Integrating weed and nutrient management in organic production with corn gluten meal

AGRONOMY AND HORTICULTURE
College of Agricultural Sciences and Natural Resources

Allison A. Butterfield and Sam E. Wortman

SARE Sustainable Agriculture Research & Education

Introduction

Weed management is consistently ranked as one of the worst problems in organic production. To combat this, by-products from bioprocesses, such as corn gluten meal (CGM), are often used as organic fertilizers and have demonstrated herbicidal potential. Using these products to integrate weed and nutrient management may increase the profitability of vegetable farms by reducing labor to control weeds and apply fertilizer.

Figure 1. Preparing to transplant broccoli into raised beds in Lincoln, NE.

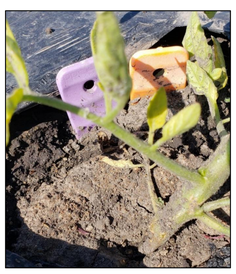
Objective

Our research objective is to determine the effects of different bio-based products and application rates on weed suppression, mineral soil nitrogen (N), and crop yield.

Figure 2. Tomato planting hole after application of 50g corn gluten meal.

Methods

- Velvetleaf (*Abutilon theophrasti*) and shattercane *(Sorghum bicolor)* were seeded into each planting hole prior to treatment application.
- Corn gluten meal (CGM; 10% N) was applied at rates of 20g, 35g, and 50g per planting hole in tomato and broccoli crops and 941 g per plant in hops.
- Each treatment was compared against a weedy, weed-free and synthetic fertilizer (100lb N/acre equivalent) controls.



Figures 3 & 4. Anion and cation pair of PRS probes to measure plant available NO_3-N and NH_4-N. (New and buried pairs, respectively.)

- Soil mineral N was measured continuously for 6 weeks after treatment application with ion-exchange resin membranes (PRS Probes; Western Ag Innovations).

Tomato Results (*Solanum lycopersicum 'Defiant'*)

Average Weed Emergence in Tomato

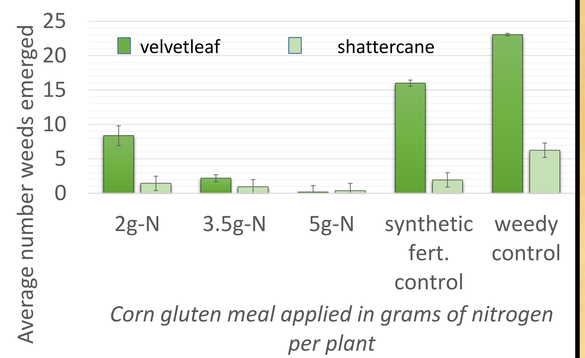


Figure 5. Weed suppression from corn gluten meal applications compared to controls.

Figure 6. Velvetleaf emergence.

Average Tomato Yield

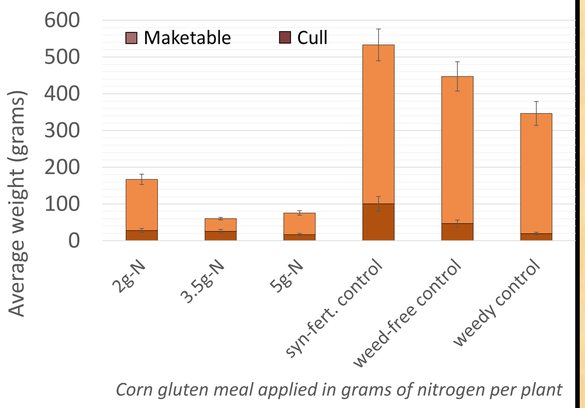


Figure 7. Total harvest weights for tomato crop in 2018.

- 2017 tomato yield not affected by CGM treatment, but in 2018, all CGM rates severely reduced yield due to *Rhizoctonia* infection (stress from CGM and elevated soil NH_4 – see Fig. 8 – may have increased disease susceptibility).
- Weed emergence was reduced 95%, however the 5g-N CGM had a high plant fatality rate.

% NH_4 of Mineral Soil Nitrogen in Tomato

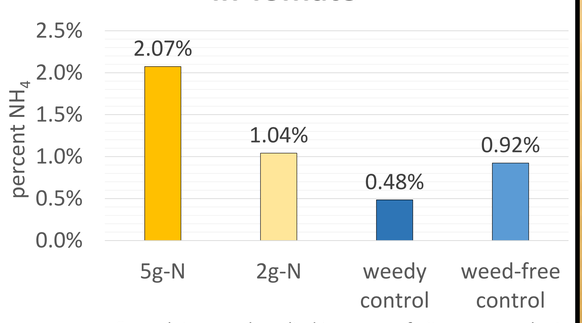


Figure 8. Percent ammonium of total soil nitrogen as detected with PRS probes for tomato crop.

Broccoli Results (*Brassica oleracea 'Arcadia'*)

Average Weed Emergence in Broccoli

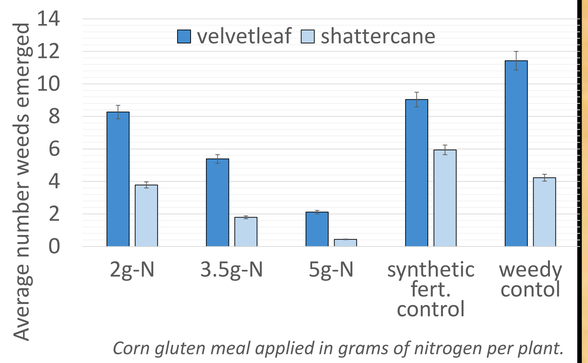


Figure 9. Weed suppression from corn gluten meal applications compared to controls.

Broccoli Head Yield (g)

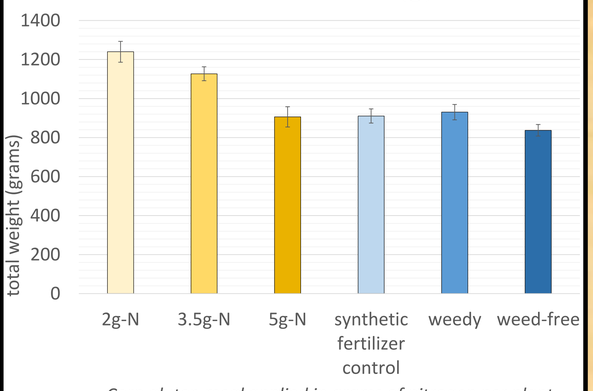


Figure 10. Total harvest weight for broccoli crop.

Figure 11. Broccoli head ready for harvest.

% NH_4 of Mineral Soil Nitrogen in Broccoli

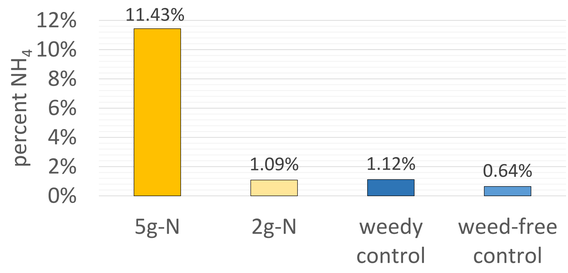


Figure 12. Percent ammonium of total soil nitrogen as detected with PRS probes for broccoli crop.

- Relative to the weedy control, velvetleaf emergence in broccoli was reduced up to 80% with the highest rates of CGM.
- % NH_4-N was 10x greater in the 5-g N treatments than in the control, and may have contributed to weed suppression.
- Improved weed control and supplemental nutrition from CGM increased broccoli yield up to 50% compared to controls. Yield in 2017 was not influenced by treatments.

Hop Results (*Humulus lupulus*)

Leaf chlorophyll measurement of hops using a SPAD meter

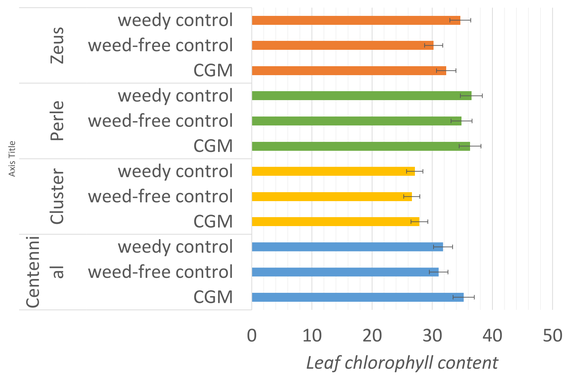


Figure 13. Chlorophyll content of hops leaves measured with a SPAD meter.

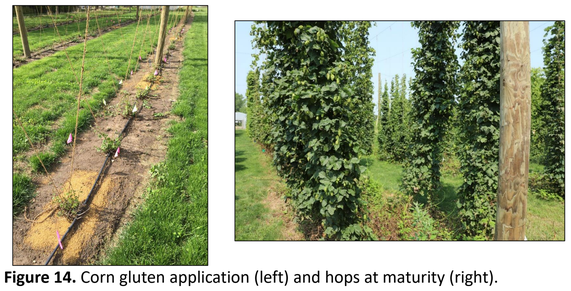


Figure 14. Corn gluten application (left) and hops at maturity (right).

% NH_4 of Mineral Soil Nitrogen in Hops

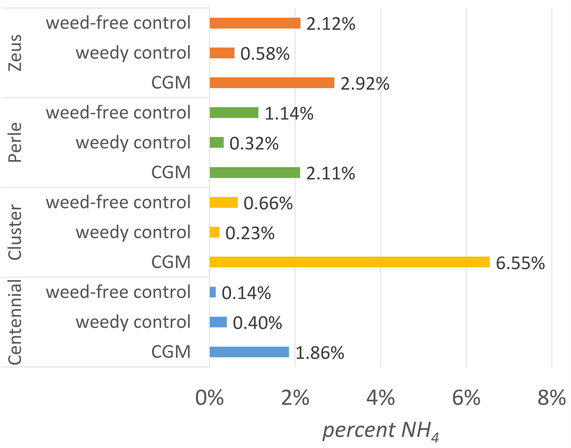


Figure 15. Percent ammonium of mineral soil nitrogen as detected with PRS probes for hops.

Conclusions

- Increasing the rate of corn gluten meal improved weed control and increase soil N availability, but also increased crop stress and disease incidence.
- Weed suppressive rates of corn gluten meal did not negatively impact broccoli or hops; further research is needed to determine crop-specific responses and effects of application timing.
- NH_4-N has known phytotoxic effects on plant seedlings – our data suggests this is the primary mode of action for corn gluten meal use as an organic herbicide.

Acknowledgements

This project is based on research that was partially supported by the Nebraska Agricultural Experiment Station with funding from the Hatch Act (accession 1014303) through the USDA National Institute of Food and Agriculture (NIFA), and the USDA AMS Specialty Crop Block Grant Program and Nebraska Department of Agriculture.