



# Using High Glucosinolate Mustard as a Cover Crop to Reduce Weeds and Disease

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## What are benefits to growing cover crops?

Cover crops are seeded primarily to provide soil health and other benefits. Cover crops have been shown to prevent soil erosion, increase soil aggregation, fight weed competition, promote soil microorganism biodiversity, and increase soil organic matter. Increasing soil organic matter can increase the soil's ability to retain water and nutrients, feed microorganism populations, promote healthy soil structure, help to prevent disease, and increase overall plant health.

Cover crop species are often selected to provide specific functions. For example, grains, like rye, are especially good at building organic matter, brassicas are generally good at scavenging for nutrients deep in the soil and leguminous cover crops, like vetch and peas, provide nitrogen to the soil. Other cover crops—like high glucosinolate mustards (HGM)—have unique properties that influence soil biology. HGM cover crops have become popular for their biofumigant properties, meaning that they have compounds that when managed can reduce pest pressure in the soil.



HGM planting, Alburgh, VT, 2016

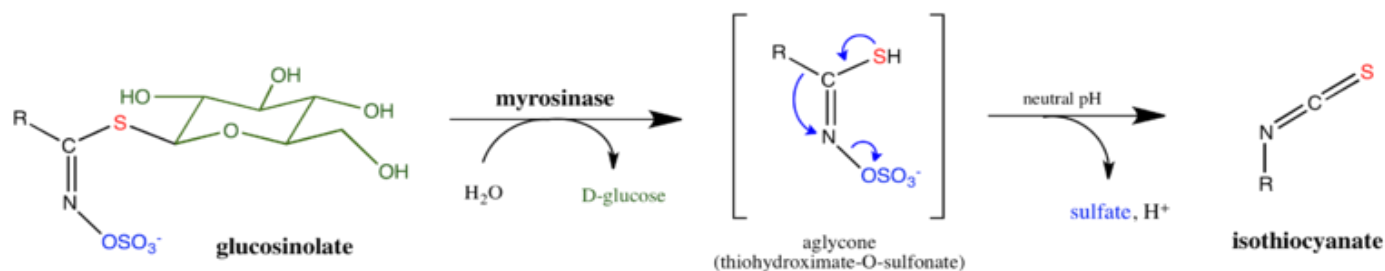


Figure 1. A glucosinolate molecule breaking down to isothiocyanate, aided by the enzyme, myrosinase.

## What is high glucosinolate mustard?

High glucosinolate mustard cover crops have been bred to contain elevated levels of glucosinolates, throughout the whole plant. These plants also contain an enzyme called myrosinase. When the plant is growing, the glucosinolates are separated physically from the myrosinase enzyme. When the HGM cover crops are damaged through mowing or tillage, the glucosinolate comes in contact with the myrosinase and is broken down to secondary compounds, including isothiocyanates. The isothiocyanates are the active ingredients that make the plant work as a biofumigant. The isothiocyanates also give mustard its pungent odor. At high concentrations, isothiocyanates are general biocides that

behave similar to commercial pesticides. Mustards vary with the types and concentrations of glucosinolates they contain. Some glucosinolates are biologically active against insects, nematodes, and fungal pathogens, while others are better for preventing weeds from growing. The mustard can be grown in fruit and vegetable gardens, grains, vineyards, orchards, hoop houses, and fallow soil in need of rehabilitation. There is also possibility for biofuel production from pressing the seed, while the meal may be used as a soil amendment and biofumigant. The seed meal is also high in glucosinolates and nitrogen (generally 5-6%).

## HGM Biofumigant Benefits

### Weed Suppression

Generally, greater biomass of mustard will provide greater weed control (Norsworthy et al., 2007). Plant residues containing glucosinolates have been shown to prevent the germination of weeds such as pigweed, wild oat, dandelion, lambsquarter, Bermuda grass, purslane, crabgrass, quackgrass, spurge, fleabane, barnyard grass, fall panicum, ragweed, stinkgrass, henbit, and carpetweed. Many weed seeds are killed even while dormant (Brown and Morra, 2005; Norsworthy et al., 2007; University of Idaho). The mustard seed contains the highest concentration of glucosinolates in the plant. In a USDA trial, Indian mustard (*Brassica juncea*) seed meal was mixed into soil to represent 0.1% of the soil concentration and completely inhibited wheat seed emergence, which was planted in the soil as a “weed;” it also reduced redroot pigweed (*Amaranthus retroflexus*) biomass by 72%, lambsquarter (*Chenopodium album*) biomass by 87%, and common chickweed (*Stellaria media*) by 99% (Rice et al., 2007; Vaughn et al., 2006). Indian meal and brown mustard at 0.5% concentration was also able to completely inhibit sicklepod growth (Vaughn et al., 2006).

### Insect Pest Suppression

Studies have shown the efficacy of glucosinolate mustards at reducing wireworms, common fruit fly (*Drosophila melanogaster*), housefly (*Musca domestica*), black vine weevil eggs, white-fringed weevil larvae, symphilitids, and nematodes (Brown and Morra, 2005).

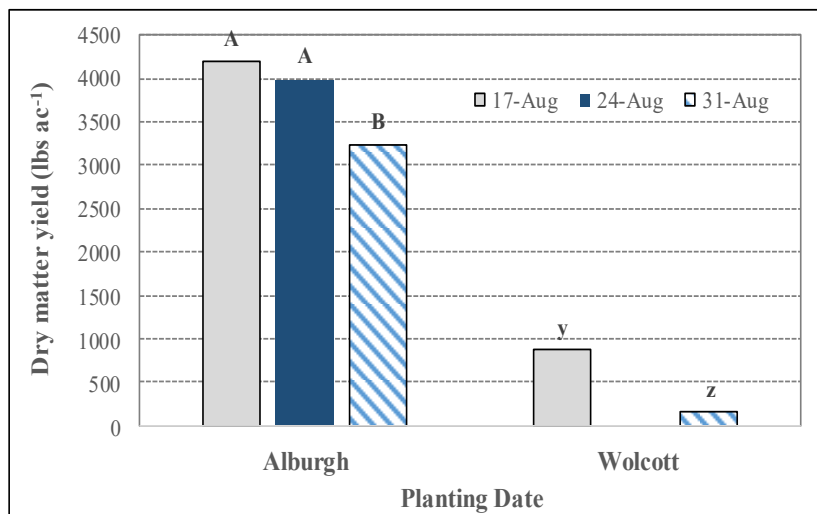
### Disease Suppression

Glucosinolates in cover crops have been shown to be effective for preventing the following common vegetable diseases: *Aphanomyces* root rot, cucurbit scab (*Cladosporium cucumerinum*), Fusarium dry rot (*Fusarium sambucinum*), take-all root rot (*Gaeumannomyces graminis*), *Phytophthora* root rot, *Pythium* root rot, *Rhizoctonia solani*, southern blight (*Sclerotium rolfsii*), white mold (*Sclerotinia sclerotiorum*), *Verticillium* wilt, and other soilborne diseases (Brown and Morra, 2005; Larkin, 2013; Larkin et al., 2011).

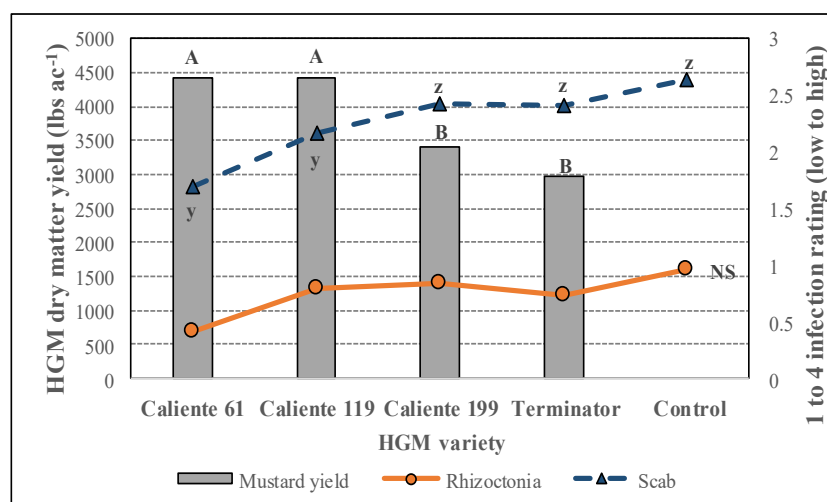
In a trial at the University of Maine, HGM was drilled at 11 pounds per acre, followed by a potato planting that showed a 52% lower incidence rate of *Rhizoctonia solani* and potato scab (Jemison, 2014). Recent research conducted in Vermont showed that potatoes planted where HGM was grown had lower rates of *Rhizoctonia solani* and potato scab (*Streptomyces spp.*).



**Figure 2. Pigweed, quackgrass, wireworm, fruit fly, potato scab (*Streptomyces spp.*), *Rhizoctonia solani*, white mold (*Sclerotinia sclerotiorum*), from top to bottom.**



**Figure 3. Mustard dry biomass yields, across all varieties, Alburgh and Wolcott, VT, 2015. At each location, planting dates with the same letter did not perform significantly different from each other.**



Research at the University of Vermont evaluated the impact of HGM variety and planting date on yield and quality of beans and potatoes. Results indicated that a mid-July to mid-August planting date produced the maximum HGM biomass in northern Vermont locations (Figure 3).

Biomass yield also varied by mustard variety. At the Alburgh location, Caliente 61 and Caliente 119 yielded the most biomass and also resulted in significantly less scab in the subsequent potato crop (Figure 4). In this experiment, HGM variety did not have a significant impact on rhizoctonia in the subsequent potato crop, however, Caliente 61 plots showed the least amount of rhizoctonia. Those varieties performing well for disease prevention is likely related to them also yielding comparatively well.

At the Wolcott location, a spring-applied HGM seed meal, reduced root rot of snap bean 37% more than the treatment that evaluated incorporating the whole mustard plant.

**Figure 4. HGM variety yields and subsequent impact on potato scab and rhizoctonia, Alburgh VT, 2015. Varieties with the same letter did not perform significantly different from each other.**

## Tips for Growing HGM Cover Crops

### Planting Date

Mustards are cool season crops so planting them in early spring or late summer will yield the best results. For cool, Northeast climates, planting between mid-July and mid-August will yield highest quantities of biomass.

### Seeding Rate

Seeding rates found in the literature range from 5 to 25 pounds per acre. If seeding with a grain drill, lower rates can be used as the seed-to-soil contact will be better and more consistent germination and populations will be obtained.

### Fertility

It is recommended to maintain a soil pH of 6-7 throughout the process of growing and incorporating the mustard (Campbell-Nelson et al., 2015). If the soil is too acidic when the mustard is incorporated, the crop will not release its fumigating properties. Although it is not commonly recommended to fertilize HGM cover crops it should be noted that low fertility fields may result in poor yields.



## ***Terminating the Crop***

Terminate the mustard at the flowering stage by flail mowing and then incorporate the mustard into the top 5 to 10 inches of the soil using an implements such as a rototiller or disc. Adequate soil moisture is needed to help break down the mustard's glucosinolates and activate its biofumigant properties. As an option, you can roll or pack the field, cover with a tarp, or use rain or irrigation to create a better seal over the incorporated mustard. As the mustard hydrolyzes, or breaks down due to a reaction with water, hydrogen ions are released that may lower the soil pH. Regular soil testing will help monitor how soil quality may change. Do not let the mustard grow to seed development. The fallen seed will grow back the following year and may be considered a weed.

It is best to wait at least 14 days before planting your cash crop to avoid crop injury. If soil temperature is less than 50°F, more time may be needed.

## **Additional Considerations**

While HGM has the ability to reduce disease, weed, and insect pest pressure, biofumigation should not be considered a single solution to these management issues. HGM and biofumigation from cover cropping should be used as part of an integrative approach to maintaining healthy crops, especially considering that biofumigation efficacy will decrease as the season continues.

## ***Costs and Sources***

Cost of seed can range from \$3.67 to \$17.57 per pound and is generally at \$5.00 per pound. Seed may be sourced from Siegers Seed Co., Holland, Michigan; Johnny's Selected Seeds, Winslow, Maine; and Seedway Seeds, Shoreham, Vermont. This is not an exhaustive list and not meant to be an endorsement of individual companies.

## **Additional Resources**

To learn more about HGM, check out the following resources. Our research reports and two videos on our trial are here: <http://www.uvm.edu/extension/cropsoil/soil-health-and-nutrient-management>. A webinar on HGM, done in collaboration with University of Massachusetts Amherst Extension and eOrganic may be found here: <http://articles.extension.org/pages/74057>.

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