Effects of Reduced Tillage and Split Fertilizer Application in Organic Broccoli and Pepper Production Systems

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Dana Jokela, graduate student
Ajay Nair, assistant professor
Department of Horticulture

Introduction

The use of tillage is widespread in organic vegetable production, due to its importance for cover crop incorporation, seedbed preparation, and weed control. However, its harmful effects on soil health have spurred interest in systems that reduce the need for tillage. Because nitrogen is often limiting under high residue/reduced tillage conditions, fertilizer management is considered key to crop productivity. This two-year study is being conducted to evaluate the effects of cover crop-based no tillage and strip tillage systems, as well as split fertilizer application, on yields and nitrate leaching in organic broccoli and pepper production systems.

Materials and Methods

Field plots were established at the ISU Horticulture Research Station, Ames, Iowa, on Clarion loam and Nicollet clay-loam soils. A cereal rye-hairy vetch cover crop mixture was drilled in all plots on September 12, 2013 at a rate of 90 lb/acre for cereal rye and 25 lb/acre for hairy vetch. Strips were tilled in strip-till plots on November 14 using a Hiniker 6000 strip tiller. In conventional-till plots, the cover crop was mowed and tilled in mid-May and then rotovated just before transplanting. The cover crop in no-till and strip-till plots was roller-crimped on June 3, when rye was at anthesis. Strips were re-tilled in strip-till plots and a narrow band of soil was loosened in no-till plots just before transplanting on June 11. Dehydrated poultry manure fertilizer was banded at this time at a rate of 150 lb N/acre for broccoli and 80 lb N/acre for pepper. Split fertilizer subplots received only a 2/3 rate of the preplant fertilizer.

Pepper and broccoli plugs were transplanted in rows 30 in. apart with in-row spacing of 12 and 18 in. for broccoli and pepper, respectively. Split fertilizer treatment rows were fertigated with liquid fish fertilizer to provide the remaining 1/3 of N.

Nitrate leaching was measured using lysimeters installed to 24 in. depth and sampled weekly during early season and biweekly during late season. Broccoli and green bell peppers were harvested and graded according to USDA Standards for Grades.

Results and Discussion

Pepper yield. Yields were equal among conventional-till, strip-till, and no-till treatments ($P < 0.05$). The preplant only fertilizer treatment tended to produce slightly higher yields than split fertilizer, though differences were not statistically significant (Table 1).

Broccoli yield. Conventional-till produced yields higher than strip-till, but equal to no-till using preplant fertilizer only. The effect of the fertility treatment varied with tillage system. The only significant effect was the preplant-only fertilizer treatment yielding more than split application in no-till (Table 1).

Nitrate leaching. Conventional-till using split fertilizer application resulted in more nitrate leaching than all other treatments, with twice the nitrate levels of no-till and strip-till using split application and 40–70 percent more than all preplant only treatments. Differences between treatments were greatest during June

and July, decreasing later in the season (Figure 1).

Based on the first year's results, no-till and strip-till seem to be good alternatives to conventional-till in pepper production. However, no-till and strip-till generally reduced broccoli yield. One potentially confounding factor in broccoli plots was the presence of the fungal disease Fusarium yellows. It developed after three weeks of waterlogged conditions in June. The slow decline of plants throughout the season likely favored the earlier-maturing conventional-till treatments.

No-till and strip-till systems, which maintain rolled cover crop residue between rows, were effective in reducing nitrate leaching. This indicates such practices may play a valuable role in reducing nitrate contamination of ground water.

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Table 1. Marketable yield (kg ha^{-1}) of pepper and broccoli under different tillage systems and fertility regimes.[1]

Treatment	Pepper	Broccoli
Conventional tillage		
Preplant only	20,238 a	7,016 a
Split application	15,648 ab	6,729 ab
Strip tillage		
Preplant only	18,934 ab	4,264 c
Split application	14,279 b	5,073 bc
No tillage		
Preplant only	17,630 ab	6,650 ab
Split application	14, 279 b	4,720 c

[1]Values in each column containing the same letter are not significantly different from each other ($\alpha = 0.05$).

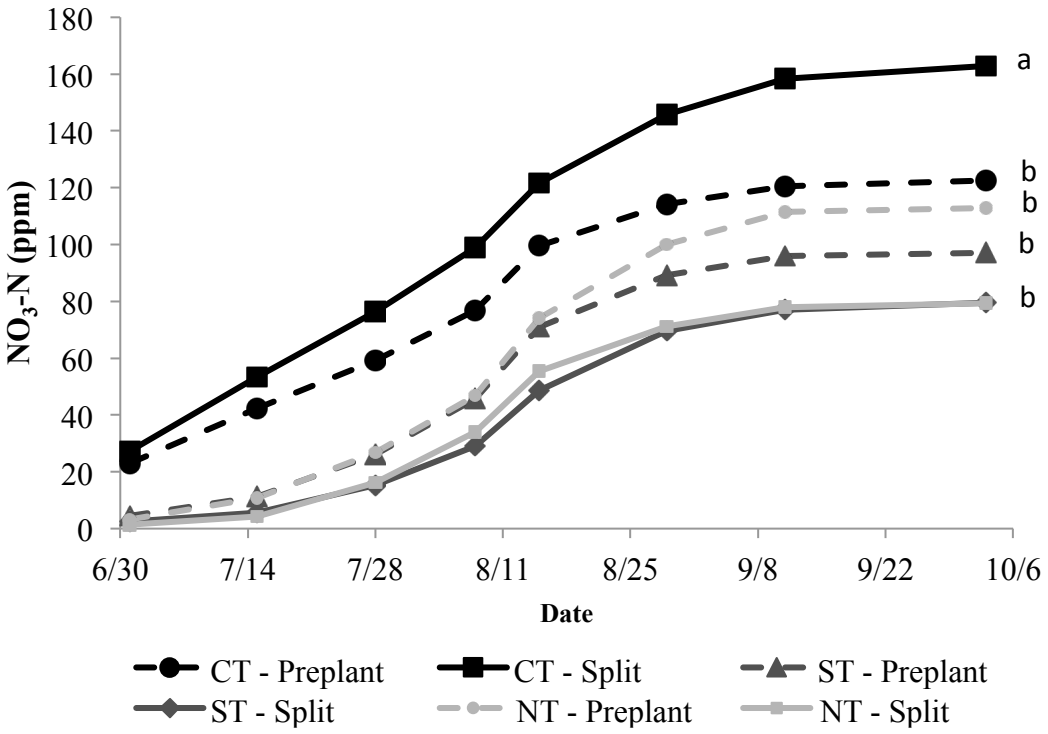

Figure 1. Cumulative levels of NO3-N measured in leachate samples during 2014 from lysimeters installed to 24-in. depth. Line labels containing the same letter are not significantly different from each other (α = 0.05). CT = conventional tillage, ST = strip tillage, NT = no tillage.