge-till conditions.

The similarity of corn response to applied N suggests that the cropping sequences did not differ in N use efficiency at fertilizer rates from 0 to 135 kg N/ha. However, it appears that higher rates would have been required to attain maximum yields in rotated corn, based on the substantial yield response to the final 45 kg N/ha increment. Continuous corn required 123, 207, and 199 kg N/ha to maximize grain yield at Waseca in the three years, which indicates that University of Minnesota recommendations for N (125 kg N/ha regardless of tillage regime) may be insufficient for ridge-till.

Summary

Based on these results, we do not recommend inclusion of alfalfa or hairy vetch with wheat as a consistent source of N for subsequent ridge-tilled corn. With excellent management and perhaps slightly higher fertilizer N rates, including wheat in strip-intercrops may produce corn yields that are competitive with those in the conventional soybean-corn rotation. Other benefits may also accrue, such as improved soil protection from erosion and lower pest activity due to increased crop diversity in strip-intercrops.

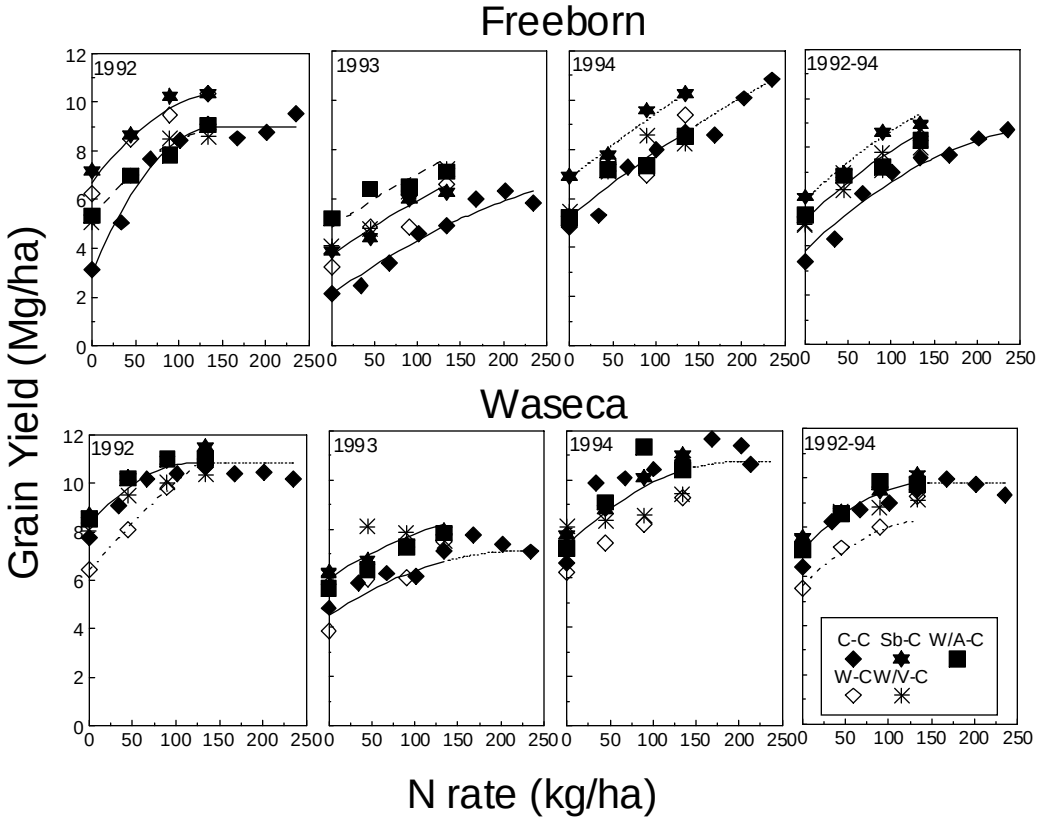

Figure 1. Grain yield (155 g/kg water content) of corn following corn (C-C), soybean (Sb-C), wheat alone (W-C), wheat/alfalfa (W/A-C), or wheat/hairy vetch (W/V-C) at Freeborn and Waseca, MN. Solid lines are for continuous corn and also when intercept and slope coefficients were identical for more than one cropping system.