IOWA STATE UNIVERSITY
Extension and Outreach

Short Duration Cover Crops for Vegetable Production Systems


Pearl Millet

What is a short duration cover crop?

Cover crops are crops that are not intended for harvest and are managed to maintain and enhance the sustainability of a production system by improving soil fertility, water quality, and lead to the suppression of weeds, soil erosion, and pests. A short duration cover crop is one that is grown or managed for a short period of time, usually 45 to 60 days. Examples include buckwheat, cowpea, oats, oilseed radish, yellow mustard, and sorghum-sudangrass.

Advantages of planting cover crops

There are many advantages to planting cover crops. Cover crops provide multiple benefits such as soil and water conservation, organic matter input, nitrogen fixation, weed suppression, and bio-fumigation. Cover crops provide specific advantages based on their physiology, shape, size, and growth habit. Each individual cover crop might not provide every advantage, depending on their growth, morphology, and composition, certain cover crops have advantages over others. The same can be said for the disadvantages. For example, planting cowpea, a cover crop from the legume family, can fix atmospheric nitrogen but may not provide a high level of weed suppression compared to a cover crop like buckwheat. Buckwheat, on the other hand, can provide high levels of weed suppression but cannot fix nitrogen since it is not a legume.

Weed suppression is a common topic when evaluating cover crops. Suppression of weeds is accomplished by a cover crop in multiple ways: interception of sunlight, competition for soil nutrients, and allelopathy. Not all cover crops possess these characteristics and certain cover crops express these characteristics more than others. Figure 1 (page 2) displays the weed suppression capabilities of four cover crops tested in Iowa.

SUSTAINABLE VEGETABLE PRODUCTION

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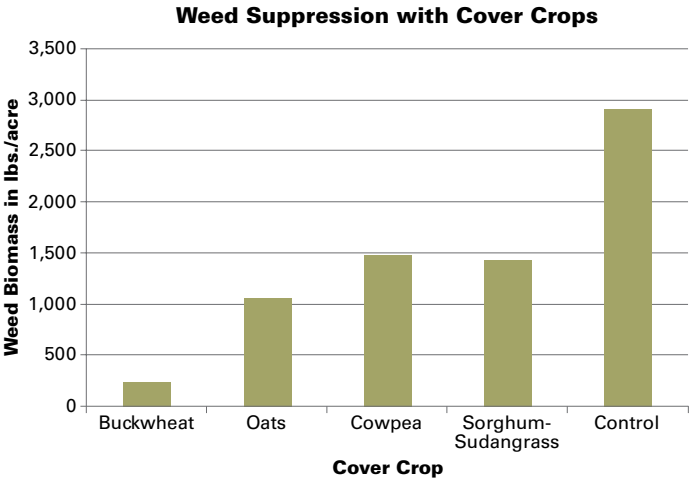

Figure 1. Amount of weed biomass collected in four cover crop plots 61 days after seeding as compared to plots with no cover crop (Control). Data collected at the Horticulture Research Station, Iowa State University in August 2013.

Where do short duration cover crops fit in crop rotation?

Short duration cover crops are typically planted to occupy a fallow period between two vegetable crops. They work well in occupying the field space when not enough time exists to grow another vegetable crop, for example, between a vegetable crop that is harvested in early summer and a fall planted vegetable crop. Short duration cover crops can also be planted after a fall harvested vegetable crop. There could also be repeated plantings of cover crops, usually two to three, within a given year, if the intent is to rotate the field out of vegetable production for a year. Care has to be taken when leaving a short duration cover crop to grow for an extended amount of time. These cover crops can reseed themselves and become a weed in the following vegetable crop. For information and examples of integrating cover crops into vegetable crop production systems please refer to Iowa State University Extension and Outreach publication *Cover Crops in Vegetable Production Systems (HORT 3026)* (Nair et al., 2015).

Cover crop biomass and composition

When deciding on a cover crop, the amount of biomass generated from the cover crop and the carbon to nitrogen (C:N) ratio of the biomass are important factors to consider. Figure 2 displays the cover crop biomass generated from four cover crops at the Iowa State University Horticulture

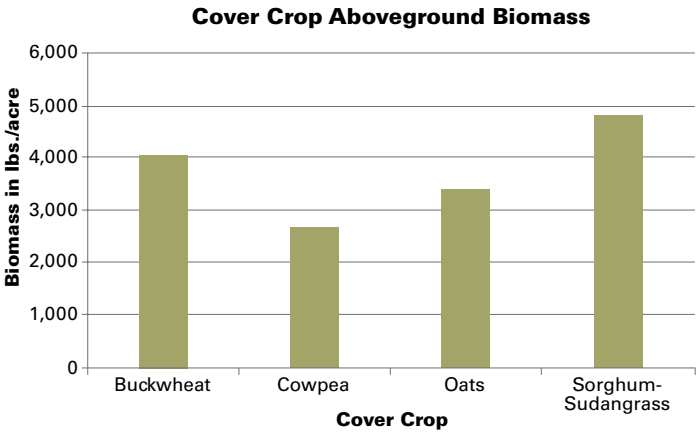

Figure 2. Cover crop biomass (dry weight basis) of four cover crops collected 61 days after seeding. Data collected at the Horticulture Research Station, Iowa State University in August 2013.

Research Station. Cover crops such as sorghum-sudangrass have a high carbon to nitrogen ratio in the biomass. This could lead to a temporary nitrogen immobilization in the soil and limited nitrogen availability to the following crop once the cover crop is terminated and could potentially decrease vegetable yields. If nitrogen is a limiting factor in the field and additional nitrogen will not be supplied to the following vegetable crop, a cover crop with a low C:N ratio should be considered. Examples of cover crops with lower C:N ratio include buckwheat, cowpeas, or soybeans. Grass cover crops such as millets, sorghum-sudangrass, cereal rye, etc. usually have higher C:N ratio than broad leaved cover crops.

Growers plant cover crops with the goal of fixing nitrogen for the following crop. One possible option to enhance nitrogen fixation is by treating legume cover crop seeds with beneficial bacterium, *Rhizobium* sp. The bacterium, through symbiotic relationship with the plant, fixes atmospheric nitrogen. Rhizobium inoculants come in dry (powder) or liquid form but dry forms are more common due to ease of use. When using a dry inoculum, one way to treat legume cover crop seeds is by adding and mixing the inoculum in the planter box of the seed drill. *Rhizobium* sp. are plant specific and must be matched correctly with the plant species for optimum nitrogen fixation. Table 1 lists compatibility matrix with some legume species and the rhizobia that colonize them.

Table 1. *Rhizobium* sp. compatibility with host plants

Genus	Species	Plant
Rhizobium	*melilo*	Alfalfa (*Medicago, Melilotus*)
Rhizobium	*leguminosarum*	Peas (*Pisum*)
Rhizobium	*leguminosarum*	Vetches (*Vicia*)
Rhizobium	*leguminosarum*	Clover (*Trifolium*)
Rhizobium	*leguminosarum*	Beans (*Phaseolus*)
Rhizobium	*fredii*	Soyabean (*Glycine*)

Things to consider when planting a short duration cover crop

- **GROWING SEASON:** The preferred growing season of the cover crop should be considered when making a planting selection. This ensures that the grower is able to successfully capture the intended goal of the cover crop. Summer cover crops are typically warm season plants that prefer the heat of the summer for optimum growth. Generally, cool season cover crops are not recommended for warm season plantings and the same is true for warm season cover crops planted during a cool season. The use of oilseed radish, a cool season plant, is a great example. When planted into a hot summer-like environment, oilseed radish exhibits reduced vegetative growth and is prematurely forced into a reproductive stage where it produces seeds. When planted into a cool season environment, oilseed radish provides lush vegetative growth that competes well with weeds. Exceptions to this concept can be made, but growers should be cautious as to how the cover crop will perform when not planted during the optimal preferred growing season of the cover crop.

- **CULTIVARS:** When choosing cover crops to plant, there may be selected cultivars for use as cover crops. A grower should consider these cultivars because they may have been selected to more optimally perform for their intended purpose as a cover crop. Some aspects that cover crops are selected for are: plant vigor, optimal flowering and cold tolerance. A grower could plant non-specific cultivars of cover crops (ex. grain cultivars of oats) but may not be able to harness the full effect of the intended cover crop planting as one that is selected specifically for cover cropping.

- **FIELD PREPARATION:** How and when the cover crop will be planted has to be taken into consideration when selecting a cover crop to plant. Some questions to consider: is the amount of residue that exists on the current soil surface going to affect the ability to till and plant the cover crop into the soil, is the soil temperature in the adequate range for cover crop seed germination, can the cover crop be planted into a no-till situation, will the cover crop be broadcasted or drilled, etc.

  Whatever cover crop growers chose, proper seed-to-soil contact is required to allow the seeds to absorb water for germination. Optimal seed to soil contact is most often achieved by tillage prior to placing the seed in the soil. Tillage breaks up the soil into a crumbled material that surrounds the seeds for contact (Fig. 3). What is not desired is a cloddy seed bed where seeds can fall into deep cracks that do not offer much contact with the soil (Fig. 4).

Figure 3. Good seedbed

Figure 4. Bad seedbed

Figure 5. Drill with pack wheel

Figure 6. Cultimulcher

Figure 7. No-till coulter

Figure 8. Drill with cereal and legume box

Large clods can also cover seeds and prevent them from emerging. Once the seed is placed into the soil by a planter the soil is often firmed. This is commonly done on drills with a pack wheel behind the area where the seed drops (Fig. 5). Another option to firm a seed bed is a cultimulcher (Fig. 6). This is an implement with large heavy iron rolls that pack the soil to firm the seedbed and offer greater seed to soil contact. Spike tooth harrows are another tool a grower can use to firm the seed bed. This implement consists of heavy steel bars with iron spikes sticking out to the soil. The implement is towed across the soil to break clods and pack the soil. This is a less optimal option but does perform a satisfactory job at firming the seedbed when used. No-till is an option that a grower may choose to plant a cover crop. This process allows the cover crops to be planted without tilling the soil. A no-till coulter attached to the planter frame leads in front of the furrow opener for soil disturbance (Fig. 7). This is usually a fluted coulter disk that provides a very small amount of soil disturbance for seed to soil contact.

- **Seeding rate and method:** Selecting an appropriate seeding rate is a requirement for successful establishment of the cover crop. Lower than optimal seeding rates could lead to a thin stand of cover crops with wide open spaces for weeds to grow with sub-optimal cover crop biomass. For information on appropriate seeding rates please refer to the USDA SARE cover crop manual (*Managing Cover Crops Profitably* 3rd Edition). There are also modified seeding rates of certain cover crops mentioned later in this publication that have been used successfully in research at Iowa State University. To achieve the appropriate seeding rate when selecting a cover crop, it is also important to consider if the seeds can be metered through the planter with the available seeder the grower has on hand. Limitations with certain planters exist since not all planters have a wide variety of planting options for different seed sizes and rates. Some planters have small meter holes that cannot fit large seeds, while other planters have problems seeding small seeds at the low enough rates to keep seed costs down and the

Figure 9. Drop spreader

Figure 10. Roller crimper

cover crop economically feasible. One common practice is to seed using a drill that contains a cereal and legume box (Fig. 8). Most drills that have both a legume and a cereal seed metering system have the ability to plant a wide range of seeds. Another option to seeding a cover crop is a broadcast spreader. Broadcast spreaders are relatively low in cost and have the ability to meter just about any cover crop for spreading. Drop spreaders are another option for seeding cover crops (Fig. 9). They simply drop the seeds like a broadcast spreader but have more control over the area that is getting seeded. With both the drop and broadcast spreader, seeds need to be incorporated into the soil for adequate seed to soil contact. An additional tillage pass or a pass using a harrow is needed to incorporate the seeds for this reason. A cultimulcher or spike tooth harrow can also achieve this goal. One planting implement that is not recommended for cover crop planting is a row crop planter. The row spacing on the planter is too far apart, causing wide open areas between cover crop rows for weeds to grow and establish.

- **Cover crop termination:** How the cover crop will be terminated with the tools available to the grower has to be taken into consideration before planting ever begins. The last problem a grower wants is to have a cover crop come back voluntarily due to inadequate kill and compete with their next vegetable crop. In organic systems herbicides cannot be used to kill the cover crop so the grower has to be sure they have the appropriate equipment to terminate the cover crop. One option that many organic growers use to terminate cover crops is a roller crimper (Fig. 10). This tool is used to flatten the cover crop and crimp the stems of the cover crop, preventing it from regrowing. Another option for terminating a cover crop is a flail mower (Fig. 11). This implement has sharp iron blades that swing on a shaft inside the machine, chopping the growing cover crop into many small pieces and spreading it on the ground. A rotary brush mower can also be used for cover crop termination. This tool is similar to a lawnmower with rotating blades, but the construction of the tool is strong enough to handle the large amounts of biomass a cover crop can generate. After this operation, tilling is often needed to incorporate the chopped biomass and roots of the cover crop. In conventional production a herbicide can be used to terminate the living cover crop. Once the cover crop is dead, tillage is used to incorporate the cover crop in to the soil.

Figure 11. Flail mower

Examples of short duration cover crops

There are a number of short duration cover crops that could be planted but growers need to use crops that are adapted to their region and growing conditions. Table 2 lists a few examples of short duration cover crops along with their advantages and disadvantages for Midwest vegetable production systems.

Table 2. Examples of short duration cover crops and their advantages and disadvantages

Cover Crop	Advantages	Challenges
Buckwheat	• Weed suppression • Pollinator habitat • Easy to terminate • Quickest to establish for ground cover	• Easily reseeds if left to flower • Not very drought tolerant • Not good for breaking up hard soils
Cowpea	• Fixes nitrogen • Rapid breakdown after soil incorporation • Tolerates drought and heat	• Warm season cover crop and does not do well in the fall
Oats	• Suppresses weeds • Quickly establishes for erosion control	• The following crop may need supplemental nitrogen due to soil nitrogen tie up • Not good for breaking up hard soils
Oilseed Radish	• Large roots help reduce soil compaction • Great nitrogen scavenger • Biofumigation capability	• Does not do well in warm season environments • Winter kill can be a problem
Pearl Millet	• Good ground cover after termination due to slow breakdown • Good drought tolerance	• The following crop may need supplemental nitrogen due to soil nitrogen tie up
Sorghum-Sudangrass	• Excellent producer of biomass • Good weed suppression • Good ground cover after termination due to slow breakdown	• May decrease the yield of the following crop due to allelopathic effects • The following crop may need supplemental nitrogen due to soil nitrogen tie up
Soybean	• Fixes nitrogen • Has a low carbon to nitrogen ration that encourages rapid breakdown	• Harbors grain soybean pathogens that could affect successive crop • Not the most optimal for soil conservation
Yellow Mustard	• Handles warm season environments better than other brassica cover crops • Easy to establish when seeded • Biofumigation capability	• Easily goes to seed if left to mature

Buckwheat – a cool season cover crop that does well in warm conditions and those with little nutrient availability. It has excellent weed suppressing capabilities. Seeding rates common for this cover crop are 50 to 60 lb/acre. Biomass ranges from 2,000 to 5,000 lb/acre. Buckwheat should be terminated before it goes to seed which happens approximately 45-50 days after seeding.

Cowpea – a warm season broadleaf legume. It does very well in hot environments. It survives dry periods extremely well. The seeding rate for this cover crop is 30 to 90 lb/acre. Biomass growth ranges from 3,500 to 5,000 lb/acre.


Buckwheat


Cowpea

Oats – a cool season cereal that quickly establishes. It is easily able to be killed with chemicals or mowing if done at the right time. Seed is usually the cheapest when compared to most other small grains. Seeding rates range from to 32 to 128 lb/acre. Cover crop biomass production ranges from 3,000 to 8,000 lb/acre.

Oilseed Radish – a cool season brassica that does very well in cool season environments. Though roots are not the most optimal for weed suppression, the vegetation of the cover crop does a very good job covering the soil once established. Biomass can reach up to 9.8 tons per acre. The seeding rate is 4 to 15 lb/acre.

Pearl Millet – a warm season annual that is close in comparison to sorghum-sudangrass. This millet can do well in soils with low fertility and water. It can get up to 12 feet tall and biomass can reach up to 6,600 lb/acre. The seeding rate is 25 to 30 lb/acre.

Sorghum-Sudangrass – a warm season annual grass that does well in heat. It grows in infertile soils but does much better in soils with more nutrients, especially nitrogen. It is slow to establish but then thrives in the heat once the plants are established. The seeding rate ranges from 40 to 50 lb/acre. Biomass yields can range from just under 3,500 to 12,000 lb/acre.

Soybean – not a new crop to the Midwest, but its use as a cover crop is not common. For use as a cover crop drilling at close row spacing or broadcasting the seeds is a better choice than planting them using row crop spacing patterns. This gives the emerging plants a better chance to more evenly intercept sunlight. Later maturing cultivars are preferred since they produce more biomass and fix more nitrogen. Seeding rates for cover crop soybeans range from 60 to 100 lb/acre.

Yellow Mustard – a cool season brassica that thrives in cool weather but tolerates warm weather much better than oilseed radish. Care has to be taken so that the plants do not get to maturity to reseed themselves in warmer temperatures. Biomass can reach up to 8,500 lb/acre. The seeding rate ranges from 4 to 10 lb/acre.

There are many cover crop options available for use in the Midwest. We simply do not know how all of them perform in vegetable rotations for use as a summer cover crop so further research is necessary. Some other warm season cover crops that growers may want to consider are: sunflowers, velvet bean, mung bean, sun hemp, german millet, proso millet, and teff.

Resources

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