Rye-vetch proportion and plastic mulch affect cover crop biomass production, soil NO_3^- and bell pepper yield

Cereal Rye in late winter.

Hairy Vetch seedling in early autumn.

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INTRODUCTION

Rationale

Mixtures of rapid-growing cereals and N-fixing legumes have the potential to yield cover crops that effectively suppress weeds and scavenge residual nitrate while contributing significant amounts of fixed nitrogen to following cash crops.

The extent to which these benefits are realized within vegetable cropping systems will depend on a number of environmental and management factors, including **relative species proportions in the mixture** (seeding rates) and cultural practices that alter the soil environment following residue incorporation, such **as the use of plastic mulch.**

A better understanding of how such management decisions interact with the dynamics of plant competition and organic matter decomposition to determine cover crop performance is an important first step toward achieving more-informed and adaptive seeding rate recommendations to benefit growers.

Objective

To investigate 1) the effect of species proportions in a hairy vetch - cereal rye winter annual cover crop mixture on **biomass production and quality**, and 2) the interactive effects of incorporated residues and black plastic mulch on **bell pepper yield** and **soil nitrate dynamics.**

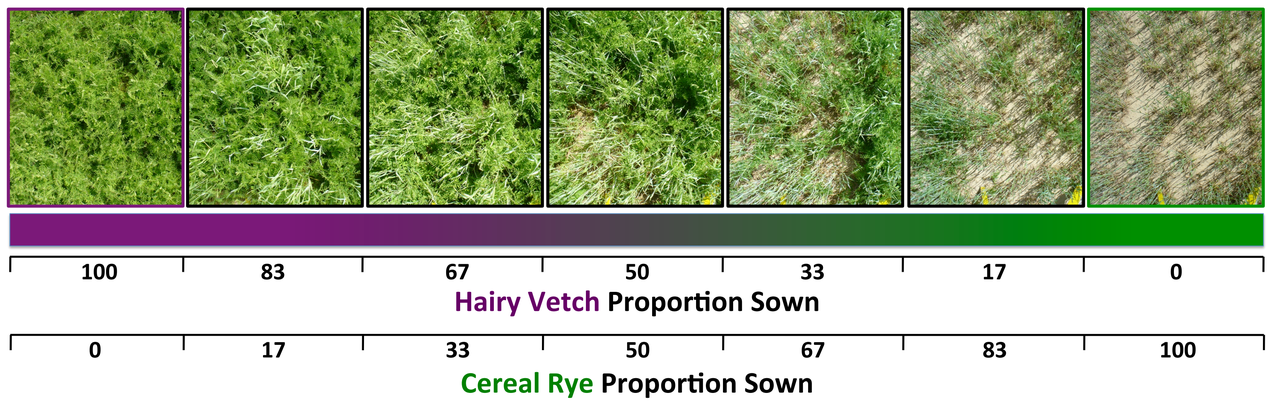
MATERIALS AND METHODS

Experimental Design: Split-plot RCBD with 4 replications.

Main Plot Factor: Rye-Vetch Cover Crop Proportional Replacement Series (PRS)

Fig. 1: PRS treatments consist of a monoculture of each component species and a gradient of species mixtures in between. Proportions refer to the monoculture seeding rate of the respective species. Images are top-down photos of the 7 cover crop treatments used in this study (taken in May). **Also included in the experiment was a no cover crop (0:0 Vetch:Rye) control treatment.**

Species in Mixture	Functional Group	Monoculture Seeding Rate
Hairy Vetch (*Vicia villosa* Roth)	Legume	42 kg/ha (114 seeds/m^2)
Cereal Rye (*Secale cereale* L.)	Cereal/ Grass	94 kg/ha (384 seeds/m^2)



Subplot Factor: Plastic Mulch Use

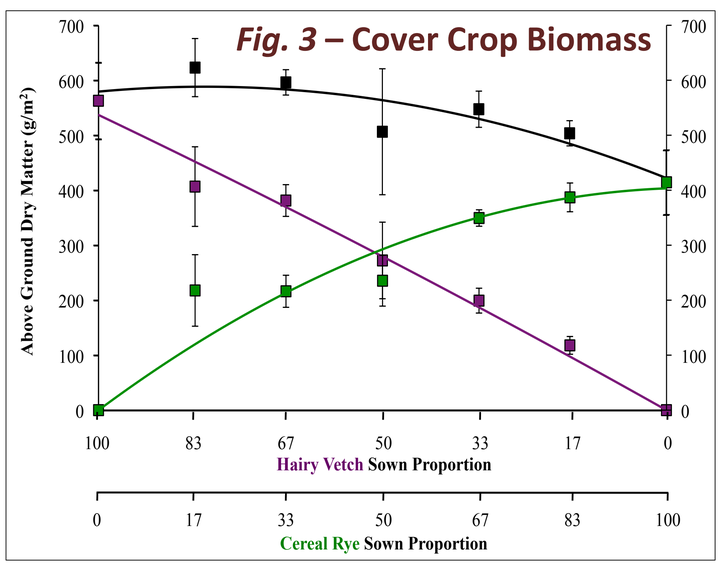
Fig. 2: Bell Pepper (variety 'Paladin') was grown either with or without black polyethylene mulch. Image shows peppers growing following 100% vetch whole plot treatment.

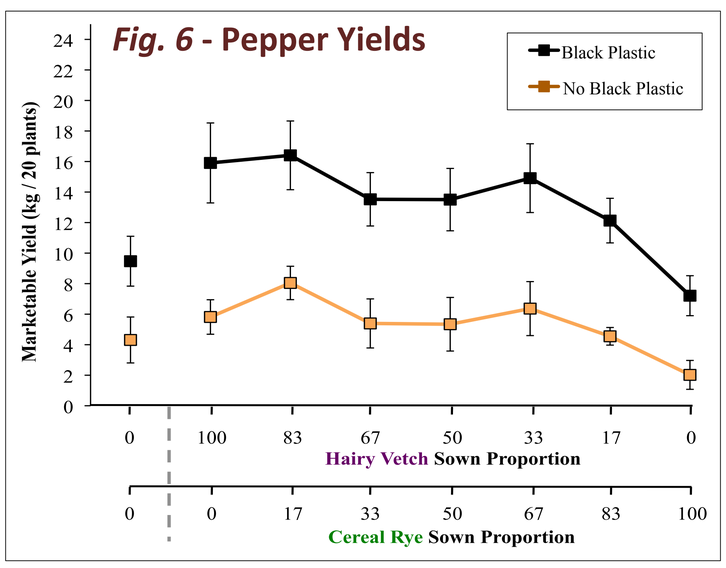
Timeline of Field Activities and Data Collection

Activity	Date
Cover crops seeded[1]	9/1/09
Cover crop density and biomass sampling[2]	5/10/10
Cover crop termination (by flail mower)	5/10/10
Cover crop incorporation (by rototiller)	5/17/10
Soil sampling and nitrate analysis (2-week intervals)[3]	5/24/2010 – 8/16/2010
Bed preparation and pepper transplanting[4]	6/3/10
Pepper harvests	7/27/2010 – 8/31/2010

[1]Treatments were broadcast sown into 20 x 25 ft main plots by hand and lightly incorporated to a depth of 5 cm.
[2]Following overwintering and early spring growth, cover crop density (data not presented) and aboveground biomass by species was sampled from four 0.125 m^2 quadrats in each main plot (**Fig 5**). Biomass was dried to a constant weight prior to dry weight measurement and nutrient analysis.
[3] Composite soil samples were collected to a depth of 12 cm and analyzed for NO_3^- and NH_4^+ concentration by extraction with 1 M KCl and subsequent colorimetric analysis.
[4]The field was managed according to USDA organic guidelines with no additional fertility inputs other than the incorporated cover crops.

RESULTS





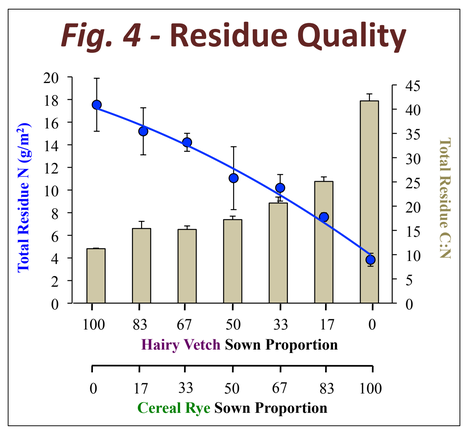


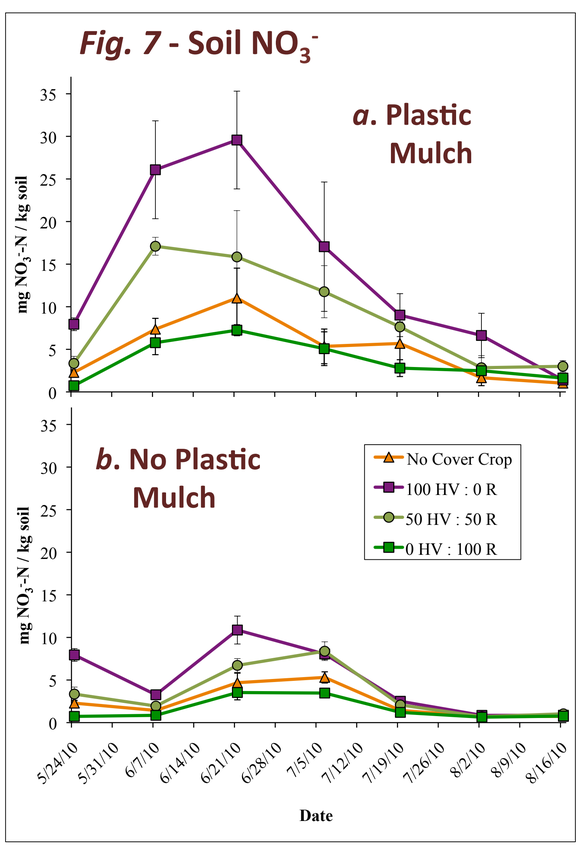
Fig. 3: Trends in above ground dry matter production across cover crop mixture proportions for vetch (purple), rye (green), and total cover crop (black) biomass. Data points are treatment means (*n=4*) ± SE.

Fig. 4: Trends in total cover crop mixture (vetch and rye combined) residue N content (blue circles) and C:N (tan bars). Data presented are treatment means (*n=4*) ± SE.

Fig. 6: Effect of cover crop mixture proportion on total marketable yield of bell pepper ('Paladin') grown on plastic mulch (black squares) and without plastic mulch (orange squares). Data points are treatment means (*n=4*) ± SE. The 0:0 treatment on the x-axis (to the left of the dotted line) represents the no cover crop control.

Fig. 7: Effect of select cover crop mixture treatments on soil nitrate concentrations during summer 2010 under plastic mulch (a) and without plastic mulch (b) Data points are treatment means (*n=4*) ± SE. Only four select treatments are depicted for clarity of presentation and because they bracket the responses of the treatments not included in the figure.

Fig. 5 (below): Cover crop density and biomass sampling, May 2010.



SUMMARY AND CONCLUSIONS

Cover crop biomass production across mixture proportions followed a gradient generally intermediate to the vetch and rye monoculture yields, as expected based on the seeding rates used (**Fig 3**). The resulting cover crop mixtures differed significantly in total residue quality— total N content generally decreased with lower proportions of vetch in mixture while the total residue C:N generally increased (**Fig 4**).

Cover crop mixtures with higher proportions of vetch generally resulted in higher soil nitrate concentrations, though the general pattern of nitrate availability over time appeared to be largely unaffected by mixture treatment. However, both the magnitude and duration of the increases in soil nitrate following cover crop incorporation were overall greater under plastic mulch (PM) than without (**Fig 7 a, b**), likely due to a combination of higher mineralization rates and lower rates of nitrate leaching under PM.

In general, total bell pepper yields tended to be higher following cover crop mixtures with greater proportions of vetch. Particularly where black plastic was used, all cover crop treatments with the exception of the rye monoculture produced average yields greater than the no cover crop control. PM use had a considerable effect—peppers grown on PM yielded more than twice as much as those grown without PM for most cover crop treatments (**Fig 6**). Our results suggest that PM can be an important tool for maximizing fertility benefits from incorporated cover crop residues, particularly for high N, readily decomposable materials like hairy vetch.

Evaluations of overall mixture performance must ultimately be based on a systems-level consideration of cover crop services, including weed suppression, contributions to soil organic matter, and production costs, for example, in addition to vegetable yields. Such a synthesis will be the subject of future analysis.

ACKNOWLEDGEMENTS

Thanks to USDA North Central Region SARE (Project #: GNC09-108), Michigan State University Project GREEEN (Project #: GR09-068) and The Ceres Trust Organic Research Initiative for project financial support; Michigan State University Graduate School and the C.S. Mott Group for Sustainable Agriculture for graduate fellowship support; and to Drey Clark, Damen Kurzer, and Aristarque Djoko for project technical support.