Extension Bulletin E-2956 • New • February 2006

Mustards – A Brassica Cover Crop for Michigan

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Michigan farmers rely on a wide range of cover crops as vital management tools. A living cover is the best protection available against erosion and nutrient loss. Cover crops are grown during breaks between cash crops or on fallow land, often as a means to break pest cycles and to provide the extra organic inputs necessary to improve soil organic matter, tilth, porosity and fertility.

Recently, interest has grown in the use of brassica cover crops as specific biological interventions to improve crop health. Generally, cover crops reduce pest outbreaks by providing enhanced biocontrol by providing roots, leaves and flowers (nectaries) that promote the survival and growth of beneficial insects and microbes, both aboveground and belowground. Beyond these general benefits that support soil health and a more balanced ecosystem approach to farming, recent reports indicate cover crops from the brassica family can be used as biofumigants (Ngouajio and Mutch, 2004).

Fig. 1. Field of mustard ready to be incorporated in a Michigan potato rotation.

Brassicas such as Oriental mustard have been associated in some reports with improved root health in a subsequent cash crop, such as potatoes, grown after a green-incorporated brassica cover crop. Brassica cover crops can be managed as a green manure — when green residues are incorporated — and this may reduce or suppress some pathogens, including *Verticillium* in potato; *Pythium, Fusarium* and *Rhizoctonia* root rots in beans; *Pythium* in lettuce; pink root in onion; *Aphanomyces, Pythium, Rhizoctonia* and *Fusarium* root rot in peas; and cavity spot and *Fusarium* in carrot (summarized in Sanders, 2005).

The disease suppression property of brassica residues is associated with the amount of glucosinolates in the tissue (these are the compounds responsible for the hot taste of mustard and the sulfur-like smell associated with cooking plants in the brassica family). Field experiments during the early 1990s demonstrated that potatoes generally grew more vigorously following use of brassica cover crops such as rapeseed and Oriental mustard. Conflicting reports have occurred regarding the benefits of incorporating brassica cover crops into vegetable and field crop rotations. Effects from mustard and other cover crops are species-, variety- and location-specific; sorting out their value will take a concerted effort.

Farmer interest in this alternative cover crop has grown and was the incentive for initiating research in Michigan on the properties and management of a mustard cover crop. Early findings indicate that soil-borne fungal pests may be suppressed when brassica plant material is incorporated in the field and volatile chemicals are released from the tissue (Date, 2004). See, for example, the limited growth of *Rhizoctonia* on a petri dish exposed to volatile chemicals from cut up Oriental mustard residues (Fig. 2).

Fig. 2. Inhibition of fungal growth by mustard plant matter.

In many cases — but not all — incorporating a brassica cover crop appears to promote root health in subsequent crops. We have also noted disease suppression and crop root-health promoting properties from incorporating a conventional rye cover crop, so alternative cover crops such as mustard should be carefully evaluated for benefits and problems under various environmental conditions.

About mustard

Mustards and canola (Cruciferae or *Brassica* spp.) are broadleaf, cool-season spring annuals with large, deep taproots. They are native to the Mediterranean region of Europe and were domesticated about 4,000 years ago as a source of oil, spice and medicines. Today, they are grown around the world and throughout North America as specialty grain crops, green manures and forage crops for animals.

Table 1. Mustard classifications and common varieties.

Species names	Common	Varieties
Brassica napus	Canola Rapeseed	Dwarf Essex
Brassica juncea	Brown & Oriental mustards	**Brown:** Blaze, Common Brown **Oriental:** Pacific Gold, Cutlass, Forge, Lethbridge 22 Caliente blends
Brassica negra	Black mustard	
Brassica alba, Brassica hirta	White & yellow mustards	IdaGold, Martegena, Tinley

Growth habit/plant characteristics: Mustard seed is very small — 1 to 3 mm in diameter and 100,000 to 200,000 seeds per pound. Mustards emerge rapidly, within 5 to 10 days after planting, and will germinate in soil temperatures as low as 40 degrees F. Seedlings have broad, kidney-shaped cotyledons with distinct indentations at their tips and grow quickly with adequate soil moisture and ambient temperatures below 85 degrees F. Mustard is an annual herbaceous plant. In 4 to 5 weeks, plants will completely cover the ground. Flower buds appear from 3 to 5 weeks after emergence, and yellow flowers are visible 1 week later. At maturity, plant height ranges from 30 to 45 inches, depending on variety and environmental conditions. Taproots can reach depths of 1 to 3 feet, although they may be much shorter in suboptimal growing conditions.

Cultivation of mustard

Timing: Mustard can be planted in spring following corn or potatoes or in fall into wheat residues. Fall planting should be done by mid-August for optimal growth. The cultivar 'Pacific Gold' has the highest glucosinolate levels, but it is challenging to grow because it is photoperiod-sensitive and flowers quickly under long days. Sufficient biomass yields from this variety will be observed only with fall planting in Michigan, and other varieties should be considered for spring use.

Soil preparation: Mustard should be planted into a firm seedbed for optimal growth. No-till planting will improve soil quality more than conventional establishment. Mustard's very small seeds make it difficult to establish using a no-till drill. Farmers are experimenting with no-till establishment of mustard into wheat stubble, which may require an irrigation or manure slurry application to enhance establishment. An example of successful no-till mustard cover crop establishment in Michigan is described by a fact sheet on slurry seeding of biofumigant crops (Harrigan and Mutch, 2004).

Mustard growth is best in soils with neutral pH, but the plant tolerates moderately acid and basic soils ranging from 5.5 to 8.3.

Sowing rates: Nine to 15 lb/acre is a general recommendation. It appears to establish well if broadcast and harrowed to a depth of 1/2 inch or irrigated into sandy soil.

Irrigation: Mustard does best on well-drained soil with sufficient moisture. It is not particularly drought-tolerant and also does not perform well on waterlogged soil.

Fertility: To optimize fertility, the level of nutrients available should be evaluated through a soil test. Sufficient nitrogen and other nutrients may be available when mustard is grown after a fertilized crop. If necessary, additional nutrients can be applied at a rate of about 45 lb/acre P^2O^5 and 100 to 120 lb/acre N. Sulfur can also be applied with nitrogen at a 6:1 nitrogen to sulfur ratio. Sulfur is needed to produce the glucosinolates in the plant, which are the basis for biofumigation of the soil through residue incorporation.

Cold survival calculations: At time of planting the topsoil (top 4 inches) temperature should be at least 40 to 45 degrees F (see Table 2). Mustard will not survive a hard frost. Estimated dates of first frost have a 50 percent probability. We estimate 900 GDD (growing-degree-days) — about 40 average fall days — to produce acceptable levels of biomass from a mustard cover crop for incorporation.

Table 2. Estimated dates for spring soil temperatures and fall frost in Michigan.

Location	Estimated spring date when 4" soil temp. is 40°F	Estimated First Frost	Fall GDD* (Aug. 15 to first frost)	Spring GDD* (Spring soil temp at 40°F by May 31)
Benton Harbor	Apr. 3	Oct. 30	1620	862
Albion	Apr. 8	Oct. 12	1364	793
Lansing	Apr. 1	Oct. 22	1416	771
Ithaca	Apr. 13	Oct. 23	1458	661
Saginaw	Apr. 9	Oct. 25	1420	694
Sandusky	Apr.16	Oct. 13	1377	604
Entrican	Apr. 10	Oct. 11	1448	655
Escanaba	Apr. 16	Oct. 4	1077	355

*GDD — growing degree days.

Crop management

Weeds: Weeds can significantly reduce mustard stands, so it is essential to begin with a clean field. Mustard seedlings do not compete well with weeds. Shallow seeding is also important to obtain quick, uniform emergence. Perennial weeds should be controlled before planting.

Disease management: Mustard is susceptible to a number of diseases. The most serious are white mold, downy mildew, white rust, leaf spots and mosaic virus. Diseases are of greatest concern when mustard is grown continuously as a cash crop. As a cover crop, mustard is grown for only about 6 weeks. This minimizes disease pressure. Planting mustard in rotation with small grains is the best way to avoid disease problems.

Insect pests: Flea beetles are one of the major insect pests on mustard and may attack mustard seedlings, in particular. Cultural practices that encourage vigorous seedling growth, such as a firm seed bed with optimum fertility, are the best way to defend against flea beetle damage. Diamondback moth larvae are the other major pest of mustard. Larvae eat leaves, flowers and green seed pods.

Harvest/incorporation equipment needed: The biofumigation benefits of mustard residues are maximized if plants are incorporated at or just before full flowering. We suggest that residues be flail chopped or mowed and incorporated immediately while still green into moist soil. If the soil is dry, irrigate before chopping and incorporating, immediately after incorporating and again in about 5 days to help hold the volatile compounds in the soil.

To maximize soil protection, a winter cover is required. This is a challenge to achieve after a fall mustard cover crop, but it can be addressed by planting a rye cover crop after mustard is incorporated or by leaving some mustard residue on the surface. This partial incorporation may reduce biofumigant effects, however. If feasible, planting a second, winter-hardy cover crop such as rye is recommended.

Fig. 3. Mustard plant at the time of incorporation (left) and decaying residues shown 1 week after incorporation (right).

Can mustards become a weed?

It is important not to let mustard species go to seed. Mustards are rapid growing species and can become a weed in a subsequent crop. (See S.S. Snapp and D.R. Mutch, Cover crop choices for Michigan vegetables, http://web4.msue.msu.edu/veginfo.) Green seed pods may contain viable seed, so early incorporation is advised.

Fall-planted mustard will require about 40 days (900 degree-days) from planting to incorporation. A spring cover of 'Pacific Gold' will yield roughly 2,000 pounds of biomass per acre; preliminary research suggests that in fall one can expect 3,000 to 5,000 lb/acre. As farmers gain experience with growing this cover crop, the biomass yield potential could increase substantially.

Summary

Oriental mustard is recommended as an alternative cover crop. Its special properties include soil quality improvement and flowers that provide food for beneficial insects. There is still much to be learned about how to enhance growth of brassicas as cover crops and how best to manage the residues to enhance crop root health.

Seed sources

Genesee Union Warehouse, Genesee, Idaho.
http://www.geneseeunion.com
(208) 285-1141

Rupp Vegetable Seeds
17919 County Road B
Wauseon, OH 43567-9458
(419) 337-1841 (419) 337-5491 FAX

Vegetable Order Desk
800-700-1199

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