Cover Crops for All Seasons

Expanding the cover crop tool box for organic vegetable producers

Mark Schonbeck and Ron Morse
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Organic farmers and gardeners have striven for decades to maximize the health of the soils they cultivate. Meanwhile, soil scientists have identified three key factors in soil organic matter balance and soil quality: tillage, biomass input, and soil erosion. They recommend:

- reduce intensity and frequency of tillage
- grow cover crops to:
  - maximize biomass
  - optimize nitrogen (N) dynamics
  - minimize bare-soil periods
  - eliminate erosion

Studies have shown dramatic increases in active and total soil organic matter under continuous no-tillage systems. Because these systems rely on herbicides to control competing vegetation during cash crop production, they are not suitable for organic producers. Organic agriculture has even been criticized from a soil-conservation standpoint for its heavy reliance on tillage and cultivation for weed control. However, skillful use of cover crops adds considerable biomass to the soil organic matter cycle and reduces the need for tillage and cultivation. Some cover crops can be rolled, mowed or frost-killed to allow organic no-till planting, while others require tillage or undercutting. The latter can sometimes be grown as a living mulch between beds or rows of the production crop, thus continuing to contribute biomass and protect soil. Researchers at Virginia Tech and several VABF member growers are developing and testing cover-crop based conservation tillage systems for organic vegetables, including no-till vegetable planting into mechanically killed cover crops.

One of the basic tenets of sustainable agriculture is that greater diversity yields greater agro-ecosystem stability, more beneficial organisms, fewer pests and diseases, more sustained crop yields, and more opportunities for farmer innovation. Thus one of our research goals is to develop a larger cover crop "toolbox" from which growers can select cover crops most suited to their regions and production systems. The table on pages 4-6 gives some basic information

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on a number of cover crops, including hardiness, planting time rates and depths, maturity date, biomass and other characteristics; and management methods. The following paragraphs on individual cover crop species are based partly on our observations and partly on decades of collective experience of growers and researchers in the southern region.

Winter rye (cereal rye) is the most often used winter cover crop. It produces lots of biomass, suppresses weeds through competition and allelopathy (release of natural substances that inhibit weed germination and early growth), takes up and conserves soluble soil N, and provides support for viny legumes like vetch. It tolerates somewhat acid or low-fertility soils, and can be killed by mowing after full heading in late spring. Rye may tie up soil N if grown alone, and its allelopathy can inhibit crop seeds sown too soon after it is tilled in. Wait 3-4 weeks.

Wheat and *Triticale* also make good, hardy winter cover crops. Generally similar to rye, they mature a little later and may be harder to mow-kill.

Barley provides good biomass and weed suppression. It prefers light textured soils, roots fairly deeply, and tolerates drought better than other small grains.

Annual ryegrass (Italian ryegrass) can be grown as a winter or summer annual. Its dense fibrous root system promotes crumb structure and stops soil erosion. It forms a lot of biomass, suppresses weeds and conserves soil N. It cannot be mow-killed and must be tilled in as green manure. Note: any seed sold as "annual rye" is *ryegrass* if it looks like lawn grass seed, and is *winter rye* if it looks like wheat berries.

Hairy vetch is the best winter annual legume for cooler regions in the South, surviving freezes to -10°F. It performs well on a wide range of soils, fixes over 100 lb N per acre, and releases about half of it to the following cash crop. Other vetches include *lana vetch* (hardy to zone 7), and *purple vetch* (zone 8), which give more biomass and N than hairy vetch from *spring* plantings. Vetches make soil phosphorus (P) more available, and provide excellent habitat for beneficial insects that eat or parasitize insect pests.

Bicultures (two-species combinations) of N-rich vetches with rye, barley or oats are often planted for maximum cover and biomass, weed suppression, and beneficial habitat. Their balanced carbon-to-nitrogen (C:N) ratio also maximizes soil organic matter formation and provides season-long, slow-release N.

Crimson clover is the best winter annual legume for mild temperate climates (zones 7-8). Known for its spectacular bloom in the spring, it provides valuable beneficial habitat, weed suppression, good biomass and nitrogen fixation. Because of its lower N content (about 2-2.5%, compared to 3-4% for vetches), crimson clover residues release N more slowly than other winter legumes. It is easy to kill by mowing at full bloom and it self-seeds readily if allowed to stand more than a few days past peak bloom. Caution: crimson clover may support pest nematodes that can affect tomato and some other vegetables, in regions where these nematodes are prevalent. Other winter annual clovers with good N fixation potential include *berseem clover*, and *subterranean clover.*

Austrian winter peas, hardy to zone 7, add a lot of biomass and N. Peas are viny and do best when grown with a cereal grain for support. Several other varieties of *field peas* are semi-hardy and can be planted in early spring or late summer. In the latter case, they will winterkill except in zones 8b or higher. Spring planted Austrian peas also perform well.

Spring oats are semi-hardy, and are the best cool-season grass to plant in early spring or late summer with cool season legumes. Like rye, oats suppress weeds, tolerate a wide range of soils, form a lot of biomass and conserve soluble soil N. Oats are somewhat higher in N than rye and less likely to tie up soil N upon incorporation. Black oat is a close relative, grown in Brazil, and experimentally in the US.

Bell bean or *fava bean* is a good N fixer, it also provides abundant nectar for beneficial insects, and is a good legume companion for spring oats. It does not tolerate drought or heat, so late summer plantings may not always thrive. Bell beans are smaller seeded than horticultural favas and are better suited as cover crops.

Daikon, oilseed and *fodder radishes* are deep-rooted, semi-hardy cover crops that open subsoil hardpan, scavenge and conserve soluble soil N, and choke out weeds through rapid canopy closure and strongly allelopathic root exudates. Fall-planted radish decays rapidly after winterkilling, leaving a clean, weed-free seedbed for spring vegetables. To avoid pest and disease problems, radishes should *not* be grown immediately before or after brassica vegetables.

Buckwheat is the most widely available and widely grown summer annual cover crop. Its short (30-45 day) lifecycle, rapid canopy closure, and weed suppression make it ideally suited for short fallow periods during the frost-free season. Buckwheat makes soil P more available. It is also one of the best nectar sources for beneficial insects. It likes warm weather and moist soil, and does not tolerate much drought.

Sudangrass and *sorghum-sudan hybrids* produce tremendous biomass, reaching nine feet within two to three months. Sorghum-sudan chokes out weeds through competition and strong allelopathy. When grown to about 5-6 feet, then mowed back to one foot and allowed to regrow, sorghum-sudan sends its fibrous roots deep into the subsoil to break hardpan. It tolerates heat and drought, but requires warm soil with ample N to thrive, and does well planted in alternate rows with a vigorous summer legume. Difficult to mow-kill, this crop is best planted at midsummer and allowed to winterkill ahead of spring vegetables.

Various species of *millet* make good summer cover crops with high heat and drought tolerance. Foxtail, proso and Japanese millets are best suited for *early* summer (June) plantings, as later plantings produce little biomass because of daylength responses. Foxtail and proso millet are easy to mow-kill, while Japanese and browntop millet grow back readily. Pearl millet is very tall and rivals sorghum-sudan in late summer biomass production, yet is easy to kill by mowing or rolling. Millets do well with cowpeas or soybeans.

Cowpea is a versatile summer legume that fixes lots of N, provides food and habitat for beneficial insects, suppresses pest nematodes, rapidly shades out weeds, and offers edible shell beans (blackeyed peas, *etc*.). Cowpeas are not bothered by Mexican bean beetles, Japanese beetles or deer, and are incredibly tolerant of hot, dry conditions. They require warm soil to emerge well and are not easily killed by mowing.

Soybean also makes an excellent summer legume cover crop. Late maturing or forage varieties should be grown to obtain ample top growth before they set seed and die down. Soybeans are a little more cold-tolerant than cowpea and can produce more biomass and N, but are more susceptible to drought and pests.

Sunnhemp (crotolaria) is a tall, stemmy tropical legume that tolerates lower soil fertility, produces lots of biomass and chokes out weeds. *Lablab bean* is a viny tropical legume that appears to leave a strongly allelopathic (weed-suppressing) residue after frost-kill. Both are experimental in our region. The seeds can be expensive and difficult to obtain.

Yellow sweetclover is a very hardy biennial that can be planted in spring through late summer, then tilled or mow-killed early the following summer after flowering. Sweetclover has strong deep taproots that can break hardpan and make soil P more available. Annual *white sweetclover* is semi-hardy.

Perennial clovers such as red, white and alsike clovers make good living mulches when overseeded into established cash crops, fixing N and offering beneficial habitat over winter and into the next season.

Alfalfa, the "queen of forages", is drought tolerant and a superior N fixer, but it requires *quite* fertile soil. These legumes can also be grown with *perennial grasses* such as timothy, orchardgrass and perennial ryegrass, for two to four years to give intensively cultivated fields a good rest. Rotating to a grass-legume sod can restore soil organic matter levels and reduce summer annual weeds. Perennial cover crops start slowly and are often planted with a *light* sowing of spring oats to help them get started. The oats are mowed off at heading to allow the perennials to get established.

Contact Information:

Virginia Association for Biological Farming
Post Office Box 1003
Lexington, Virginia 24450

www.vabf.org

Crop Species	Hardiness, °F	Seeding, lb/ac[1]	Depth, in.	Seed inoculant	When to plant[2]	Maturity[3]	Ht, ft[4]	Biomass, tons/ac[5]	Main benefits[6]	How to manage[7]
Annual Legumes:										
Hairy vetch	-10	20-40	½-1½	pea/vetch	early fall	May	v 3-5	1-3	**N, B**, P, TS, W	Mow
Crimson clover	0-10	15-30	¼-½	clover	late summer	late April	2	1.5-3	**B**, N, NR, P, W	Mow or Roll
Aus. winter peas	0-10	70-120	1-3	pea/vetch	late summer	May	v 3-5	1.5-3	**N,** B, P, TS, W	Mow
Subclovers	0-15	10-30	¼-½	clover	late summer	late spring	1-2	1.5-4	**B, W*, N,** NR, P	SK
Lana vetch	0-15	20-60	½-1	pea/vetch	early spring late summer	early June WK or late April	v 3-5	1.5-4	**N, B,** P, TS, W	Mow WK (zone 6) or Mow
Berseem clover	5-20	8-20	¼-½	clover	mid- late summer	April-May	2-3	2-4	**N,**NR,B,P,W*,TS	WK (zone 6) or Till
Field peas	10-20	70-120	1-3	pea/vetch	early spring late summer	June-July 55-70 DAP or WK	v 3-5	1-2.5	**N**, B, P, TS	Mow WK
Lupine	15-20	70-120	¾-1	lupine	early spring late summer	July? WK	2		**N, P,** B, SS	Mow WK
Purple vetch	20	30-80	½-1	pea/vetch	early spring late summer	June WK	v 3-6	1.5-4	**N, B,** P, TS, W	Mow WK
Bell / fava bean	20	80-150	1-3	pea/vetch	early spring late summer	June 60-70 DAP or WK	2-4	1-2.5	**N, B,** P, SS,	Mow, Roll? WK
Soybean	tender	60-120	1-2	soybean	after frost	50-75 DAP	2-4.5	1.5-4	**N,** B, TS	Mow, WK
Cowpeas	tender	50-100	¾-1½	cowpea	when soil ≥ 65°F	50-90 DAP	v 2-5	1-3.5	**N, B,** W, P, TS	WK best; Mow?
Sunnhemp	tender	30--50	½ -1	cowpea	after frost	90 DAP or V	5-7	2.5-4.5	**W**, N	Mow, Roll or WK
Lablab bean	tender	10-50	1-1 ½	lablab	when soil ≥ 65°F	V	v 5-10	1-2	**N**, W*	WK, Mow

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Annual Non-Legumes:										
Winter rye	-40	60-150	¾-2		fall	May	4-6	2-5	**W*, NR,** K,TS,B	Mow or Roll
Winter wheat	-25	60-120	½-1½		fall	late May	3-4	1.5-3.5	W, NR, K, TS	Mow?
Triticale	<-10	60-120	½-1½		fall	late May	3-5	2-4	W, NR, K, TS	Mow?
Winter Barley	0	50-125	¾-2		early fall	late April	2-3	1.5-5	**W*,** NR, B, TS	Mow/Roll at milk stage
Ryegrass, ann.	l0-10	15-30	¼-½		early spring late summer	Summer Spring	3	2-3	**W***, TS, K Till	 Till (WK zone 5-6)
Spring Barley	15	50-125	¾-2		early spring	early June	2-3	1.5-4	**W*,** NR, B, TS	Mow/Roll at milk stage
					late summer	60 DAP or WK				WK
Spring oats	15-20	80-140	½-2		early spring	June	3	1.5-4	**W*, NR,** TS, B	Mow/Roll at milk stage
					late summer	70 DAP or WK				WK
Black oats	20	15-50	½		early spring late summer	June-July WK	3	1.5-3	**W, NR,** TS	Mow, Roll? WK
Radish (daikon, oil or fodder)	20	10-20	½		early spring late summer	June Oct. or WK	1.5-3	1.5-3	**SS, W*, NR,**B,TS	Mow WK
Buckwheat	tender	60-80	½-1½		after frost –late sum.	30 DAP	2-3.5	1-1.5	**B**, **W*, P,** TS	Mow or Roll
Sorghum-sudan	tender	25-50	½-1½		when soil ≥ 70°F	65-75 DAP	7-9	3-6	**W*, SS,** NR, B	WK best, Mow? or Till
Foxtail millet	tender	20-35	¼-½		after frost – June	60 DAP	3-4	1.5-3.5	**W**, NR, TS	Mow or Roll
Pearl millet	tender	10-30	¼-½		June – August	65-70 DAP	6-8	3-5	**W**, **NR**, TS	Mow, Roll or WK
Japanese millet	tender	20-30	½-1		after frost – June	50 DAP	4-6	2-4	**W,** NR, TS	Till or WK
Browntop millet	tender	20-30	¼-½		after frost	45 DAP	3	3	**W,** NR, TS	Till or WK

Crop Species	Hardiness, °F	Seeding, lb/ac[1]	Depth, in.	Seed inoculant	When to plant[2]	Maturity[3]	Ht, ft[4]	Biomass, tons/ac[5]	Main benefits[6]	How to manage[7]
Biennials and Perennials:										
Sweetclover	< 0	12-20	¼-½	alfalfa	spring or late sum.	late 2nd spring	3-6	1.5-3	**SS,P,**N,B,W,NR	Mow
Red clover	< 0	10-15	¼-½	clover	spring or late sum.	2nd season	2-3		**N,** P, SS, B, W	Till
White clover	< 0	5-15	¼-½	clover	spring or late sum.	2nd season	0.5-1.5		**B,** N, P	Till
Alfalfa, dormant	< 0	20-25	¼-½	alfalfa	spring or late sum.	2nd season	1.5-2		**N, SS, B,** W, NR	Till
Orchardgrass	< 0	15-20	¼-½		spring or early fall	2nd season	4-5		TS, W, K, B	Till
Timothy	< 0	12-15	¼-½		spring or early fall	2nd season	2-3.5		TS, W, K, B	Till
Ryegrass, peren.	0	25-35	¼-½		spring or early fall	2nd season	3-4		**TS**, NR, W, K, B	Till

[1] Lower rates for drilling, higher rates for broadcast seeding. For grass + legume biculture, sow grass at lower rates, legume at medium rates.
[2] after frost = spring frost-free date until midsummer; late summer = ~6-8 weeks before fall frost;
[3] Full bloom or full head, days after planting (DAP), or month of full bloom in Appalachian region of Virginia. V = remains vegetative; WK = winterkills.
[4] At full bloom or full head. A "v" indicates crop is a vine; number gives typical vine length. Unsupported vines generally form mat 1-2 ft thick.
[5] Estimated aboveground biomass for cover crop grown until full bloom, immature seed stage, or winterkill in Zones 6a-8b of southeastern US, including VA, NC, SC, KY, TN, GA, AL. Total biomass including roots + exudates is about 50% more. Biomass for grass + legume covers may exceed either one grown alone.
[6] B = harbors beneficial insects; N = fixes nitrogen; NR = takes up and holds soluble soil N; P = makes soil phosphorus more available; K = makes soil potassium more available; W = suppresses weeds; SS = opens subsoil; TS = conditions/mellows topsoil. *All* cover crops add organic matter and protect soil from erosion. **Boldface** = particularly strong effect. W* indicates allelopathic effect – residues can inhibit emerging cash crop, effect subsides in a few weeks or over winter.
[7] Till = requires tillage. Mow, Roll = mow or roll at or after full bloom for no-till; WK = allow to winterkill; SK = self seeds and dies in late spring, seeds germinate at end of summer. *All* cover crops can be managed by tilling in at any time before mature seed forms. Mow heavy top growth a week before tilling.