Integrated Pest Management
University of Missouri

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Missouri Produce Growers *Bulletin*
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Cover Crops for Vegetable Production

by Justin Keay, *Field Specialist in Horticulture, MU Extension in St. Charles County*

Soil management of vegetable crops takes on added importance because of their high dollar value. Therefore, soil improvement via the use of cover crops is an important management consideration for vegetable growers. Cover crops represent an effective way to improve both the physical and chemical properties of soils dedicated to vegetable production.

A number of questions must be considered before planting cover crops. They include:

- Is the primary goal of the cover crop to fix nitrogen, suppress weeds or add organic matter to the soil?
- When will the cover crop be planted (i.e, fall, spring or summer) and how long will it take to mature?
- Does the cover crop chosen need to be able to withstand freezing temperatures?
- How will the cover crop be terminated (e.g., mowing, herbicides, etc.) so that the field may be planted?
- Will the cover crop seed itself before termination and risk becoming a weed?
- What cash crop will be planted after the cover crop?

Additionally, growers must be aware of the advantage and disadvantages of various cover crops available for use. For example, legumes, such as clover, hairy vetch, Austrian winter pea and others do a good job of fixing nitrogen, but they don't leave high amounts of residue or contribute greatly to soil organic matter. However, since most vegetable crops require between 100 and 220 pounds of nitrogen per acre, the use of legumes as cover crops can help supply a substantial portion of nitrogen fertilizer requirements.

Alternatively, grasses such as cereal rye, Japanese millet and others produce a lot of biomass and build soil organic matter more rapidly, but they don't fix nitrogen. Additionally, they can tie up nitrogen in soils due to their high carbon-to-nitrogen ratio. Tillage radish and buckwheat neither fix nitrogen or produce abundant residue. However, each serves a function of its own.

The majority of vegetable growers employ fall-planted cover crops, since most of their available land is occupied during the growing season by vegetables. That said, there are several major considerations for fall-planted cover crops. For example, for larger, transplanted crops such as tomato and pepper, a cover crop that can be terminated and left on the soil for mulch and weed suppression might be the best choice. Alternatively, cover crops that are low residue such as tillage radish can be planted directly into the following spring, or incorporated into the soil and then planted.

Fall seeding of cover crops most generally occur from mid-August until mid-September. This allows for an adequate time to achieve the maximum amount of growth. Cereal rye can be planted until Thanksgiving. Some simple options like tillage radish are worth trying, especially for growers who have not planted cover crops before. Tillage radish leaves very little if any residue left on the soil.

Oats is another common cover crop used in vegetables systems. However, it will winter kill and leaves low residue. It often is combined with Austrian winter pea, which is able to fix nitrogen. Hairy vetch is a winter annual that can be planted in the fall and terminated in the spring, using a variety of different methods. Cereal rye is also a winter annual often used as a companion plant to hairy vetch.

The establishment of a cover crop is just as important as the establishment of a cash crop. Cover crop seed germination will be enhanced through good seed-to-soil contact. This can be accomplished through mechanical preparation of the soil, or through the use of hand tools to help rough up the soil surface. Additionally, it is important to remove or kill weeds before planting cover crops, since the latter find it difficult to compete with already established weeds. When legumes are used as cover crops, it is important to remember that different species might require different bacterial inoculant species. Therefore, make sure to purchase the appropriate inoculant for the cover crop being seeded to ensure maximum nitrogen fixation.

Also in this Issue:

Cover crops may be seeded by broadcasting seeds by hand, through the use a belly seeder, or a fertilizer spreader. Drop seeders/spreaders and powered broadcast spreaders represent another option. In any case, covering the seed will also help to enhance seed germination and establishment. The latter can be accomplished through the use of tractor tools such as light harrow, cultipacker or a firmer/roller. Growers also might consider spreading a light layer of compost on top of the seeds, if covering the seeds using the above mentioned options isn't possible. Seeds should be watered in well, especially if the soil is dry. In the absence of rain, irrigation should be considered to help seeds germinate.

The following comprehensive chart was taken from ***Managing Cover Crops Profitably*** published by the Sustainable Agriculture Research and Education (SARE) program.

Chart 3B **PLANTING**

	Species	Depth	Seeding Rate					Cost ($/lb.)[1]	Cost/A (median)[2]		Inoc. Type	Reseeds[3]
			Drilled		Broadcast							
			lb./A	bu/A	lb./A	bu/A	oz./100 ft²		drilled	broadcast		
NONLEGUMES	Annual ryegrass	0–½	10–20	.4–.8	20–30	.8–1.25	1	.70–1.30	12	24		U
	Barley	¾–2	50–100	1–2	80–125	1.6–2.5	3-5	.17–.37	20	27		S
	Oats	½–1½	80–110	2.5–3.5	110–140	3.5–4.5	4–6	.13–.37	25	33		S
	Rye	¾–2	60–120	1-2	90–160	1.5–3.0	4–6	.18–.50	25	35		S
	Wheat	½–1½	60–120	1–2	60–150	1–2.5	3–6	.10–.30	18	22		S
	Buckwheat	½–1½	48–70	1–1.4	50–90	1.2–1.5	3–4	.30–.75	32	38		R
	Sorghum-sudangrass	½–1½	35	1	40–50	1–1.25	2	.40–1.00	26	34		S
BRASSICAS	Mustards	¼–¾	5–12		10–15		1	1.50–3.00	16	24		U
	Radish	¼–½	8–13		10–20		1	1.50–2.50	22	32		S
	Rapeseed	¼–¾	5–10		8–14		1	1.00–2.00	11	16		S
LEGUMES	Berseem clover	¼–½	8–12		15–20		2	1.70–2.50	22	39	crimson, berseem	N
	Cowpeas	1–1½	30–90		70–120		5	.85–1.50	71	113	cowpeas, lespedeza	S
	Crimson clover	¼–½	15-20		22–30		2–3	1.25–2.00	27	40	crimson, berseem	U
	Field peas	1½–3	50–80		90–100		4	.61–1.20	50	75	pea, vetch	S
	Hairy vetch	½–1½	15–20		25–40		2	1.70–2.50	35	65	pea, vetch	S
	Medics	¼–½	8–22		12–26		2/3	2.50–4.00	58	75	annual medics	R
	Red clover	¼–½	8–10		10–12		3	1.40–3.30	23	28	red cl, wht cl	S
	Subterranean clover	¼–½	10–20		20–30		3	2.50–3.50	45	75	clovers, sub, rose	U
	Sweetclovers	¼–1.0	6–10		10–20		1.5	1.00–3.00	16	32	alfalfa, swt cl	U
	White clover	¼–½	3–9		5–14		1.5	1.10–4.00	19	30	red cl, wht cl	R
	Woollypod vetch	½–1	10–30		30–60		2-3	1.25–1.60	30	65	pea, vetch	S

Managing Cover Crops Profitably is one of the most comprehensive resources on cover crops for use both in row crop production, vegetable production as well as perennial crops. It can be viewed online or downloaded from the internet by going to the following web address: https://www.sare.org/wp-content/uploads/Managing-Cover-Crops-Profitably.pdf. Individuals who lack internet access may obtain a copy by sending a check for $25.95 payable to SARE Outreach Publications to: SARE Outreach Publications, c/o International Fulfillment Corp., 3570 Bladensburg Road, Brentwood, MD 20722.

On-Farm Sweet Potato Slip Production for Field Planting by Ramón Arancibia

Sweet potato is grown throughout the U.S. for its enlarged storage roots. More than 147,500 acres were planted in 2019. In Missouri, it is produced mainly by small produce growers, but the market is larger than what is grown locally and is expected to increase further. Therefore, Missouri growers have an opportunity to increase local production to supply local markets. The initial steps in sweet potato production are cultivar selection and propagation for field planting. See the "Midwest Vegetable Production Guide for Commercial Growers" for cultivars and pesticides recommended in Missouri and the Midwest. This article discusses on-farm sweet potato slip (sprouts or cuttings for field planting) production to optimize quality and timing for field planting.

Sweet potato is a perennial tropical crop but cultivated as annual in the U.S. It is sensitive to chilling temperatures (cold temperatures between 32°F and 60°F) and will die with freezing temperatures. However, production of sweet potato slips begins early in the spring under protected systems to harvest slips for field planting as soon as the soil temperature in the field reaches 65°F and the risk of freezing has passed.

Sweet potato is propagated by vegetative slips from sprouted seed-roots (storage root used for vegetative propagation). Select good quality, certified G1 or G2 seed-roots that are uniform and free from insects and diseases to plant in slip production beds. 'G' is referred to the generation or annual cycles after certified virus tested, true to type mother plant from tissue culture (G0). Plan to start propagation from seed-roots 10 to 12 weeks before the optimal date for field planting. Start by pre-sprouting seed-roots in a room at 85°F (29°C) and 90% relative humidity for 2 to 3 weeks or until sprouting is visible. Make sure room is ventilated because the process requires oxygen. Bedding can be done in the field with floating row covers as well as under low and high tunnels. Avoid sites that had sweet potato in the past 3 years to reduce the risk of soil-borne diseases.

Fertilize with 4-5lb/100sqft bed area of 8-8-8 or equivalent fertilizer. Prior to bedding, treat seed-roots with appropriate fungicides to reduce decay. Plant seed-roots in beds 8 to 9 weeks before expected planting date. Spread seeds-roots (one layer) in beds 2-3 ft wide (**Fig. 1**) and cover with 2-3 inches of moist soil or sand. Large growers use an offset rotary ditcher to throw soil on top to cover the seed-roots. Smooth the bed top for good contact and cover with black plastic mulch to warm the soil (**Fig. 2**). Lay two lines of drip-tape before laying plastic mulch and irrigate as needed. Clear plastic mulch can be used but weed problems may arise and herbicides will be necessary. Punch holes every 3-4ft on each side of the bed for ventilation to prevent accumulation of carbon dioxide. Moist soil and temperatures between 75°F and 85°F (24-29°C) are optimal for growth.

Remove plastic mulch when sprouts begin to emerge (2 to 4 weeks after bedding) and cover with floating spun-bonded row cover or low tunnel to promote growth and protect against cold temperatures (**Fig. 3**). Irrigate either by drip or overhead sprinkler as necessary to promote growth especially during drought periods. Remove row cover when sprouts reach 12 to 14 inch or 5-7 day prior to planting to top trim to 10-12 inch and promote slip hardening under direct sunlight. The warmer conditions in greenhouses and tunnels promote sprouting and growth for an early slip production; however, slips are less sturdy for field planting than those from open beds.

Expect yields of 500 to 1,000 slips per 50-lb bushel of seed-roots in 10-15sqft of bed area. For field planting, 10- to 12-inch long sturdy slips with two to four leaves are best. Cut the slips (do not pull) from the beds at 1 to 2 inch above the soil line to minimize the risk of carrying soil pests and diseases (**Fig. 4**). Small growers can use a hedge trimmer, knife or sickle to cut slips, but there are slips harvesters used by large sweet potato growers. Cut the slips and put them in boxes to move them to the field. Select for quality and plant them in the field within 2 day after cutting to avoid loss of reserves and roots that have emerged while waiting to plant. Slip strength and quality influence root quality, which influences the root potential to develop into storage roots. Secondary weak roots are thinner without the potential for storage root development, so they grow into what is known as “pencil roots”.

Sweet potato is cold sensitive and should be planted after danger of frost is over and the soil temperature at 4 inch-deep is >65°F (>18°C). In Missouri, sweet potato planting varies because of the temperature differences between north and south. In northern areas, growers start field planting the first week of June, but in southeastern areas, planting may start the last week of May. Check the weather forecast to make sure there is no risk of freezing before planting.

Figure 1. Bedding sweet potato seed-roots for slip production.

Figure 2. Beds covered with black plastic mulch to warm up the soil.

Figure 3. Bed covered with floating row cover after plastic mulch has been removed.

Figure 4. Cut sweet potato slips for field planting.

Snow Removal from High Tunnels

By David Trinklein

Late winter snow or ice events can be very damaging to plant forcing structures such as high tunnels and greenhouses. Not too many years ago, a wet, heavy snow accompanied by high wind gusts caused considerable structure loss to Missouri vegetable growers. This article is written to provide some tips on how to avoid snow damage in future winter storms.

Avoiding damage from snow, sleet or ice begins with planning the high tunnel structure, and the architectural style selected can make a big difference. As a rule, Gothic arch styles are able to cope with heavy snowfall better than Quonset styles. First, the somewhat pointed ridge of the Gothic arch design helps to facilitate natural shedding of snow. Second, the weakest point of a Quonset unit is ridge, which is nearly horizontal. A Gothic arch (with its pointed ridge) distributes this weak point to the sides of its ribs which are more vertical in orientation, especially toward the edge of the unit.

Rib (bow) spacing also helps to determine a high tunnel's ability to withstand snow. Given the same pipe diameter, a high tunnel with four-foot rib spacing will be significantly stronger than one with six foot spacing. Closer rib spacing does add to initial construction cost but the extra strength (and peace of mind) might be well worth the cost in a heavy snow event.

Anchoring the ribs of a high tunnel properly during construction also helps strengthen it. In areas of high snow load or wind, anchoring every second rib in a concrete caisson is advisable. The caisson should be at least 24 inches in depth to prevent "frost heaving." Additionally, equipping the ribs of a high tunnel with cross members to form an A truss, greatly increases its strength. This can be accomplished by securely attaching a metal pipe inside of the high tunnel from one side of the rib to its other, above head height or about eight feet from the ground.

Given a high tunnel of questionable strength is already in place and a heavy snow is predicted there are measures that can be taken to protect it. A rope thrown over the top of the structure and "walked" back and forth by workers holding the rope on either side can help to remove snow, especially from the high tunnel's ridge area. Snow that builds up on the sides of the ribs can be manually scraped off with a rake or scrapper with an extra long handle attached. Make sure that a material that will not damage plastic is attached to the bottom of the scraper. Also, a wooden pole or three-inch PVC pipe with several layers of carpet affixed to the end can be used to push or "poke" the plastic from the inside of the unit. The flexing of the plastic that occurs from this procedure causes snow that has built up to slide off, in many cases.

Finally, adding internal support in the form of temporary purlin posts extending from the ground to the apex of every second or third rib can be very helpful in preventing snow damage. Wooden 2X4's make excellent supports and are relatively easy to install if two of them are pieced together. Make certain, however, the internal support sits on something with a fairly wide "footprint" (e.g. concrete block) so the weight of the snow does not push the end of the support into the soil.

If none of the above is able to keep up with snow accumulation, a difficult managerial decision needs to be made. Slitting the plastic from the inside to allow accumulated snow to fall through to the ground will ruin the plastic but save the metal ribs. While not inexpensive, plastic is considerably cheaper to replace than metal ribs.

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Free microbial water testing for Missouri produce growers

By Londa Nwadike, *KSU/MU Extension Food Safety Specialist*

Many Missouri produce growers are utilizing the free microbial water testing available through the University of Missouri Extension and Kansas State University. These water test reports are very beneficial for growers to understand the microbial safety of both pre-harvest and post-harvest water. We are pleased to announce that the free testing program will be available until at least December 31, 2021.

As a reminder, growers can go to their local (usually county) health department to ask for a bacteriology private water testing kit (for as many water sources as you would like to test), which will include a sample bottle and submission form. An example of how growers might fill out the form for a pond sample is included below.

Please ensure that filled sample bottles are returned to the local public health department (generally Monday-Thursday, 8AM-4PM) within 24 hours of collection of the sample, and in time to catch the courier that transports the sample to the testing lab.

The test results, including the level of generic E. coli and total coliforms in the water sample, are received within approximately one week of the sample arriving at the laboratory. If test results indicate that E.coli levels are greater than about 126 MPN/100mL, we suggest re-testing the water in a few more weeks, using good hygienic practices when collecting the sample. If test results are consistently high, consider treating the water or utilizing the water source with high E.coli levels for lower-risk activities, such as drip irrigation of non-root crops. Please contact Londa Nwadike (913 307 7391) or Patrick Byers (417-859-2044) of MU Extension if you have more questions on water quality.

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MISSOURI DEPARTMENT OF HEALTH AND SENIOR SERVICES
MISSOURI STATE PUBLIC HEALTH LABORATORY
BACTERIOLOGY PRIVATE WATER TEST REQUEST

101 NORTH CHESTNUT STREET, PO BOX 570
JEFFERSON CITY, MO 65101
(573) 751-3334
http://health.mo.gov/lab/index.php

TEST REQUESTED

- ☐ $10 Routine Well (Total Coliform and E.coli)**
- ☐ Non-Drinking Dairy Water
- ☒ Other MPN for produce
- ☒ No Charge Routine Well (MUST CHECK APPROPRIATE NO CHARGE JUSTIFICATION BELOW)

Accession Number Barcode (For LAB use only)

COLLECTOR / SAMPLE INFORMATION (If different from submitter information)

DATE COLLECTED (YYYY/MM/DD)	TIME COLLECTED (24 HR FORMAT)	BOTTLE NUMBER	COLLECTOR LAST NAME, FIRST NAME
2020/03/11	13:00	1	Wright, Johnny

COLLECTION POINT (ex: sink, outside spigot)	COLLECTION LOCATION NAME
center of pond	south pond

COLLECTION LOCATION STREET ADDRESS	CITY	STATE	ZIP CODE
1849 S Ridge Rd	Buxton	MO	68345

SUBMITTER INFORMATION (RESULTS ARE RETURNED TO THIS ADDRESS)

SUBMITTING FACILITY NAME	PROJECT NAME
High Hill Produce	produce safety

SUBMITTER LAST NAME, FIRST NAME	SUBMITTER TELEPHONE NUMBER/EXT
Wright, Johnny	573-761-5292

SUBMITTING FACILITY ADDRESS	CITY	STATE	ZIP CODE
1845 S Ridge Rd	Buxton	MO	68345

ADDITIONAL INFORMATION

COLLECTION LOCATION COUNTY	COLLECTION LOCATION GPS LATITUDE	COLLECTION LOCATION GPS LONGITUDE
Platte		

COLLECTION LOCATION OWNER LAST NAME, FIRST NAME	COLLECTION LOCATION OWNER TELEPHONE NUMBER
Wright, Johnny	573-761-5292

SUPPLY TYPE
☐ Non-Community Public ☐ Community Public ☐ Private Well - Single Family ☐ Private Well - Multi Home ☐ Chill Water

LOCATION TYPE
☐ Child Care Facility ☐ Restaurant ☐ Motel / Resort ☐ Grocery / Convenience Store ☐ USDA Inspected ☒ Non USDA Inspected ☐ Dairy Plant / Farm

LOCATION EST NUMBER	CONSTRUCTION TYPE	SEWAGE DISPOSAL
	☐ Drilled Well ☐ Driven Well ☐ Spring ☐ Bored/Dug Well ☒ Other Pond	☐ City-Sewer ☒ On-Site

RESAMPLE AFTER TREATMENT	NO CHARGE JUSTIFICATION
☐ Yes ☒ No	☐ Government ☐ WIC ☐ Foster Care ☐ Head Start ☐ Child Care ☒ USDA / Non USDA Inspected Facility