BRASSICAS AS BIOFUMIGANTS FOR CONTROLLING SOILBORNE ORGANISMS IN POTATO PRODUCTION FOR UPSTATE NEW YORK AND NORTHERN PENNSYLVANIA

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QUICK FACTS

Equipment

- Grain drill
- Brillion Sure stand
- Fan spreader (e.g. Vicon seeder)

Equipment for chopping and incorporation

- Flail chopper
- Heavy disc, or rototiller
- Roller/culti-packer

Equipment for plowing

- Chisel plow

Seed

- Caliente 199 9-11 lb/acre
- Caliente 61 5-7 lb/acre
- Nemat Arugula 5-7 lb/acre

Fertilizer and soil pH

- Nitrogen 100lb/acre (ammonium nitrate, urea or composted chicken manure)
- Sulfur 20lb/acre (ammonium sulfate, or if pH low, potassium sulfate, gypsum or sulfur
- Soil pH 5.5 and above

Herbicides (if needed)

- Trifluralin: pre-plant
- Select Max: post-emergence

Irrigation

- Depending on soil type and season may be needed

Why brassicas?

Soilborne organisms are becoming more difficult to control due to pathogen resistance and restricted use of some chemicals. The cost of chemicals is also becoming a concern. Brassicas are of interest in that they produce glucosinolates, which can be converted to chemicals with biofumigant activity. In addition to providing some disease control, growing and incorporating the brassica improves soil structure, assists in weed control, reduces soil erosion and provides organic matter. They are of particular value to the organic producer, who has limited resources for disease and pest control.

Know your pests

Growing a brassica as a rotational crop is not ideal for all situations. It is important to know your major disease issues as brassicas can increase levels of some pathogens. Brassicas are a host for *Sclerotinia sclerotiorum*, causal agent of white mold, and therefore if this is a significant problem in your potato production, growing brassicas as a biofumigant may not be desirable. In addition, if crucifer cash crops such as broccoli are grown, the brassica cover crop should be used several years before or after these cash crops due to potential issues with club root caused by *Plasmodiophora brassicae*. This organism causes serious

malformation of the roots which will reduce yield and marketability of the cash crop. Brassicas have been shown to have a role in controlling Rhizoctonia (canker and black scurf), common scab (*Streptomyces scabies*), powdery scab (*Spongospora subterranean*), and verticillium wilt (*Verticillium dahliae*). Populations of nematodes, Heterodera (cyst), and Meloidogyne species (*M. chitwoodi* and *M. hapla*) have be reduced.

Growing a brassica is not a silver bullet, and having one season/year of brassicas in a 3-year rotation with potato may not result in dramatic changes in disease level. The use of brassicas in rotations for pathogen control in potatoes is in its infancy and has received limited on-farm evaluation in the Northeast.

Not all brassicas are equal

Brassica species produce a significant quantity of glucosinolates (GSLs) in their tissue. When these are hydrolyzed by the enzyme myrosinase which is also present in the brassica tissues a range of products are produced that include the volatile, biocidal isothiocyanate (ITCs) which is similar to the active ingredient in the nematicide, metam-sodium (Vapam). The brassica varieties used in Caliente Mustard Blends and Nemat Arugula Blends have been bred and selected for the glucosinolate type that on hydrolysis will produce high concentrations of ITCs with activity against common soilborne plant pathogens. For maximum biofumigant activity the plants need to be chopped and incorporated into moist soil when the tissue is lush and green. The glucosinolates are highest in the leaf tissue, so production practices need to promote lush leafy biomass. Plants should be flail chopped and incorporated no later than full bloom for best glucosinolate production.

Caliente Mustard Blends can tolerate temperatures to 19.4°F (-7°C), so they can be utilized as late summer and early spring cover crops. Nemat Arugula can withstand colder temperatures and has glucosinolate activity in leaves and roots, therefore if the leaves die, the roots can contribute glucosinolates.

Caliente 61 is more drought and heat tolerant than Caliente 199 and will not bloom prematurely when stressed. Even though it has lower glucosinolate levels than Caliente 199, it can produce significantly more biomass under long photoperiod summer conditions with intermittent rainfall. Caliente 199 is quicker growing and typically used in spring or late summer sowings. Nemat can be planted in spring and mowed several times as it approaches bloom to maintain a vegetative state and provide longer term soil cover. As typical tillage implements only incorporate to a depth of 6-8 inches (15-20 cm) and nematodes can be found to 3 feet (1 m) in many soils, attracting them to the surface potentially increases control. Using a Nemat/Caliente blend can be useful for nematode control as the root exudates from Nemat attract nematodes to the upper soil profile. At incorporation the volatile compounds from the Caliente will be present in the soil profile at a depth where the nematodes will have migrated.

Caliente Mustard Blends and Nemat Arugula are unlikely to become weeds as they contain no hard seeds.

Nemat Arugula can be used as an indicator plant. The leaves will turn red, if there are high nematode populations in the soil, a deficiency of phosphorus or if residual herbicide is present (Figure 1).

Figure 1.

Fertilizer needs for brassica production

To optimize biomass production for soil building, biofumigation, and weed competition it is important to provide adequate fertilization early in the production cycle. There should be a soil analysis performed that shows the available sulfur and soil pH. Nitrogen and sulfur should be added to give 100lb/acre (112 kg/ha) and 20lb/acre (22 kg/ha), respectively. This should be applied pre-plant or as soon as the crop is established and just prior to expected rain, if irrigation is not available. To provide the sulfur, for soil with pH 5.5 or below potassium sulfate or gypsum should be used. For soils with higher pH, ammonium sulfate may be used. Organic growers may use composted chicken manure for the nitrogen requirement and either gypsum or sulfur for the sulfur.

Soil pH is important for good biofumigation, with soils above pH 5.5 producing more consistent results. As the pH drops below this level, more nitriles are produced resulting in significantly reduced biocidal activity.

Herbicides, fungicides and insecticides

Brassicas are sensitive to herbicide residue and drift. However if Metribuzin was applied the previous season there is usually no problem. If weeds are removed by tillage and/or glyphosate prior to seeding brassica production rarely needs herbicides. Trifluralin is labeled for pre-plant incorporation and Select Max for post-emergence grass control. Neither fungicides nor insecticides are usually needed for success brassica production.

Seeding

Brassicas can be seeded into wheat stubble or a prepared seedbed, but the soil needs to be moist to allow rapid germination and establishment. Brassicas will grow on most soil types though obtaining uniform establishment on rocky ground is difficult. Newly emerged seedlings can withstand a light frost, but if the crop is to be overwintered, the plants should be no bigger than about 4 inches (10 cm) when subjected to snow cover.

Recommended seeding rate for are **Caliente 199**: 9-11 lb/acre (10-12 kg /ha); **Caliente 61**: 5-7 lb/acre (6-8 kg/ ha); and for **Nemat Arugula**: 5-7 lb/acre (6-8 kg/ha).

No specific equipment is needed for seeding. The seed is similar in size and density to alfalfa, clover, and canola, and hence using setting appropriate for these seeds provides good cover. From our experience a Case IH model 6300 grain drill with a high speed sprocket set on 3 and a Brillion Sure stand set on heavy #2 both provided good uniform ground cover. If the seed is to be broadcast with a fan spreader such as a Vicon seeder, performing two passes and applying half the seed on each pass and off-setting the second pass, is likely to result in the most uniform cover.

It takes 60-70 days for good biomass production; therefore seeding in our region in the Spring will not allow potatoes to be grown on the field during that season. Overwintering, even the Nemat, from our limited experience seems very location/season dependent. Fields subject to blowing snow or soils that frost-heave are not suitable for overwintering. Locations with well drained soils, and/or that retain snow cover throughout the winter may be able to sustain the brassica and produce adequate re-growth and biomass in the Spring for chopping and incorporated to occur prior to planting potatoes. Some situations may warrant two seedings of a brassica in one growing season, however, the financial outlay needs to be considered in the light of potential improvement in the next seasons potato production gain.

The production of a crop of brassica with high biomass requires no maintenance during the 60 days of growth and unless heavy rain and or winds are experienced will not lodge. Irrigation may be required depending on soil type/water holding capacity and if there are long dry periods with temperatures of 80°F (27°C) or above. During the mid-growth-stage about 2” (5cm) of water is required per week for maximum biomass. Chopping and incorporation should be accomplished before

full bloom as the glucosinolate levels and green manure effects decline rapidly at maturity. Figure 2 shows the ideal stage of growth for chopping.

Figure 2.

Chopping and incorporation

Flail chopping and immediate incorporation into warm at least 50°F (10°C) moist soil with a heavy disc or rototiller is important for best results. The soil surface should be sealed with a roller or culti-packer to minimize loss of volatile compounds. Rupturing of the plant cells is critical to provide adequate glucosinolate/enzyme contact for rapid production of volatile compounds. Mowers do not provide adequate maceration of the plant cells and tend to windrow the material, resulting in lower pest suppression.

The field should be undisturbed for at least 2 weeks before seeding another crop, and future plowing even in the Spring before potatoes should be with a chisel plow rather than a moldboard. Soil temperatures above 50°F (10°C) allow for rapid decomposition of the plant material. Lower soil temperatures may require longer fallow periods.

Sources of seed

Rupp Seeds Inc
17919 County Road B
Wauseon, OH 43567-9458
Phone: (419) 337-1841
See 2011 catalog pg 36 under 'cover crops'
http://digital.zoompubs.com/publication/?i=61734

Siegers Seed Company
13031 Reflections Drive
Holland, MI 49424
Phone: (616) 786-4999
http://www.siegers.com/

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