Solving the
SOIL HEALTH
Puzzle?

WE HAVE YOU COVERED

Soil First®
PREMIUM
COVER CROP SEED

Soil First® Management Guide | Edition 6

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About Soil First® & La Crosse Seed

Since 1947, La Crosse Seed has been reliably supplying its customers with quality seed, expert advice and prompt service. Our mission is simple, to be your preferred seed partner. We know you have options and it's our job to prove to you that doing business with La Crosse Seed is your best choice.

The team at La Crosse Seed has carefully researched and selected a family of products that we believe link sound agronomics to practical solutions. Combining solid advice on what to plant and how to manage it - from establishment practices to removal strategies - you can count on the team at La Crosse Seed and the Soil First® family to help you reach your productivity goals. Soil First® products were designed to meet the needs of farmers and landowners looking to increase productivity by preserving and bettering their soils. We believe integrating soil conservation practices like cover crops takes planning, commitment and a long-term dedicated approach.

We take pride in working with a group of dealers dedicated to delivering the cover crop message to the field. We invite you to think "SOIL FIRST®" when making your cover crop planting decisions.

The goal of this manual is to go into more detail on soil health concepts, cover crop species, management strategies and practical solutions. We hope this management guide reassures you that cover crops can successfully be implemented and that through a simple, practical approach, significant advances in soil conservation and health can be reached.

STAY CONNECTED

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Our new Seeding Success App can be downloaded on iOS and Android devices from the App Store or Google Play. Just search "La Crosse Seed"!

THE INDUSTRY STILL HAS SO MUCH TO LEARN ABOUT COVER CROPS

Across multiple regions and soil environments, more data needs to be collected that would be useful in supporting the use of cover crops and green manures as a means of increasing plant available nitrogen (PAN), suppressing costly winter and summer annual weeds and preventing nutrient losses, to only name a few examples. Through the many partners we're working with, La Crosse Seed is working hard to uncover as many data points as possible. Research to date does show cover crops are making strides in bettering our soils overall in the short term and encouraging soil structure and soil health improvements for decades to come. Initiatives across the country support the agronomics behind keeping soil and their nutrients in place and keeping our natural resources protected for the next generation. Hence our name: Soil First®.

Yet, without the proper commitment and planning, seeing gains in soil quality will certainly be delayed and making cover crops function in today's complex cropping systems will simply not work as well.

1. **Have a goal when planting a cover crop.** Ask yourself: "What do I want to get accomplished by planting a cover crop and what benefits do I want to work toward?"

2. **Select the right cover crops to help you reach your goals.** There are many species on the market and each species has a distinct set of characteristics aimed toward achieving different outcomes. Wrong choices can lead to more problems than when you started.

3. **Have a plan!** Think about the changes that may be needed to your current farming system to allow for correct establishment (and management):

    - » Modifying your crop rotation (perhaps the addition of another crop to your rotation allows for a wider window in the fall)
    - » Altering the previous crop's harvest slightly, allowing for more timing flexibility
    - » Adjusting your herbicide program to allow for timely cover crop seeding
    - » Integrating an additional pass in fall and/or spring for planting and spring termination

4. **Select a field** or areas of your farm that will benefit the most from a cover crop.

5. **Think small acres starting out.** Consider the new management concepts needed when trying cover crops or green manures for the first time.

6. **Get seed ordered sooner than later.** It may take longer than you think for our less-traditional seeds to make their way to you. Good, clean seed will be the most demanded. (Seed, not grain, is professionally grown and maintained to ensure good quality and germination.)

7. **Allocate labor and equipment.** Depending on your seeding plan, it may be imperative to have extra help in the summer/fall to allow for the quickest seeding after cash crop harvest. If the plan includes using custom seeding, communicate your plans early to ensure the most timely application.

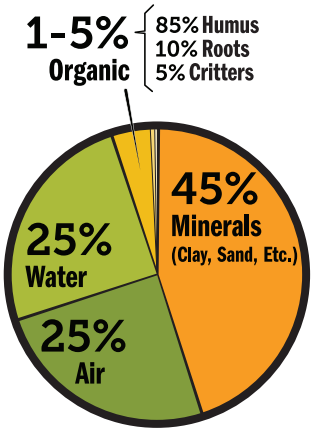
8. **Consider leaving a check strip for comparison.** How better to determine the progress than by seeing uncovered ground side-by-side?

9. **Balance your goals and spring management wisely.** Even the perfect cover crop not managed or terminated correctly in the spring can lead to huge setbacks for your subsequent cash crop.

10. **Make a commitment. Some goals are easily noticed and well defined, but improving soil health is a journey, not a destination. It takes time to regenerate soils and it demands that producers consider long term expectations, no matter their initial goals or objectives.**

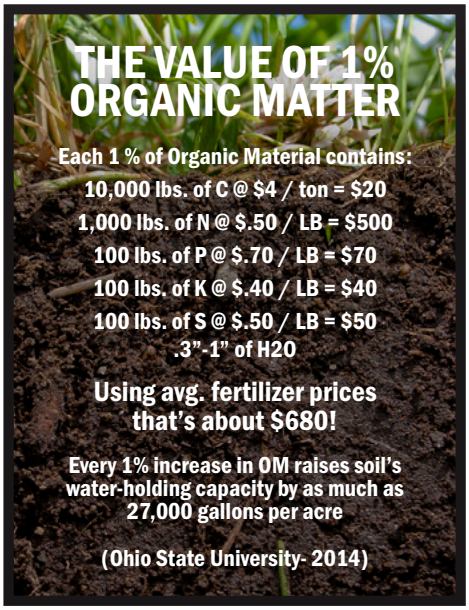
IMPACTING SOILS WITH COVER CROPS

Our soils are a dynamic system composed of living and dead organisms, decomposing and residual organic matter, minerals, water and oxygen. A large portion of our soils cannot be changed or altered. No matter the soil type or condition, that fraction has some level of minerals, air, and water that together typically comprise 95 to 99% of the soil makeup. The balance is the segment that can be affected by conservation practices, both long and short term. This organic section is how we can impact nutrient cycling, water quality and overall soil structure and condition.



Soil health can be defined as the continued capacity of a specific soil as a living system, whereby plant and animal growth, as well as environmental quality are sustained and regenerated. Soil health promotes plant, animal and human health.

Since "health" suggests something living, viewing soils as a living resource to protect and improve makes the idea of using practices like cover crops more practical and more economical.

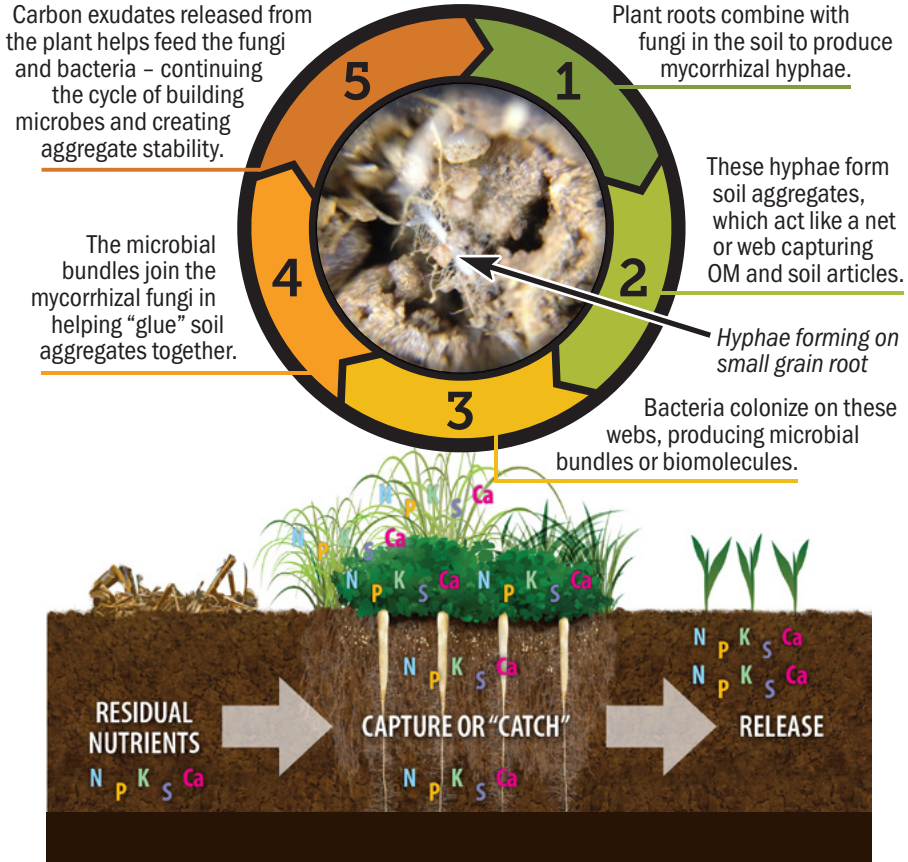


It may take time to create major advances in soil quality, however progress can be discovered by following four basic principles:

1. **Minimize Disturbance.** Unlike soil texture, the soil's structure can be greatly impacted by tillage. Disturbing the soil destroys pore space, ultimately decreasing infiltration of water and the movement of oxygen. Whereas minimum-tillage systems have had a huge impact in improving soil organic matter (a leading indicator of soil quality), no-till by itself isn't enough.
2. **Maximize Biodiversity.** As soil is less disturbed and plant diversity is improved, nutrients become more available for cash crops while restricting unwanted plants and organisms.
3. **Maximize Soil Cover.** Bare soils introduce the probability of wind and water erosion, during which nutrients and organic matter can be carried away and the opportunity for carbon capture is lost.
4. **Provide Continuous Living Roots.** Living organic material (along with dead plant material) in the soil improves soil structure and stores more nutrients, available later for cash crops. Adding continuous roots speeds up organic matter gains (and at the very least maintains organic matter levels). Building OM levels is one goal and we can't afford to mine organic matter either. It's simply worth too much.

Cover crops and green manures stimulate microbial activity because they supply food for the microorganisms to feed on. Soils with living roots contain 1000 - 2000 times more microbes versus those that are bare (Ohio State University). Microorganisms in our soils build organic matter and in turn store nutrients. Nitrogen, phosphorus, and other nutrients are required to build soil organic matter. However, cover crops scavenge those nutrients, supplying food for the microbes instead of the microbes' reserves left from the organic matter.

Aggregate stability leads to increased soil structure, which ultimately leads to better nutrient cycling, and better movement of water and oxygen. Cover crops and green manures prevent those captured nutrients from being lost through soil erosion, leaching and volatilization.



MATCHING COVER CROPS TO YOUR GOAL*

*See pages 25 & 26 to see how Soil First® cover crops can be integrated into your system

1 SEQUESTER NUTRIENTS:

Cover crops can aggressively scavenge and cycle nutrients from deep within the soil profile making them available in the root zone of subsequent crops, improving yields and reducing runoff into sensitive watersheds.

2 REDUCE SOIL EROSION:

Extensive root systems cling to the top layer of soil creating an interior shield from erosion while top growth minimizes "splash" and wind erosion.

3 CREATE A NITROGEN SOURCE:

Legumes produce additional nitrogen (N) by fixing atmospheric nitrogen in the soil.

4 BREAK UP SOIL COMPACTION:

Deep burrowing roots break through compacted soil to create pore space improving aeration, water movement and helping soil organisms flourish.

5 PROVIDE WEED CONTROL:

Cover crops create competition for winter annuals and other weeds by shading them out, and preventing them from robbing valuable moisture and nutrients from subsequent cash crops with the potential of lowering herbicide requirements per acre.

6 PROVIDE PEST CONTROL:

Most cover crops that suppress weeds during the winter months can consequently reduce nematode populations. Some cover crop options deplete nematode by causing premature egg hatching. Other species provide control by eliminating winter annuals that have historically provided a refuge for nematode populations. Still other cover crops contain chemicals that naturally fumigate at risk soil environments.

7 GENERATE ADDITIONAL FORAGE:

Certain cover crop species have the added benefit of being "dual-purpose," meaning they provide both the benefit of a soil cover while providing a valuable forage source for livestock.

8 ADD HABITAT FOR WILDLIFE & ESSENTIAL POLLINATORS:

Fall, winter and spring cover crops create environments crucial for wildlife protection and nesting. Additionally, the biodiversity created by many cover crop systems have positive effects on native pollinators.

9 BUILD ORGANIC MATERIAL:

As cover crops grow, die and break-down, they add organic humus to soil and feed soil microbes, improving soil tilth, soil quality and water holding capacity.

10 INCREASE SOIL STRUCTURE:

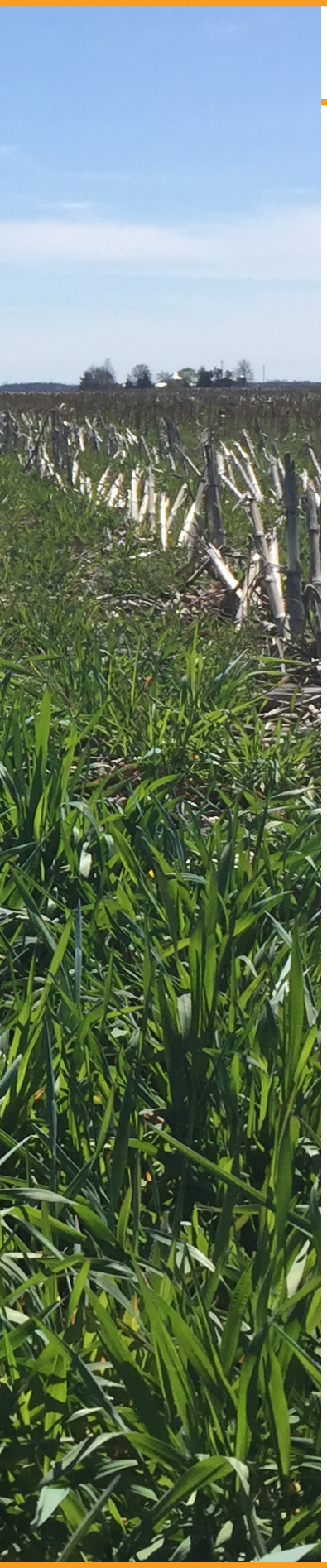
Active plant roots contain mycorrhizal hyphae which form soil aggregates that act like a net capturing organic matter and soil particles. Aggregate stability builds soil structure that leads to better nutrient cycling and better movement of water and oxygen.

11 INCREASE SOIL MOISTURE CAPACITY:

By converting the suns energy into growing biomass and the opportunity for organic matter, runoff and evaporation are reduced while increasing soil moisture.

12 CREATE FINANCIAL VALUE:

The above benefits create the opportunity for better yield potential in cash crops, lower input costs and ultimately higher land values. In addition many states and counties offer cost-sharing initiatives for this important practice.



CEREAL RYE

Fall (cereal) rye is an upright, cool season annual grass that germinates in cool conditions. Very few species offer the many benefits as fall rye while allowing extended planting flexibility long into the fall.

- Fast growing and very hardy (hardiest of all the cereal grains)
- Tolerant of poor soil conditions
- Fights soil erosion
- Captures excess nutrients left from cash crops
- Work well in nurse environments with legumes
- Bears a good symbiotic relationship with brassicas
- Ideal for helping suppress weeds when planted at heavier seeding rates
- Several sound methods exist for successful spring management (refer to page 7)
- Spring and fall forage option (best use – spring, fall, winter pasture)

Considerations:

- Ideal pH = 5.0 – 7.0
- Quick spring growth can easily get away from many producers – have a plan to manage effectively

GUARDIAN® FALL RYE

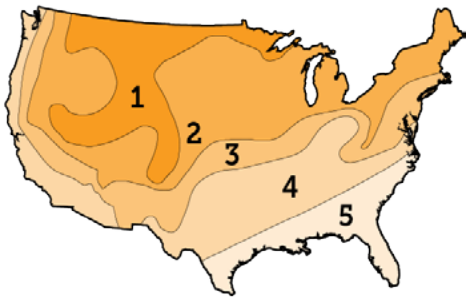
Guardian® fall rye grain seed was carefully screened to provide dependable results in cover cropping situations. Excellent germination and early vigor in cooler temperatures, combined with solid winter hardiness and quick spring green-up make Guardian® an excellent choice for a low-risk entry into cover cropping.

- Created from strong demand for reliable seed from a trusted, weed-free source
- Screened for purity & cleanliness
- Excellent germination & early vigor (allows for later fall seedings)
- Strong winter hardiness
- More management considerations on pages 7 & 8
- ≥ 90% Germ, ≥ 98% Purity

SEEDING RATE: VARIES WITH USE, SEE CHART ON PG. 17 - 18

Planting Window

1. No later than September 25
2. No later than October 5
3. No later than October 15
4. No later than October 25
5. No later than November 1



PLANTING WINDOW DATES ARE FOR FALL RYE, TRITICALE AND BARLEY

WINTER TRITICALE

Winter Triticale is an upright, cool season annual grass bred for crossing wheat and rye grain. This brings together the cover crop benefits (and tonnage potential) of cereal rye with the increased feed value of wheat.

- Performs well on marginal land and/or poor soil environments
- Fights soil erosion
- Captures excess nutrients left from cash crops
- Growth patterns favor use with legumes and brassicas
- Ideal for helping suppress weeds when planted at heavier seeding rates
- Triticale can be seeded earlier in fall than other small grains (less susceptible to Hessian Fly)
- Tolerates poorly drained soils
- Higher levels of digestible energy and crude protein compared to barley
- Spring and fall forage option (best use – fall and spring pasture, silage and hay)

Considerations:

- Ideal pH = 5.2 – 7.0
- Spring growth can be a management concern; terminate early when preceding a grass crop

HY OCTANE WINTER TRITICALE

Hy Octane is a new winter triticale variety that has shown favorable forage yield and winter hardiness across the Midwest. Hy Octane makes a great option for fall and winter grazing, extending the season far past brassicas or cool-season perennial grasses.

- Reduced awned variety to aid in livestock palatability
- Excellent standability - superior to Fridge, Bobcat, Pika in early evaluations
- Good early season vigor and earlier heading date than traditional varieties
  - » Allows greater flexibility for potential double cropping
- Medium straw length allows for easier hay wilting and silage packing

SEEDING RATE: VARIES WITH USE, SEE CHART ON PG. 17 - 18

WINTER BARLEY

Winter Barley is an upright, cool season annual grass known for its quick growth and low water use. Barley is often used on soils where reclamation and/or rapid soil recovery is the goal.

- Drought-tolerant; low water use
- Ideal for suppressing weeds when planted at heavier seeding rates
- Captures excessive nutrients left from cash crops
- Silage value resembles whole-plant corn silage
- Reduces some pests in fruit and vegetable crops
- Known suppression to root knot nematode
- Fall forage option (best use – fall pasture, silage and hay)

Considerations:

- Prefers pH 6.0 – 8.5
- Inconsistent at overwintering versus other winter small grains
- Avoid seeding in cold, damp soils

SPRING MANAGEMENT TIPS FOR WINTER CEREAL GRAINS

TERMINATING SMALL GRAINS

Assuming the predetermined goal allows, it's always recommended to kill small grains early. If terminating with herbicides, glyphosate and/or grass herbicides have been effective in late spring prior to boot stage. This lessens nitrogen immobilization, conserves soil moisture and reduces exposure of voles, armyworms, and other pests. It's common for vegetable and orchard growers to let small grains stand as long as possible in between plant rows. This practice also allows for proper bedding under many fruit and vegetable crops, reducing the risk of root rot while keeping them clean and dry.

OTHER TERMINATION METHODS

- **Tillage –** usually eliminates regrowth, but wait until rye and triticale are at least 10 - 12" tall. Once crop grows taller than 18 - 24", tillage becomes less effective and will most likely take two passes, if not more. Tillage can be effective on barley at mid-late bloom stage (before seed set).
- **Mow/killing –** wait until the stand has begun flowering (rye usually flowers around 14 hours sunlight and temps above 40°F). The use of sickle mowers usually work better than flail mowers. Mowing barley at mid-bloom has been effective.
- **Utilizing rollers, stalk choppers and crimpers** at milk or soft dough stage (usually around 20-24" tall) can flatten stems and potentially eliminate a burndown pass. For barley, rolling needs to take place earlier (mid-bloom).
- Triticale and wheat grow slower in spring than rye and barley, offering more flexibility in wet conditions.

All winter cereal grains require vernalization to produce seed/grain. Spring grazing or mowing can postpone and prolong cereal grain flowering if that fits into the goal.

SEEDING CASH CROPS INTO CEREAL GRAIN STANDS

Adequate seed-to-soil contact and good seed placement is crucial to proper cash crop establishment, but it's a challenge where residues remain on the soil surface, especially small grain residue. Equipment that removes this residue from the immediate seeding area can help reduce stand losses, increase soil temperature in the seed zone and decrease the amount of residue that comes in contact with the seed. Equipment manufacturers have developed several tools to help manage these challenges that cover crops potentially pose to the soil surface in spring. Row cleaners are designed to clear away residue from the opening disks of the planter units. Removing this residue reduces the chance of hair-pinning residue into the seed furrow (common with small grains). Row cleaners should be adjusted to move only residue and not soil (soil movement results in soil drying out and potentially introducing weed competition). Spoked closing wheels improve establishment in poorly drained soils, where traditional smooth rubber closing wheels can result in soil crusting. They also crumble the seed trench, allowing for proper seed-to-soil contact and leaving the soil loose for plant emergence. Any planting equipment should be properly maintained with adequate weight and down pressure for ideal penetration into the soil.

NOTE: The practice of "planting green", or planting cash crops into living cover crops is not for the cover crop beginner. If dry weather is forecasted or a dry spring is expected, it is always recommended to kill the cover crop early, saving valuable soil moisture.

PLANTING CORN AND SOYBEAN CROPS AFTER SMALL GRAINS

Many people attribute the inhibition in corn growth by rye to allelopathy, the release of chemicals by one plant that inhibits the growth of adjacent plants. While rye does produce chemicals that can inhibit plant growth, under most situations the rye biomass on the soil surface is responsible for suppression of weeds rather than the release of phytotoxic chemicals. The chemicals produced by rye probably have little influence on corn growth. Research has shown that susceptibility to allelochemicals is indirectly related to seed size — the smaller the seed the more susceptible the plant. The large seed of corn and its relatively deep planting depth should minimize the impact of any chemicals released by the cover crop. The specific reason for rye's negative effect on corn is unknown, but several factors might be involved besides allelopathy.

1. The presence of rye mulch on the soil surface alters the soil environment in a way that inhibits corn growth. The mulch may delay soil warming and drying, creating a less favorable environment for corn.
2. The decaying rye biomass may tie up soil nitrogen.
3. Rye may act as a 'green bridge' for plant pathogens. The dying rye could serve as a host for pathogens that move to corn seedlings after the rye dies.

Proper management reduces the risk rye poses to corn production. Terminating rye 10 to 14 days prior to planting corn greatly minimizes the chance of a negative impact. Burndown herbicides also are more consistent at killing rye when applied to small plants; however, much of the benefit in suppressing weeds will be lost when treating the rye while it is small. Soybeans can tolerate heavy amounts of rye residue, thus early termination is not as critical when planting soybeans following cereal rye.

(Hartzler, Iowa State, 2011)

MANAGING SMALL GRAINS FOR FORAGE

With the greater need for quality feed sources, cereal grain options are becoming increasingly popular as forage supplements to existing perennial hay and summer annual acres. Many forage benefits are consistent across all these cereal grain options but differences do exist in quality and tonnage based on proper management.

TRITICALE

Triticale is a cross between wheat and rye. This makes for a crop with higher yields than wheat, but lower quality. Triticale is best suited for grazing pasture. Because of its large stems, hay wilting and silage packing can be difficult.

» **Best Use: Fall & Spring Pasture; Silage & Hay (boot to dough stage)**

RYE

Rye offers the advantage of being the easiest cereal grain to establish in poor soils and having the greatest cold tolerance. Rye offers the greatest production for hay or pasture ground because of its quick growth both in the fall and spring.

» **Best Use: Fall, Winter, & Spring Pasture**

SPRING OATS

Oats can be planted in the fall, as long as it's early enough to justify 60 - 90 day production.

» **Best Use: Silage (milk to dough stage); Hay (boot to heading stage)**

WHEAT

Wheat has good potential for forage and is usually higher in quality than rye, triticale and oats but not barley. However, wheat usually produces more dry matter than barley.

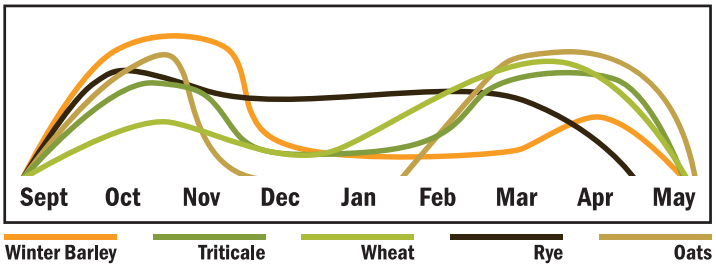
» **Best Use: Fall & Spring Pasture; Silage (boot to dough stage); Hay (boot to milk stage)**

WINTER BARLEY

Winter barley is the most susceptible to winterkill of the cereal grains. Consideration should be made when grazing late into the fall. Barley's value as a silage crop is the most comparable to whole-plant corn (90-100%).

» **Best Use: Fall Pasture; Silage & Hay (boot to dough stage)**

Relative Production of Small Grain Cereals



(Kansas State University)

FERTILITY

Fertilizer removal rates need to be considered as well. When utilizing cover crops as forage, it's critical to consider the nutrients being removed along with the biomass. These fertilizer levels will need to be added to ensure maximum nutrient availability for the following cash crop.

Removal Rates	
Wheat/Rye as Silage • Equivalent 60 bushel yield crop	80-100# N 40# P 60-70# K
Oats • Equivalent 80 bushel yield crop	70-90# N 30# P 100# K

HAY PRODUCTION

Hay yields often average between 2 and 4 tons/acre. Moisture content should be between 15 - 20% moisture. Hay quality is more maturity-dependent at harvest than is silage.

The most efficient time to harvest small grain cereals for hay is at early-milk stage. This allows for the greatest compromise between forage yield and quality (quality would be greatest at the late-boot stage). To help speed up drying, a crimper is recommended when harvesting in the late-boot stage.

SILAGE PRODUCTION

Wheat, barley, oat and triticale silage yields are similar, 4 - 7 tons/acre of 35% dry matter forage in the boot stage and closer to 6 - 10 tons/acre when harvested in the late-boot stage. Small grains should be ensiled at between 62 – 68% moisture. Chop length should be set finer than when harvesting corn or forage sorghum.

(Kansas State University)

RADISH

Radish is an upright, cool season annual broadleaf. Perhaps no cover crop species has been planted on more acres recently than radish, and for good reason. Radish tubers and taproots reduce compaction and scavenge excess nutrients left in the soil from cash crops. Radish stands suppress weed growth, reduce soil and wind erosion, and increase soil microbial activity, especially when mixed with a grass or small grain cover crop. Tolerant of many kinds of manure, radish work especially well after late summer applications.

There are two 'types' of radish to distinguish. Daikon types are strong biomass producers making them a great option for fall grazing. Daikon types (like Soil First® Select Radish) have been bred to produce a deep taproot. Some oilseed radish varieties (like Image) provide the additional advantage of suppressing nematode populations. The oilseed varieties typically do not produce as deep of a vertical taproot, but they still alleviate soil compaction with their lateral taproots and fibrous root system.

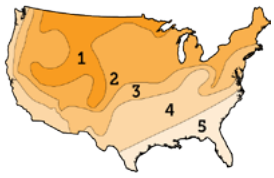
- Reduces compaction and improves drainage and air/water movement (through rapid spring decay)
- Soaks up and releases nitrogen and other nutrients in spring when cash crops need it most
- Dense seed makes for easy planting, typically reaching full growth in 6 - 8 weeks (about 900 GDD)
- Shades out winter annuals and suppresses spring annual weeds
- Winterkills with temperatures in the teens

Considerations:

- Benefits from nitrogen applications (30 - 60# N). Depending on goal, adding nitrogen and other nutrients may or may not be needed.
- Grow best in pH 6.0 – 7.5
- Avoid using radish in cropping systems with other brassicas (disease bridge – club root)
- Radish produce a compound when decaying that omits an odor similar to natural gas (see FAQ #9)

Planting Window

1. No later than August 10
2. No later than August 20
3. No later than September 1
4. No later than September 10
5. No later than September 25



Soil First® Select Radish (daikon type) on the left; Image (oilseed type) on the right

SOIL FIRST® SELECT RADISH

Soil First® Select Radish was selected based on performance in the field. This new daikon type radish was evaluated across many different soil types and environments from the Northwest to across the upper Midwest and Transition Zone. A superior, deep, penetrating taproot is one characteristic that separates Soil First® Select from other radish varieties - growing to a level of 3 - 6', based on soil type, region, and planting date. The upper portion of the taproot (or tuber) can grow to a length of 12 - 24". Select Radish will germinate in only a couple days when moisture is present.

IMAGE RADISH

- Up to 90% nematode control (sugar beet cyst nematode)
- Alleviates soil compaction vertically and horizontally
- Suppresses weed growth
- Excellent at scavenging residual nitrogen and other nutrients
- Reduced odor when decomposing

IMAGE
NEMATODE CONTROL RADISH

RAPESEED

Rapeseed is an upright, cool season and/or winter annual broadleaf. Rapeseed is versatile enough to be planted in the spring for a summer cover, or may be utilized in the fall for a winter cover crop. Rapeseed works great as a dual-purpose crop, adapting to a wide range of soil types and conditions. Rapeseed tends to be extremely drought-tolerant and stands frost better than many brassicas. Because of its winter hardiness, it's common for growers to get multiple grazing cycles when feeding rapeseed.

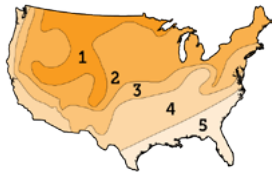
- Deep, fibrous root system, scavenging both nitrogen and soluble phosphorus
- Strong biomass production makes it great for fall and winter grazing
- Offers the most grazing cycles of brassica when planted in late summer/early fall
- Performs well in poor soil fertility conditions
- Likely to overwinter in Transition Zone and South

Considerations:

- Rapeseed can be more difficult to control with glyphosate
- Prefers soils with a pH 5.8 – 8.0
- Rapeseed may attract some non-beneficial pests

Planting Window

1. No later than August 20
2. No later than September 1
3. No later than September 10
4. No later than September 20
5. No later than October 1



TURNIPS

Turnips are an upright, cool season broadleaf which make the perfect dual-purpose cover crop. Their tubers and roots penetrate the soil and cycle nutrients. Early fall planted turnips provide a massive amount of dry matter, while helping to control erosion and suppress weeds. They also work great as a forage crop, especially when mixed with small grains to extend the fall grazing period. While popular options like purple top turnips have large bulbs or tubers, some varieties are bred for a lesser bulb size and larger tops. These options work especially well in grazing environments, and depending on how quickly they regrow, some varieties even allow for multiple grazing cycles into the fall and winter months.

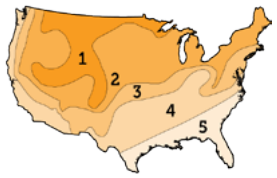
- Small seed size is conducive for easier planting (especially in broadcast applications)
- Good tolerance to dry weather
- Rapid growth provides good early season weed suppression
- Aids in breaking up compaction
- Longer stay-green improves sequestration of excess nutrients left from cash crops

Considerations:

- Grows best in pH 5.5 – 6.8
- Avoid using radish in cropping systems with other brassicas (disease bridge – club root)
- Turnips should be combined with other forages, namely lesser digestible grass or dry hay in ruminant animals (to prevent potential livestock disorders)
- Introduce livestock to turnips slowly

Planting Window

1. No later than August 20
2. No later than September 1
3. No later than September 10
4. No later than September 20
5. No later than October 1



VIVANT HYBRID BRASSICA

Vivant Hybrid Brassica is a quick-growing brassica (upright and spreading cool season annual) with very little bulb development. Vivant is best suited for multiple grazing cycle situations because of its excellent regrowth. It can be used to extend the grazing season in the fall or planted alongside warm season annuals for multiple grazings in the summer. With proper management (first grazing in 40 - 45 days AND subsequent grazing cycles every 25 - 30 days when grazed no less than 4"), it has the potential to yield over 5 tons of dry matter per acre.

- Known for its quick regrowth, even under close grazing
- Different than turnips, all the energy of the plant is contained in the leaves
- High digestibility – suitable for dairy, beef and sheep
- When fed, brassicas need to be combined with other forages (no more than 1/3 of the total animal diet) to prevent potential livestock disorders

PREMIUM COVER CROP OPTIONS - LEGUMES

CRIMSON CLOVER

Crimson clover is a semi-upright winter annual legume that germinates quickly and prefers well drained soil. Crimson tends to remain actively growing in cooler temperatures when warmer season clovers go dormant. Crimson can be successfully established in both fall and spring. To maximize success in late summer plantings, seed at least 6 - 8 weeks before frost. Spring plantings should occur after all danger of frost has passed.

- Strong nitrogen fixing and high biomass potential – N production will be greatest when termination occurs at or after bud stage
- Really good shade tolerance – suitable for interseeding plantings in grass cash crops
- Good option for hay or grazing
- Increases water-holding ability and flowering stands attract many beneficial insects and pollinators
- Suited for many cropping systems across the country, from potatoes to corn to wheat to cotton
- Hardy to USDA Zone 7 (0 – 5° F)

Considerations:

- Heavy stands may attract voles and other pests
- Crimson clover can cause bloat (see page 15 for more information)
- Ideal pH of 5.5 – 7.0

FIXATION BALANSA CLOVER

Balansa clover is a small seeded annual legume that is quick to germinate, offers excellent forage production, and is well-adapted to a wide range of soil types. Established stands tolerate waterlogging and extreme pH soils. Due to the inherent cold tolerance of Fixation Balansa Clover, it can overwinter in climates where other annual clovers cannot.

- Erosion and runoff reduced by impressive growth and root mass
- Extremely drought tolerant
- Suited for low pH environments (4.5 – 8.0)
- Great pollinator option
- Hollow stems provide greater palatability
- Dense growing clover provides good weed suppression

Considerations:

- Quick to germinate, however it is slower to establish than other clovers (crimson and red clover)
- Balansa is a prolific re-seeder; termination or grazing prior to flowering will remove the risk

WINTER HAIRY VETCH

Winter hairy vetch is a vigorous annual legume crop used for fixing nitrogen, biomass production and enhancing organic matter. It's an excellent choice for green manure as its low carbon to nitrogen ratio (C:N) allows for quick plant decay and even quicker capture of organic material and nutrients in the soil profile. Hairy vetch tends to be very tolerant of variable soil conditions, including low fertility environments. Hairy vetch will overwinter in many areas of the country (USDA Zone 3 - 4) withstanding temperatures down to -25 to -30°F, especially where snow is likely.

- Strong nitrogen fixing and high biomass potential
- Reduces runoff and recharge soils during winter (water enters the soil profile through pores created by the vetch residue)
- Phosphorus scavenger
- Heavy mulch layer provides excellent weed suppression and erosion prevention
- Excellent to plant with cereal grain (helps with spring control)
- Seeds and unmanaged vegetation can harm livestock

Considerations:

- Slow to establish
- Prefers soil pH 5.5 – 7.5
- Little forage value (seeds and unmanaged vegetation can harm)
- Glyphosate alone doesn't work well for control (close mowing or light disc will offer spring control)
- Without proper management, it has potential to become weed (high hard seed %)
- Keep off poorly drained sites to aid in spring termination and water conservation
- Potential correlation between hairy vetch and increased soybean cyst nematode/root knot nematode populations

WINTER PEAS

Winter Peas are a rapid, low growing annual legume used across the country as a legume fixing cover crop and/or a quickly decomposing green manure crop. The forage value of winter peas along with their overall management are benefited when planted alongside a cereal grain.

- Strong nitrogen fixer and very high biomass potential
- Quick growth good for weed suppression
- Plant 6 - 8 weeks before first frost to maximize growth and nitrogen production (bud stage or after)
- Hardy to USDA Zone 6 (-5 to -10° F)
- Spring Peas planted in fall (SF 125) need 60 - 90 days to maximize growth

Considerations:

- Ideal soil pH 6.0 – 7.0
- Not the best option for nutrient sequester and/or breaking up compaction
- Large seed size makes broadcast applications more difficult
- Mowing or forage harvest in spring will terminate crops

SUNN HEMP

Sunn hemp is a warm season legume, upright and quick in its growth habit. Sunn hemp needs 60° F soil temps before it can be planted and will kill at the first signs of frost. Higher seeding rates of sunn hemp will help with weed suppression.

- Produces significant amounts of nitrogen in 60 days depending on conditions
- Tolerant of dry conditions and low fertility
- Can add up to 5,000+ lbs. of biomass per acre in 7 - 8 weeks
- Research has shown levels of nematode suppression (root knot, burrowing)

Considerations:

- Prefers soil pH above 6.0 (6.0 – 7.0)
- Kills at first frost, or control by mowing or herbicide at first flower for maximum benefit
- Residue (green manure) should be incorporated while still green
- In far southern areas (below 28° latitude), sunn hemp will produce seed which can be toxic to livestock

FROSTY BERSEEM CLOVER

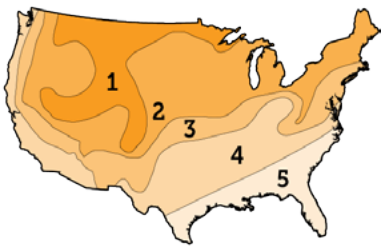
Berseem clover is a summer/winter annual legume known for its ability to tolerate waterlogged soils and soil salinity, while providing higher protein levels than many other legumes. Most berseems winterkill in northern climates (hardy to USDA Zone 8 – about 15 - 20° F), however Frosty Berseem Clover brings improved winter tolerance.

- Produces very large amount of biomass; good weed suppression
- Highly nutritious (18-28% protein)
- Non-bloating legume
- More saline tolerant than alfalfa or red clover (pH 4.8 – 7.8)
- Tolerates waterlogged soil
- Initial growth is slow, but then grows fast - expect forage to be ready in about 8 weeks

Planting Window

Crimson & Balansa Clover:

1. No later than August 20
2. No later than September 1
3. No later than September 10
4. No later than September 20
5. No later than October 1



Winter Peas & Hairy Vetch:

1. No later than September 1
2. No later than September 10
3. No later than September 20
4. No later than October 1
5. No later than October 10

Spring Peas & Berseem Clover:

1. No later than August 10
2. No later than August 20
3. No later than September 1
4. No later than September 10
5. No later than September 20

IMPORTANCE OF INOCULATING LEGUMES

For anyone that has raised legume crops like soybeans, it's common knowledge that rhizobia bacteria inoculants are a crucial component to allowing a legume to properly fix large amounts of nitrogen. But what about a cover crop? Are inoculants really required? A key reason to consider a legume cover crop is to increase nitrogen in the soil, which in turn benefits the following corn or grass crop. The problem is without the correct rhizobia present, that cover crop legume will not maximize nitrogen production, and maximum benefit for the corn or grass crop the following year will not be achieved. So cover crop legumes need rhizobia, and if the proper background population isn't present in the soil, inoculation is a must. The challenge however, is that for most common legumes planted as cover crops, including winter peas, crimson clover, winter hairy vetch, there is no viable option to "pre-inoculate" these seeds like we see in alfalfa or red clover. The rhizobium that nodulate the cover crop legumes are quite fragile and very susceptible to desiccation. In most cases, they do not survive on the seed beyond 24 hours. In contrast, the rhizobium that nodulates alfalfa can survive on the seed for up to two years. Beware of cover crop seed that is pre-inoculated. In most cases, there will not be any surviving rhizobia.

For maximum nitrogen production from our cover crop, it is recommended that we add a fresh inoculant to the seed at the time of planting. Keep in mind, each legume requires a certain strain to nodulate properly. For example, the strain that nodulates red clover will not nodulate crimson clover. Peas and vetches require their own specific strains too. Likewise, any leftover soybean or alfalfa inoculant will not work with cover crops. The challenge has been, "how do I inoculate the legumes in my cover crop?" Legume inoculation is crucial, but it has been difficult to find the right product.

Soil First® LINK™ Inoculant is the solution. This unique, peat based product will inoculate all of the common cover crop legumes in one convenient package. Soil First® LINK™ Inoculant will be offered in a package that treats 500 pounds of seed, matching up well with both 50# bags as well as 2000# bulk bags.

In most commonly used cover crop mixes, legumes generally make up only a portion of the mix. Other seeds, like small grains and radish, are often included too. Soil First® LINK™ Inoculant was designed to be applied on the entire mix, offering ease of use and convenience. The advantage of applying inoculant on the entire mix is that the non-legume seed components then "carry" the inoculant into the soil, where the legume seeds will be nearby. This benefit provides more complete nodulation of the legume and enhanced nitrogen fixation than if the inoculant was applied only to the legume seed.

Soil First® LINK™ Inoculant will be provided with all Soil First® cover crop mixes that include legumes.* In addition, LINK™ Inoculant will be available as a stand-alone item for custom mixes and other legume products. Soil First® LINK™ Inoculant will also be a great option to inoculate forage mixes that include legumes. La Crosse Seed is proud to offer this unique, all-purpose product that should take the guesswork and challenge out of inoculating cover crops, making it easier to maximize the benefit of your cover crop legumes.

*Soil First® LINK™ Inoculant is only provided on orders of at least 500 lbs

ANNUAL RYEGRASS

Annual ryegrass is a quick growing, cool season annual grass. Annual ryegrass has come under scrutiny recently as a cover crop, however the species still provides benefits much needed across the Midwest: nutrient sequestration, erosion control and compaction alleviation. It also adds biomass and organic matter while improving soil structure. With proper management in areas where it over winters, annual ryegrass should be considered as a viable option - both for cover cropping and/or forage needs.

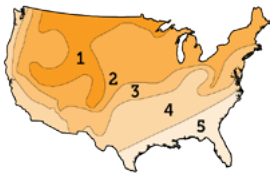
- Establishes quickly - excellent at controlling erosion and suppressing weed development
- Ability to break up hard pans and alleviate compaction with its deep root system
- Fibrous root system is excellent at scavenging residual nitrogen
- Tolerant to poor soil conditions & tolerant to flooding once established
- Good for fields where manure applications are likely
- Proven to help reduce soybean cyst nematode populations
- Beware of annual ryegrass blends - harder to manage because they exhibit different maturity stages when herbicide control is needed in the spring

Considerations:

- Prefers pH between 6.0 – 7.0
- Intolerant of heat and dry weather
- Hundreds of annual ryegrass varieties are on the market – choose the best to meet your goals

Planting Window

1. No later than September 5
2. No later than September 15
3. No later than September 25
4. No later than October 1
5. No later than October 10



9 KEY DETAILS WHEN USING GLYPHOSATE FOR ANNUAL RYEGRASS BURNDOWN

1. Use full glyphosate rates... include ammonium sulfate (AMS)
2. Check your water to ensure the correct pH levels
3. Standard or XR flat fan nozzles are the best for most applications (medium droplet size)
4. Keep spray application volume to 10 gallons/acre
5. Top growth should be taller than 4 - 8”
6. Soil temperatures need to be at least 45°F and climbing
7. Ambient air temperatures need to be above 55 - 60°F – delay applications when night-time temperatures drop below 38°F (ideally need 3 nights above 40°F)
8. Spray in the middle of the day (after dew has dried but 4 hours prior to sunset to allow for adequate translocation)
9. If a 2nd application is needed, wait at least 2 weeks after the1st pass, annual ryegrass becomes harder to control after it joints (begins stem elongation)

Oregon Ryegrass Growers - 2014
(RyegrassCovercrop.com)

COLDSNAP® ANNUAL RYEGRASS

- Excellent for scavenging nutrients and holding them for following crop
- Known for its dense root structure for added compaction relief
- Provides a uniform stand maturity for easier spring control
- Slower to mature than cereal rye and other cereal grains
- ColdSnap™ has been screened and selected for cover crop use
- Superior winter hardiness when compared to other annual ryegrasses

When the opportunity exists to plant early, warm season annuals provide large amounts of biomass while easing compaction, improving soil tilth and absorbing excess nutrients left behind from cash crops. These grasses provide quality forage suitable for all classes of ruminants (usually during periods where traditional perennial crops are less effective). Although referred to as "emergency forage", summer annuals can be part of a planned cover crop program where the dual benefit of forage is the goal.

TIPS FOR MANAGING SUMMER ANNUALS AND OTHER COVER CROPS FOR FORAGE

NITRATE TOXICITY is common when fertility or manure applications are followed by a period of drought or stress. Cut plants do not lessen in their nitrate levels as they cure. If high levels are suspected, forage should be tested for a period of a few weeks until levels subside. Though often linked to summer annual grasses, increased nitrate levels can show up in most cover crops and forages.

1. Nitrates are concentrated more in the lower stalk – raising cutting height can reduce the risk
2. When a stressful drought precedes a moisture event, it is recommended to delay harvest by 1 - 2 weeks
3. Consider split applications of nitrogen (especially useful on summer annuals) to decrease nitrate accumulations

PRUSSIC ACID poisoning can occur when feeding forage sorghums after periods of drought or other stress, including frost. Toxic levels dissipate usually after 2 - 3 weeks and will further decrease when ensiled. Prussic acid is most concentrated in new growth, so sorghum forages should not be grazed until they are at least 18" tall. Storing hay or silage for at least 30 days generally dissipates the concern.

BRASSICA CROPS can cause animal health disorders if not grazed properly. Introduce grazing animals to brassica pastures slowly (usually over 3 - 5 days). With extremely high forage values, brassicas can cause problems if hungry animals are turned out into predominate brassica pastures. Even though traditional recommendations allow for 2/3, we actually recommend keeping brassicas to under 1/3 of the grazing animal's diet - always supplement brassicas with dry hay or other grasses (higher in fiber).

BLOAT can be an issue with most legume species. Reduce bloat by:

1. Utilizing grasses alongside the legumes
2. Pre-fill livestock with coarse hay prior to turning onto pasture, ensuring animals are not turned out to fresh pasture when hungry
3. Do not start grazing when the pastures are wet from dew or rain

GRASS TETANY can occur when grazing lush cereal grain crops in the spring or fall. Tetany risk can be lessened by adding legumes (which offset low magnesium levels that induce tetany) and by keeping livestock out of fields recently fertilized or manured.

When fields are open during late spring / summer, whether part of a planned system or created by unfortunate weather, it's critical to keep soils covered, taking advantage of the longer seeding window and maintaining soil health benefits

1. **Do Something.** Leaving the ground fallow greatly increases the risk of soil erosion and improves the likelihood of leaching nitrates, sulfates and other nutrients that could be utilized by the following year's crop. Bare ground also encourages the risk of "Fallow Syndrome" the following year. **Fallow Syndrome** occurs when there is no plant growth in an area for an extended period of time. Populations of "good fungi", called active mycorrhizae, are reduced because they need actively growing roots to survive. These fungi are dependent on host plants to complete their life cycle. Adding a grass (ryegrass, oats, etc.) or a legume such as peas or hairy vetch are extremely beneficial and will better support the good fungi in the soil. Corn and small grains tend to be more affected by fallow syndrome, although it has been reported as an issue in soybean stands too. Planting some kind of an annual crop on prevented planting acres or on drowned-out spots can help maintain levels of mycorrhizae in the soil. From a biological standpoint, weeds could serve as a "cover crop" to help prevent fallow syndrome, but the resulting weed seed production and contributions to the weed seed bank would lead to increased weed management issues in the future.

2. **Determine Your Goals.** There are many "cover crop" options available to use. The crop rotation goals of the producer should help steer the decision. Normally, crop harvest can often limit the time we have available to plant a cover crop, but because our planting window is now early, just about everything can be considered. Again, this should depend on what the producer wants to accomplish with the cover crop planting.

3. **Understand the Guidelines.** If taking the full prevented plant option, haying or grazing is not allowed until after November 1 (or other dates in the Midwest, depending on state or region). Please check with your local state or county FSA office for further info on grazing restrictions with this program.

4. **Think About Herbicide Restrictions.** Consider herbicides already applied on the acres not yet planted. In many cases, cover crops and other non-traditional crops will not be listed on the herbicide label. The University of Wisconsin and other land grant universities are doing more and more work on this topic to help determine what options farmers have in the case of "prevent plant" or other cropping systems that offer quick seeding windows. If a cover crop is being planted for erosion control and will not be harvested, the grower then assumes the risk if that cover crop doesn't appear on the herbicide label. However, if that cover crop will be harvested as forage, either mechanically or by livestock, then rotational restrictions on the label must be followed. For more information on herbicide rotational restrictions, refer to FAQ #5 on page 28 of this guide.

5. **Use Mixes.** Using cover crop mixes allows for diversity and the opportunity to spread out risk. Mixes also allow for reduced weather risks, help break pest cycles and prevent erosion that some monoculture species are vulnerable to. Added benefits include nitrogen fixing and improved soil health as well.

Prevent Plant Option	Earliest Planting Dates	Compaction Buster	Erosion Preventer	Nitrogen Fixer	Nutrient Scavenger	Weed Suppressor	Forage Provider
Grasses							
Annual Ryegrass	July 10	+++	++	NB	+++	++	++
Fall (Cereal) Rye	July 10	++	+++	NB	+++	+++	+++
Winter Wheat	July 10	+	+++	NB	+++	++	++
Winter Triticale	July 10	+	+++	NB	+++	++	+++
Winter Barley	July 10	+	++	NB	++	++	++
Spring Oats	July 10	+	++	NB	++	++	++
Millets	May 20	+	++	NB	++	++	++
Sorghum x Sudangrass	May 20	+	++	NB	+++	+++	+++
Sudangrass	May 20	+	++	NB	+++	+++	+++
Teff Grass	May 20	NB	+	NB	++	+	+++
Broadleaves							
Buckwheat	June 1	NB	+	NB	++	++	NA
Sunflower	June 1						
Legumes							
Crimson Clover	July 25	+	++	+++	++	++	++
Red Clover	July 25	+	+++	+++	++	+++	+++
White Clover	July 25	NB	++	++	++	++	+++
Berseem Clover	July 25	+	++	+++	++	++	++
Cowpea	May 1	NB	+	+++	+	+	+++
Winter Peas	July 25	+	++	++	+	+	++
Hairy Vetch	July 25	+	++	+++	++	++	+
Sunn Hemp	June 1	NB	++	+++	+	++	+
Brassicas							
Daikon Radish	July 25	+++	++	NB	+++	+++	++
Oilseed Radish	July 25	++	++	NB	+++	+++	+
Turnip	July 25	+	++	NB	+++	++	++
Rapeseed	July 25	++	++	NB	+++	++	+
Mustard	July 25	++	++	NB	+++	++	+

	ANNUAL COVER CROP FORAGE	Planting Season				Carbon/Nitrogen Ratio (C:N)	SEEDING INFORMATION								
		Spring	Summer	Late Sum	Fall		Seeding Rate (mono) lbs/acre	Seeding Rate (mix) lbs/acre	Seeding Rate (for forage) lbs/acre	Seeding Depth (with drill)	Seeds/lb	Seeding Time	Bulk Density * lbs/ft³	Aerial Application Seeding Rate*	Germinat Soil Temperat (Degree Fahrenhe
BRASSICA/MUSTARD	Daikon Radish			■		Tops - 9:1	3-8	1-3	5-8	1/4”	30-40,000	Aug-Sep	44	3-8	45°F
	Oilseed Radish			■		Tops - 9:1	8-12	3-8	8-12	1/4”	30-40,000	Aug-Sep	44	6-12	45°F
	Turnips (Top)			■		Tops - 9:1	2-6	2-4	3-8	1/4”	220,000	Aug-Sep	45	2-6	45°F
	Vivant Brassica		■	■		10:1 - 15:1	4-6	2-3	5-6	1/4”	165,000	July-Sep	44	5-6	45°F
	Forage Collards	■	■	■		15:1 - 25:1	5-12	1-4	10-12	1-4”-1/2”	175,000	Mar-Apr; Aug-Oct	44	8-12	40°F
	Rapeseed	■		■		20:1 - 22:1	4-6	2-4	6-8	1/4”-1/2”	145,000	Apr-May; Aug-Sep	45	5-8	41°F
	Yellow/White Mustard	■		■		20:1 - 30:1	6-15	2-5	-	1/4”-3/4”	100,000	Apr-May; Aug-Sep	46	10-15	40°F
LEGUMES	Crimson Clover	■		■		15:1 - 20:1	10-15	4-8	6-15	1/4”	150,000	Feb-Mar; Aug-Sep	52	6-15	42°F
	Berseem Clover	■		■		15:1 - 20:1	8-20	5-10	15-20	1/4”	150,000	Mar-Apr; Aug-Sep	52	6-15	40°F
	Balansa Clover	■		■		15:1 - 20:1	3-6	1-4	3-6	1/4”	500,000	Feb-Mar; Aug-Sep	56	3-6	40°F
	Winter Hairy Vetch			■	■	10:1 - 15:1	15-30	10-20	30-40	1”	16,000	Aug-Sep	52	NR	60°F
	Sunn Hemp		■	■		18:1 - 29:1	15	5-8	5-15	1/2”-1”	15,000	July-Sep	-	NR	65°F
	Austrian Winter Peas			■	■	15:1 - 20:1	30-80	10-30	40-60	1”	2,000	Aug-Sep	52	NR	41°F
	Peas (Hay)	■		■		20:1 - 25:1	75-120	10-50	75-120	1”	3,000	Mar-Apr; Aug-Sep	50	NR	41°F
	Peas (Silage)	■		■		Pea Straw - 29:1	75-120	10-50	75-120	1”	3,000	Mar-Apr; Aug-Sep	-	NR	41°F
	Peas and Oat Mix	■	■	■	■	-	75-120	-	75-120	3/4”-1”	Varies	Mar-Apr; Aug-Sep	-	NR	41°F
	Medium Red Clover	■		■	■	12:1 - 16:1	8-12	6-8	8-12	1/4”	270,000	Feb-May; Aug-Oct	48	4-10	41°F
GRASSES	Annual Ryegrass	■		■	■	Vegetative - 20:1	15-30	10-15	25-35	1/4”	215,000	Mar-Apr; Aug-Oct	32	15-35	40°F
	Spring Oats (Hay)	■		■		Vegetative - 20:1	30-50	20-40	80-120	3/4”-1”	15-18,000	Mar-Apr; Aug-Sep	38	20-60	38°F
	Spring Oats (Silage)	■		■		Straw - 80:1	30-50	20-40	80-120	3/4”-1”	15-18,000	Mar-Apr; Aug-Sep	-	20-60	38°F
	Fall Rye (Hay)			■	■	Vegetative - 20:1	30-50	20-40	80-120	3/4”-1”	16-18,000	Aug-Oct	50	20-60	34°F
	Fall Rye (Silage)			■	■	Straw - 70:1	30-50	20-40	80-120	3/4”-1”	16-18,000	Aug-Oct	-	20-60	34°F
	Triticale (Fall)			■	■	Vegetative - 20:1	30-50	20-40	80-120	3/4”-1”	14-16,000	Aug-Oct	48	20-60	38°F
	Triticale (Spring)	■		■		Straw - 80:1	30-50	20-40	80-120	3/4”-1”	14-16,000	Mar-Apr; Aug-Sep	-	NR	38°F
	Barley (Fall)			■	■	Vegetative - 20:1	30-50	20-40	80-120	3/4”-1”	14-16,000	Aug-Oct	40	20-60	38°F
	Barley (Spring)	■		■		Straw - 80:1	30-50	20-40	80-120	3/4”-1”	14-16,000	Mar-Apr; Aug-Sep	-	NR	38°F
	Wheat (Hay)			■	■	Vegetative - 20:1	30-50	20-40	80-120	3/4”-1”	11-12,000	Aug-Oct	48	20-60	38°F
	Wheat (Silage)			■	■	Straw - 80:1	30-50	20-40	80-120	3/4”-1”	11-12,000	Aug-Oct	-	20-60	38°F
	Forage Sorghum		■			Vegetative-20:1	6-20	-	6-20	3/4”-1 1/2”	17,000	May-July	45	NR	65°F
	Sorghum x Sudan		■			Leftover Stalks-80:1	25-70	5-20	25-70	3/4”-1 1/2”	21,000	May-July	45	NR	65°F
	Sudangrass		■			-	20-45	-	20-45	1/2”-1”	43,000	May-July	40	NR	65°F
	Teff Grass		■			Vegetative - 20:1	8-12	-	8-12	1/4”	1,300,000	May-July	-	NR	65°F
	Pearl Millet		■	■		12:1 - 20:1	20-30	5-20	20-30	1/2’-1”	60,000	May-Aug	42	NR	65°F
	German Millet		■	■		12:1 - 20:1	20-25	5-15	20-25	1”	220,000	May-Aug	-	NR	65°F
	White Proso Millet		■	■		12:1 - 20:1	20-30	5-20	20-30	1"	80,000	May-Aug	37	NR	65°F
SOIL FIRST® MIXES	SF 101 Cover Starter			■	■	-	30-35	-	40-50	1/4”-1”	-	Aug-Sep	48	30-40	45°F
	SF 102 Cover Starter			■	■	-	30-35	-	40-50	1/4”-1”	-	Aug-Sep	54	30-40	45°F
	SF 120 Extender			■	■	-	35-40	-	40-50	1/4”-1”	-	Aug-Sep	52	35-50	45°F
	SF 125 N-Hancer		■	■		-	35-40	-	40-50	1/4”-1”	-	July-Sep	44	NR	45°F
	SF 140 Multi-Purpose		■	■	■	-	35-40	-	40-50	1/4”-1”	-	July-Sep	50	NR	45°F
	SF 142 Classic		■	■		-	12-15	-	15-20	1/4”-1/2”	-	Aug-Sep	52	20-25	45°F
	SF 150 Field Fit		■	■		-	30-35	-	40-50	1/4”-1”	-	Aug-Sep	36	30-40	45°F
	SF 160 Rooting			■	■	-	15-20	-	20-25	1/4”-1/2”	-	Aug-Sep	50	20-25	45°F
	SF 165 Late Grazer		■	■		-	20-25	-	20-25	1/4”-1”	-	July-Sep	52	NR	60-65°
	SF 167 Summer Grazer		■	■		-	25-30	-	25-30	1/4”-1”	-	July-Sep	50	NR	60-65°
	SF 175 AccuSpread			■	■	-	20-25	-	25-30	1/4”-1/2”	-	Aug-Sep	35	25-30	45°F
	SF 180 Shifter			■	■	-	20-25	-	25-30	1/4”-1/2”	-	Aug-Sep	33	25-30	45°F
OTHER	Phacelia		■	■		12:1 - 18:1	8	1-2	8	1/4”	230,000	Jun-Sep	-	8-10	37°F
	Sunflower		■	■		Leaves 20:1, Stalks 40:1	3-5	1-2	3-5	3/4”-1”	8,000	May-Aug	28	NR	50°F
	Buckwheat	■	■			10:1 - 18:1	40-55	5-20	40-55	1/2”-1”	15,000	May-Aug	40	NR	65°F
	Sugar Beet			■		Tops - 19:1	2-5	1-3	2-5	1/4”	-	May-July	24	NR	

[1] - Net Energy for Lactation = Energy available after subtracting digestive and metabolic losses
[2] - Acid Detergent Fiber = Low values mean more digestible
[3] - Neutral Detergent Fiber = Low values mean cows can eat more
Days to Harvest = Estimations based on average growing season to reach optimum quality
NA = Not applicable; NR = Not recommended

* +/- 5%. Bulk Density averages are only a guide. Moisture, humidity and seed quality all affect bulk density.

REFERENCES: Texas Tech University, Oklahoma State University, Iowa State University, Mississippi State University, North Dakota Stat University, Colorado State University, University of Florida, Michigan State University, University of Wisconsin, Kansas State Universit

			NON-FORAGE BENEFITS									NUTRITIONAL VALUE INFORMATION (Values Vary Greatly Depending on Maturity)										
				Non-Forage Benefits (5 = Excellent, 1 = Poor)																Ranking Good, Better, Best		
USDA Hardiness Zone	Days to Emergence	Nitrogen Fixes or Scavenges	Compaction Alleviation	Weed Suppression	Biomass Production	Erosion Control	Disease/Pest Control	Pollinator/ Beneficials	P & K Cycling	Ease of Establishment	Crude Protein	NEL[1] Mcal/lb	ADF%[2]	NDF%[3]	TDN	DM Tons per Acre	Days to 1st Harvest	Days to Next Harvest	Graze	Baleage	Chop
9	3-5	Scavenger	5	5	4	4	3	2	4	5	18	0.73	26	21	70	2-4	45	-	Best	NR	Good
9	3-5	Scavenger	4	5	4	4	4	3	4	5	18	0.73	26	21	70	2-4	45	-	Best	NR	Good
6-7	4-10	Scavenger	3	5	4	3	3	3	3	5	16	0.70	23	20	69	2-5	60-80	-	Best	NR	Good
7	4-6	Scavenger	3	4	4	3	3	3	3	5	14	-	23	22	78	2-5	35-40	25-30	Best	Better	Good
5	4-10	Scavenger	3	4	4	4	3	3	3	5	20	0.74	25	21	70	2-4	35-40	25-30	Best	NR	Good
5	4-10	Scavenger	5	3	4	4	4	4	4	5	14	TBD	28	41	57	1.5-4	60-80	-	Good	Better	Best
7	5-7	Scavenger	4	3	4	3	4	5	3	5	-	-	-	-	-	-	-	-	-	-	-
7	7-10	Fixer	2	4	3	3	3	3	3	4	17	0.56	31	42	59	.5-2	60	-	Better	Best	Good
8	5-8	Fixer	2	4	3	4	1	3	4	4	18	0.73	23	36	69	1-2.5	60	-	Good	Best	Better
5	14	Fixer	3	4	4	4	3	5	3	4	16	TBD	31	45	65	1-4	40-50	-	Better	Good	Best
3-4	14	Fixer	3	4	4	3	3	5	4	3	26	0.58	33	48	64	1-3	Spring	-	Best	NR	Good
Frost	3-7	Fixer	2	4	5	3	3	4	3	3	25		Varies Greatly			1-5	40-45	-	Best	Good	Better
6+	9	Fixer	2	4	3	3	3	4	2	4	28	0.60	38	54	70	0.5-2	Spring	-	Better	Good	Best
Frost	9	Fixer	2	4	3	3	3	4	2	4	10	0.60	52	62	60	1.5-3	60-80	-	Better	Good	Best
Frost	9	Fixer	2	4	3	3	3	4	2	4	16	0.58	44	55	58	1.5-3	60-80	-	NA	Good	Best
Frost	5-9	Both	2	4	4	4	3	3	3	4	17	0.57	30	57	59	3-5	60	-	Better	Good	Best
4	7-10	Fixer	4	4	4	3	2	4	4	3	16	0.56	36	46	55	2-5	Spring	40	Better	Best	Good
6	7	Scavenger	5	5	3	5	3	2	3	5	9	0.58	38	65	58	.5-2	90	-	Better	Good	Best
7	5-8	Scavenger	2	4	5	4	3	1	3	4	10	0.54	39	63	54	3-6	60-70	-	Better	Good	Best
7	5-8	Scavenger	2	4	4	4	3	1	3	4	12	0.60	39	59	60	1.5-3.5	80	-	NA	Good	Best
3	5-8	Scavenger	4	5	4	5	3	1	4	4	10	0.58	38	65	58	3-5	Spring	-	Good	Better	Best
3	5-8	Scavenger	4	5	4	5	3	1	4	4	14	0.59	37	59	59	2.5-4	Spring	-	NA	Good	Best
3	6-8	Scavenger	2	4	5	4	3	1	4	4	12	0.58	41	69	56	2.5-4	Spring	-	Good	Better	Best
3	6-8	Scavenger	2	4	5	4	3	1	4	4	12	0.58	39	56	58	3-4	50-60	-	Better	Good	Best
6	6-8	Scavenger	1	4	5	4	3	2	3	4	9	0.57	37	65	57	3-4	Spring	-	Better	Good	Best
6	6-8	Scavenger	1	4	5	4	3	2	3	4	12	0.58	37	58	59	2-4	50	-	Better	Good	Best
3	6-10	Scavenger	3	4	4	5	3	1	4	4	9	0.57	38	66	59	2-3	Spring	-	Better	Best	Good
3	6-10	Scavenger	3	4	4	5	3	1	4	4	12	0.59	37	62	59	2-3	Spring	-	NA	Good	Best
Frost	10	Scavenger	4	5	5	4	4	3	3	4	9	0.59	38	59	59	6-9	80-105	-	Better	Good	Best
Frost	10	Scavenger	4	5	5	4	4	3	3	4	16	0.70	29	55	55	5-8	45-70	30	Good	Better	Best
Frost	3-5	Scavenger	4	5	5	4	4	3	3	4	9	0.57	43	67	57	2-6	50	30	Good	Better	Best
Frost	3-5	Scavenger	1	3	3	4	3	2	3	4	18	0.60	33	57	64	3-5	35	25	NR	Good	Best
Frost	3-5	Scavenger	3	5	5	4	4	3	3	5	16	0.66	39	48	52	3-6	45	35	Better	Good	Best
Frost	3-5	Scavenger	3	3	4	5	3	1	3	4	14	N/A	34	60	60	2-4	50	-	Best	NR	NR
Frost	3-5	Scavenger	3	3	4	5	3	1	3	4	12	N/A	39	72	62	1.5-2.5	50	-	Best	NR	NR
-	Varies	Scavenger	5	5	5	4	3	2	4	4	10-13	Nutrition values vary due to differences in the forage quality of the mix components and differences in how and when each component is harvested (grazed versus baleage)				2-5	45-50	Spring	Best	Good	Better
-	Varies	Both	5	5	4	5	3	2	4	4	12-15					2-5	45-50	Spring	Best	Good	Better
-	Varies	Both	4	5	5	4	3	3	4	3	12-16					-	50-60	Spring	Best	Good	Better
-	Varies	Fixer	4	4	4	5	2	3	4	4	14-18					2-5	45-50	-	Best	Good	Better
-	Varies	Both	4	5	5	3	3	2	3	5	11-14					3-5	45-50	25	Best	Good	Better
-	Varies	Both	4	3	3	3	3	3	4	4	16-18					2-4	45-60	Spring	Best	Good	Better
-	Varies	Scavenger	5	5	4	3	3	2	3	5	13-17					2-4	45-50	-	Best	NR	Good
-	Varies	Scavenger	5	4	4	4	4	3	4	4	10-14					2-4	45-50	Spring	Best	Good	Better
-	Varies	Both	4	5	5	4	3	4	3	3	10-14					2-5	45-50	-	Best	Good	Better
-	Varies	Both	4	5	5	4	4	4	3	3	10-14					3-6	40-45	-	Best	Good	Better
-	Varies	Both	5	4	4	4	4	3	4	4	10-16					2-5	45-50	Spring	Best	Good	Better
-	Varies	Both	5	4	3	4	4	3	4	3	10-15					2-4	50-60	Spring	Best	Good	Better
8	10-14	Scavenger	2	5	3	3	4	5	2	4	-	-	-	-	-	-	-	-	-	-	-
Frost	4-10	Scavenger	4	3	3	4	3	5	4	3	11	TBD	36	42	63	2-3	Varies	-	Best	N/A	Better
Frost	3-5	Scavenger	3	5	4	2	1	5	5	5	12	0.68	33	44	65	1.5-4	60	-	Better	NR	Good
8		Scavenger	4	4	4	3	3	2	3	4	14	0.58	14	25	58	2-4	60-80	-	Best	NR	Good
											Alfalfa (Silage)	18	0.55	37	49	55	3-8	-	30	N/A	N/A	Best
											Alfalfa (Hay)	19	0.59	35	45	59	3-8	-	30	Good	Better	Best
											Corn (Silage)	8	0.74	27	46	72	7-10	120	-	N/A	N/A	Best

PREMIUM SOIL FIRST® MIXES

SF 101 COVER STARTER

GUARDIAN® FALL RYE + SOIL FIRST® SELECT RADISH

SEEDING RATE: 30 - 35 lbs/acre (heavier rate later in planting window)
40 - 50 lbs/acre for forage

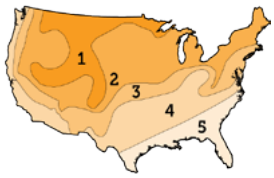
- **SF 101 meets the objectives of nutrient scavenging, erosion control, weed suppression and soil building**
- **Perfect for the 1st time cover cropper; radish winterkills in many regions & cereal rye is fairly easy to control**
- **Works well in multiple parts of the country and in marginal soil environments**
- **Ideal after silage harvest or before/after fall manure applications**

Termination: Rye can be controlled with traditional glyphosate rates prior to 12 - 18" growth. 2' tall rye should be controlled with roller or crimper. If mowing, wait until rye begins to flower. Radish will terminate with multiple nights in the teens. If radish survive, glyphosate and 2,4-D offer an effective control method.

Considerations: When seeded early in summer, additional grains or grass will need to be added to compete against radish growth. Rye can tie-up nitrogen and other nutrients. Controlling rye early results in less nutrient tie-up and conserves more water.

Planting Window

1. No later than August 15
2. No later than August 25
3. No later than September 5
4. No later than September 15
5. No later than October 1



Benefits

Compaction Alleviation	5
Weed Suppression	5
Biomass Production	5
Erosion Control	4
Disease/Pest Control	3
Pollinator/Beneficials	2
P & K Cycling	4
Ease of Establishment	4

SF 102 COVER STARTER+

SOIL FIRST® SELECT RADISH + GUARDIAN® FALL RYE + CRIMSON CLOVER

SEEDING RATE: 30 - 35 lbs/acre (heavier rate later in planting window)
40 - 50 lbs/acre for forage

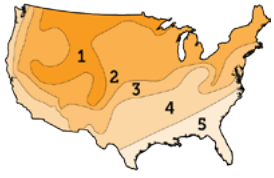
- **Crimson clover allows entire mix to decompose quicker, conserve water and decrease nitrogen immobilization**
- **SF 102 is SF 101 with the addition of crimson clover, fixing nitrogen for grass cash crops**
- **Crimson clover is fairly quick to establish, adding biomass and additional root structure**
- **Nitrogen is maximized at clover flowering, however spring management will need to be considered**

Termination: Rye can be controlled with traditional glyphosate rates prior to 12-18" growth. 2' tall rye should be controlled with roller or crimper. If mowing, wait until rye begins to flower. Radish will terminate with multiple nights in the teens. If radish survive, glyphosate and 2,4-D offer an effective control method. If crimson clover overwinters, control with glyphosate and 2,4-D.

Considerations: When seeded early in summer, additional grains or grass will need to be added to compete against radish growth. Rye can tie up nitrogen and other nutrients. Controlling rye early results in less nutrient tie-up and conserves more water. Crimson clover may attract voles and may need terminated even earlier to decrease the residue.

Planting Window

1. No later than August 15
2. No later than August 25
3. No later than September 5
4. No later than September 15
5. No later than October 1



Benefits

Compaction Alleviation	5
Weed Suppression	5
Biomass Production	4
Erosion Control	5
Disease/Pest Control	3
Pollinator/Beneficials	2
P & K Cycling	4
Ease of Establishment	4

SF 120 EXTENDER

HY OCTANE TRITICALE + FIXATION BALANSA CLOVER + SOIL FIRST® SELECT RADISH

SEEDING RATE: 35 - 40 lbs/acre (heavier rate later in planting window)
40 - 50 lbs/acre for forage

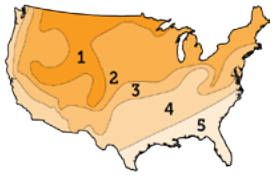
- **Multi-use cover crop mix – good for forage and/or building biomass through extended soil coverage**
- **Triticale acts similar to cereal rye, with better forage quality and animal acceptance**
- **Balansa clover has shown improved winter hardiness vs many other clover species**
- **Balansa is slower to establish than other clovers, so spring growth ultimately yields better nitrogen contribution**

Termination: Triticale can be controlled with traditional glyphosate rates prior to 12 - 18" growth. 2' tall triticale should be controlled with roller or crimper. If mowing, wait until triticale begins to flower. Radish will terminate with multiple nights in the teens. If radish survive, glyphosate and 2,4-D offer an effective control method. If balansa overwinters, herbicide applications including glyphosate prior to flowering have been effective.

Considerations: When seeded early in summer, additional grains or grass will need to be added to compete against radish growth. Triticale can tie up nitrogen and other nutrients. Controlling triticale early results in less nutrient tie-up and conserves more water. Balansa is a prolific re-seeder. Termination or grazing prior to flowering will remove the risk.

Planting Window

1. No later than August 15
2. No later than August 25
3. No later than September 5
4. No later than September 15
5. No later than October 1



Benefits

Compaction Alleviation	4
Weed Suppression	5
Biomass Production	5
Erosion Control	4
Disease/Pest Control	3
Pollinator/Beneficials	3
P & K Cycling	4
Ease of Establishment	3

SF 125 N-HANCER

SPRING OATS + SOIL FIRST® SELECT RADISH + FIXATION BALANSA CLOVER + SPRING PEAS + CRIMSON CLOVER

SEEDING RATE: 35 - 40 lbs/acre (heavier rate later in planting window)
40 - 50 lbs/acre for forage

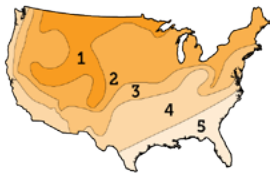
- **Designed as a nitrogen booster in front of grass cash crops; decreased spring management needed**
- **Oats work as a carrier, but also keep nitrogen from leaching or leaving the system**
- **Heavy legume mix will work in grazing environments, supplying high protein and digestibility**
- **Nitrogen production will be widely varied, based on planting date, climate, spring termination date, etc.**

Termination: In most environments, only the clovers will demand spring control. Both crimson and balansa clovers can be successfully terminated with glyphosate and 2,4-D. Radish will terminate with multiple nights in the teens. If radish survive, glyphosate and 2,4-D provide effective control.

Considerations: Early planting is the goal with SF 125. More biomass equals greater nitrogen contribution. Because of peas' larger seed size, broadcast or aerial applications are not recommended.

Planting Window

1. No later than August 10
2. No later than August 20
3. No later than September 1
4. No later than September 10
5. No later than September 20



Benefits

Compaction Alleviation	4
Weed Suppression	4
Biomass Production	4
Erosion Control	5
Disease/Pest Control	2
Pollinator/Beneficials	3
P & K Cycling	4
Ease of Establishment	4

PREMIUM SOIL FIRST® MIXES

SF 140 MULTI-PURPOSE

HY OCTANE WINTER TRITICALE + SOIL FIRST® SELECT RADISH + VIVANT BRASSICA + FORAGE COLLARDS + WINTER PEAS

SEEDING RATE: 35 - 40 lbs/acre (heavier rate later in planting window)
40 - 50 lbs/acre for forage

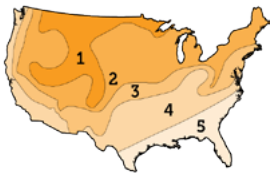
- **Fits into several systems – after silage or small grain harvest**
- **Good option to seed on acres where leftover nutrients exist**
- **Formulated ideally for maximizing forage through multiple grazing cycles**
- **Forage collards mean additional grazing opportunity, but they may need to be spring terminated in some regions**
- **Great option after silage or small grain harvest (or acres where leftover nutrients exist)**

Best Use: Designed for maximizing biomass on open opportunity ground late summer and/or early fall; can be utilized prior to any cash crop when taken off as forage

Termination: Triticale can be controlled with traditional glyphosate rates prior to 12 - 18" growth. 2' tall triticale should be controlled with roller or crimper. If mowing, wait until triticale begins to flower. Radish will terminate with multiple nights in the teens. If radish survive, glyphosate and 2,4-D offer an effective control method. Forage brassicas will typically winterkill with temperatures below 25° F and collards are winder-hardy to Zone 5 (-15° F). Forage brassica can be controlled with glyphosate and 2,4-D, however, collards require other broadleaf herbicides if not grazed out completely.

Planting Window

1. No later than August 10
2. No later than August 20
3. No later than September 1
4. No later than September 10
5. No later than September 20



Benefits

Compaction Alleviation	4
Weed Suppression	5
Biomass Production	5
Erosion Control	3
Disease/Pest Control	3
Pollinator/Beneficials	2
P & K Cycling	3
Ease of Establishment	5

SF 142 CLASSIC

CRIMSON CLOVER + SOIL FIRST® SELECT RADISH

SEEDING RATE: 12 - 15 lbs/acre (heavier rate later in planting window)
15 - 20 lbs/acre for forage

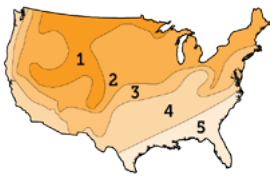
- **Ideal for acres going to corn or other grass crops; research shows positive results in V3 - V6 corn interseeding**
- **Simple mix to use on acres where excess moisture can be an issue, or prevent plant acres, etc.**
- **Low seeding rates work well in aerial seedings and where application options are limited**

Termination: Radish will terminate with multiple nights in the teens. If radish survive, glyphosate and 2,4-D offer an effective control method. If crimson clover overwinters, control with glyphosate and 2,4-D.

Considerations: When seeded early in summer/fall, consider additional grasses to help compete with the quick radish growth. Heavy crimson clover may invite voles. See FAQ #8.

Planting Window

1. No later than August 20
2. No later than September 1
3. No later than September 10
4. No later than September 20
5. No later than October 1



Benefits

Compaction Alleviation	4
Weed Suppression	3
Biomass Production	3
Erosion Control	3
Disease/Pest Control	3
Pollinator/Beneficials	3
P & K Cycling	4
Ease of Establishment	4

SF 150 FIELD FIT

SPRING OATS + SOIL FIRST® SELECT RADISH

SEEDING RATE: 30 - 35 lbs/acre (heavier rate later in planting window)
40 - 50 lbs/acre for forage

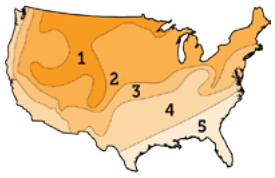
- **Very simple cover crop mix; will completely winterkill in many northern climates**
- **If sequestering leftover nutrients is the goal, this is the mix to use**

Termination: Radish will terminate with multiple nights in the teens. If radish overwinter, glyphosate and 2,4-D provide effective control.

Considerations: Because of its large percentage of oats, there is minimal lasting residue with SF 150. If grazing, introduce SF 150 slowly and don't allow brassicas to ever make up more than 1/3 of livestock's diet.

Planting Window

1. No later than August 20
2. No later than September 1
3. No later than September 10
4. No later than September 20
5. No later than October 1



Benefits

Compaction Alleviation	5
Weed Suppression	5
Biomass Production	4
Erosion Control	3
Disease/Pest Control	3
Pollinator/Beneficials	2
P & K Cycling	3
Ease of Establishment	5

SF 160 ROOTING

COLDSNAP® ANNUAL RYEGRASS + SOIL FIRST® SELECT RADISH

SEEDING RATE: 15 - 20 lbs/acre (heavier rate later in planting window)
20 - 25 lbs/acre for forage

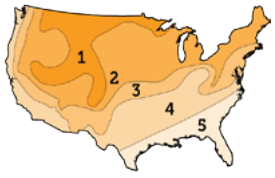
- **Best combination of species for breaking up hard pans and holding onto leftover nutrients**
- **Flexible mix to use in front of corn, soybeans and many other cash crops**
- **SF 160 works well with fall manure applications; annual ryegrass is fairly tolerant to salt differences in manure**
- **Annual ryegrass justifies spring management planning in areas where it's known to overwinter**

Termination: Radish will terminate with multiple nights in the teens. If radish overwinter, glyphosate and 2,4-D provide effective control. For annual ryegrass termination, using glyphosate by itself or with other grass killers can be used, but several key management criteria need met to ensure success. See page 14.

Considerations: Any time annual ryegrass is used, spring management has to be a main priority. Keep ryegrass from going to seed at all costs. Annual ryegrass not terminated can have adverse effects on any subsequent grass crops. The use of ryegrass blends have given ryegrass a bad reputation – make sure it is a single, respected variety. Multiple maturities make control even more complex.

Planting Window

1. No later than August 20
2. No later than September 1
3. No later than September 10
4. No later than September 20
5. No later than October 1



Benefits

Compaction Alleviation	5
Weed Suppression	4
Biomass Production	4
Erosion Control	4
Disease/Pest Control	4
Pollinator/Beneficials	3
P & K Cycling	4
Ease of Establishment	4

PREMIUM SOIL FIRST® MIXES

SF 165 LATE GRAZER

PEARL MILLET + SOIL FIRST® SELECT RADISH + SUNN HEMP

SEEDING RATE: 20 - 25 lbs/acre (heavier rate later in planting window)
20 - 25 lbs/acre for forage

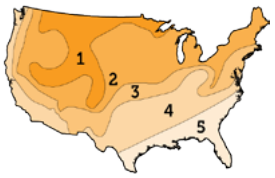
- **SF 165 needs to be planted in the summer/late summer, taking advantage of warm season species in the mix**
- **Tolerates a wide range of conditions – poor soil, low pH, hot and extremely droughty environments**
- **Pearl millet differs from sorghum x sudangrass – no threat of prussic acid poisoning**
- **Formulated to maximize biomass growth when planted early and still provide safe forage well into fall**

Termination: Any frost will terminate pearl millet and sunn hemp. Small sunn hemp (less than 3 - 4') can be effectively controlled with light rates of glyphosate. Taller plants require higher rates and equipment to allow for proper coverage. Radish will terminate with multiple nights in the teens. If radish overwinter, glyphosate and 2,4-D provide effective control.

Considerations: Sunn hemp will flower when temperatures allow across the country, but will only produce seed in the far southern areas, below 28 degree north latitude such as Orlando, FL and Corpus Christi, TX. Sunn hemp is known to contain toxic alkaloids harmful to grazing animals, present in the seeds only. Sunn hemp may not be ideal in 100% of no-till systems as any leftover residue can be tough to plant through the following spring. To maximize forage production, nitrogen applications are recommended. However, those same fertility supplements can pose an increased threat of elevated nitrates in pearl millet after plants are stressed. See page 15 for more details on managing nitrate poisoning.

Planting Window

1. No later than July 25
2. No later than August 5
3. No later than August 15
4. No later than August 25
5. No later than September 5



Benefits

Compaction Alleviation	4
Weed Suppression	5
Biomass Production	5
Erosion Control	4
Disease/Pest Control	3
Pollinator/Beneficials	4
P & K Cycling	3
Ease of Establishment	3

SF 167 SUMMER GRAZER

SORGHUM X SUDANGRASS + SUNN HEMP + SOIL FIRST® SELECT RADISH

SEEDING RATE: 25 - 30 lbs/acre (heavier rate later in planting window)
25 - 30 lbs/acre for forage

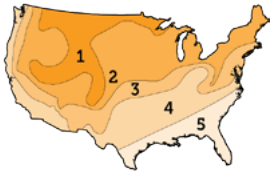
- **SF 167 needs to be planted in the summer/late summer, taking advantage of warm season species in the mix**
- **Tolerates a wide range of conditions – poor soil, low pH, hot and extremely droughty environments**
- **Conventional sorghum x sudangrass offers increased tonnage potential in grazing systems**
- **Formulated to maximize biomass growth when planted early**

Termination: Any frost will terminate sorghum x sudangrass grass and sunn hemp. Small sunn hemp (less than 3 - 4') can be effectively controlled with light rates of glyphosate. Taller plants require higher rates and equipment to allow for proper coverage. Radish will terminate with multiple nights in the teens. If radish overwinter, glyphosate and 2,4-D provide effective control.

Considerations: Sunn hemp will flower when temperatures allow across the country, but will only produce seed in the far southern areas, below 28 degree north latitude such as Orlando, FL and Corpus Christi, TX. Sunn hemp is known to contain toxic alkaloids harmful to grazing animals, present in the seeds only. Sunn hemp may not be ideal in 100% of no-till systems as any leftover residue can be tough to plant through the following spring . Sorghum x sudangrass presents the opportunity for prussic acid toxicity, especially after fall frosts. To maximize forage production, nitrogen applications are recommended. However, those same fertility supplements can pose an increased threat of elevated nitrates in sorghum x sudangrass after plants are stressed. See page 15 for more details on managing prussic acid and nitrate poisoning.

Planting Window

1. No later than July 25
2. No later than August 5
3. No later than August 15
4. No later than August 25
5. No later than September 5



Benefits

Compaction Alleviation	4
Weed Suppression	5
Biomass Production	5
Erosion Control	4
Disease/Pest Control	4
Pollinator/Beneficials	4
P & K Cycling	3
Ease of Establishment	3

SF 175 ACCUSPREAD

COATED COLDSNAP™ ANNUAL RYEGRASS + COATED CRIMSON CLOVER + SOIL FIRST® SELECT RADISH

SEEDING RATE: 20 - 25 lbs/acre (heavier rate later in planting window)
25 - 30 lbs/acre for forage

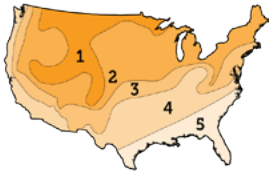
- **Traditional combination of species for breaking up compaction, sequestering leftover nutrients and building soil structure**
- **Flexible mix to use in front of corn, soybeans and many other cash crops**
- **Annual ryegrass in SF 175 utilizes CrosseCoat™ Technology – aiding in ballistics, spread patterns and more consistent germination**
- **Annual ryegrass justifies spring management planning in areas where it's known to overwinter**

Termination: Radish will terminate with multiple nights in the teens. If radish overwinter, glyphosate and 2,4-D provide effective control. Crimson clover should winterkill north of Zone 7; if crimson overwinters, control with glyphosate and 2,4-D. For annual ryegrass termination, glyphosate by itself or with other grass killers can be used, but several key management criteria must be met to ensure success. For more information, see page 14.

Considerations: Any time annual ryegrass is used, spring management has to be a main priority. Keep ryegrass from going to seed at all costs. Annual ryegrass not terminated can have adverse effects on any subsequent grass crops. The use of ryegrass blends have given ryegrass a bad reputation – make sure it is a single, respected variety. Multiple maturities make control even more complex. The addition of crimson clover may attract voles and may need to be terminated even earlier to decrease the residue. See FAQ # 8.

Planting Window

1. No later than August 20
2. No later than September 1
3. No later than September 10
4. No later than September 20
5. No later than October 1



Benefits

Compaction Alleviation	5
Weed Suppression	4
Biomass Production	4
Erosion Control	4
Disease/Pest Control	4
Pollinator/Beneficials	3
P & K Cycling	4
Ease of Establishment	4

SF 180 SHIFTER

COLDSNAP™ ANNUAL RYEGRASS + FIXATION BALANSA CLOVER + SOIL FIRST® SELECT RADISH

SEEDING RATE: 20 - 25 lbs/acre (heavier rate later in planting window)
25 - 30 lbs/acre for forage

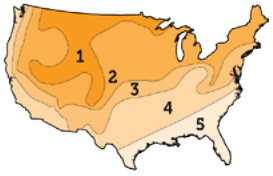
- **Much like SF 175, however crimson clover is replaced by balansa clover**
- **Perfect fit where fall or winter manure is applied**

Termination: Radish will terminate with multiple nights in the teens. If radish overwinter, glyphosate and 2,4-D provide effective control. If balansa clover overwinters, herbicide applications including glyphosate prior to flowering have been effective. For annual ryegrass termination, using glyphosate by itself or with other grass killers can be used, but several key management criteria must be met to ensure success. For more information, see page 14.

Considerations: Any time annual ryegrass is used, spring management has to be a main priority. Keep ryegrass from going to seed at all costs. Annual ryegrass not terminated can have adverse effects on any subsequent grass crops. The use of ryegrass blends have given ryegrass a bad reputation – make sure it is a single, respected variety. Multiple maturities make control even more complex. Balansa is a prolific re-seeder; termination or grazing prior to flowering will remove the risk. Early indications point to balansa clover tolerating cold temperatures better than crimson clover. The trade-off is balansa might not establish as quickly. When utilizing balansa clover, the goal should be allowing balansa to grow as much as possible into spring.

Planting Window

1. No later than August 20
2. No later than September 1
3. No later than September 10
4. No later than September 20
5. No later than October 1



Benefits

Compaction Alleviation	5
Weed Suppression	4
Biomass Production	3
Erosion Control	4
Disease/Pest Control	4
Pollinator/Beneficials	3
P & K Cycling	4
Ease of Establishment	3

MATCHING THE GOAL TO THE CROPPING SYSTEM

GOAL/BENEFIT	INTENDED CROP			
	Corn/Sorghum	**Cotton**	**Cole/Brassica Crops**	**Potatoes**
Erosion Reduction	**SF 125, SF 150, SF 175, SF 180** Grasses work well at reducing erosion. Small grains are an obvious choice, but consider spring management if planting anything other than oats.	Any grass will help control wind and water erosion. Guardian® fall rye, Hy Octane triticale, ColdSnap™ annual ryegrass are the best options. Spring oats help, but ineffective in spring/late spring.	Any grass will help control wind and water erosion. Guardian® fall rye, Hy Octane triticale, ColdSnap™ annual ryegrass are the best options. Spring oats help, but ineffective in spring/late spring.	**SF 142, SF 150** The addition of small grains is a possibility, but consider green bridge with other cereals in the rotation. Legumes (including winter peas, hairy vetch and others should be considered).
Sequestering Nutrients	**SF 150, SF 160, SF 175** Annual ryegrass and brassicas work well. Small grains do really well also, but will need a spring management plan if anything other than oats. Other Options: SF 140, SF 102	Grasses are the recommendation. Small grains - Guardian® fall rye, Hy Octane triticale will work well. The addition of radish and turnips can help sequester nutrients.	Grasses are the recommendation. Guardian® fall rye, Hy Octane triticale, ColdSnap™ annual ryegrass will all work well.	**SF 125, SF 140, SF 150** Brassicas work well at scavenging all important nitrogen. If considering small grains (spring grains or otherwise), control early to minimize nitrogen tie-up.
Compaction Reduction	**SF 160, SF 175, SF 180** Two options best equipped for deeper rooting are annual ryegrass and brassicas. Balansa clover's taproot works well too.	Plant brassicas (radish and turnips) when conditions allow for earlier seedings. Small grains will help break up hard pans, but to a lesser degree.	Plant ColdSnap™ annual ryegrass when conditions allow for earlier seedings. Small grains will help break up hard pans, but to a lesser degree.	**SF 125, SF 142, SF 150, SF 175** Brassicas should be the selection and ryegrass can help too. The addition of brown mustard will help break up hard pans as well.
Forage Production	**SF 102, SF 120, SF 140, SF 150, SF 165** Several options depending on timing in the fall. When considering small grains, harvest or graze early in spring to minimize fertility concerns.	Small grains (Guardian® fall rye, Hy Octane triticale) deliver forage and legumes enhance the protein content while supplying nitrogen. Summer annuals can deliver excellent biomass with less water.	Small grains (Guardian® fall rye, Hy Octane triticale) deliver forage in cole crop rotations. Legumes enhance the protein content while supplying nitrogen for the growing grasses.	**SF 125, SF 140, SF 150** Brassicas, legumes will provide biomass and protein for grazing animals. If considering small grains (spring grains or otherwise), control early to minimize N immobilization.
Weed Suppression	**SF 125, SF 150, SF 160, SF 175** Early plantings, use heavy biomass covers (brassicas, legumes, annual ryegrass). Limited fall timing, plant small grains (but only with a spring management plan).	Small grains (Guardian® fall rye, Hy Octane triticale) and legumes bring excellent weed competition. Summer annuals can deliver excellent biomass on low water inputs.	Small grains (Guardian® fall rye, Hy Octane triticale) deliver heavy biomass in cole crop rotations. Legumes help supply nitrogen for the growing grasses, while aiding in weed competition.	**SF 142, SF 150, SF 160** Both brassicas and legumes can provide enough competition by themselves. Adding a grass or grain will help.
Nematode Suppression	Legumes and brassicas have shown some effectiveness to nematodes that negatively impact corn. If nematode control is an objective, avoid grasses as most are host to nematodes affecting corn.	Several nematodes pose a threat to cotton. Guardian® fall rye makes the most sense for potential nematode suppression in cotton growing areas.	Sudangrass and sorghum x sudan offer some biofumigant properties. To maximize effectiveness, they need to be incorporated into the soil. Soil temps need to be above 65° and enough time for 6 weeks growth.	Brown mustards have higher glucosinolate levels and have proven to be effective at reducing potato cyst and root knot nematode levels. Need to be chopped and incorporated quickly to achieve max control.
Increased Soil Moisture	Many parts of the Midwest and Plains demand cover crops provide additional moisture for their cash crops during a portion of the growing season. Deciding on the right cover crops to help minimize moisture loss can be complex depending on climate, region, and soil type. Consider how long the cover crop will persist before termination and when and how the cash crop will be planted into the ›			
Key Points	Main objectives should be adding legumes whenever possible and managing any cover crop that includes a small grain (see page 7). Don't forget about using annual ryegrass.	Small grains and legumes form the base for most covers in cotton. Delays in cotton establishment after a cover are common, but select covers based on reducing weeds, insects and overall water requirement.	There are many cover crop options for cole crops, but other brassicas should not be included. Brassica cover crops allow disease and pest cycles in cole crops to persist and worsen.	Managing nitrogen is a major objective. Consider options that include legumes and brassicas for additional fumigation opportunities.

FOLLOWING THE COVER CROP

Soybeans	Sugar Beets	Vegetable/Fruit	Wheat/Small Grains
SF 101, SF 102, SF 120, SF 140, SF 150, SF 160 Several options based on time in the fall. Small grains will work great, but consider adding other species to accomplish multiple objectives.	Any grass will help control wind and water erosion. Guardian® fall rye, Hy Octane triticale, ColdSnap™ annual ryegrass are the best options. Spring oats help, but ineffective in spring/ late spring.	Use small grains (Guardian® fall rye, Hy Octane triticale, barley) before long season vegetable crops (90 - 120 days).	**Winter Grains: SF 142, SF 175** Fallow alternative - spring cereals and legumes (crimson, berseem clover). Continuous winter grains - options are limitless based on other benefits desired. **Spring Grains: SF 142, SF 150** Using species that terminate quickly will not impede on spring grain planting while still providing soil coverage for as long as desirable.
SF 101, SF 102, SF 120, SF 140, SF 150, SF 160 Depending on time in the fall, utilize a brassica if possible. Consider adding other species to small grains to accomplish multiple objectives.	Guardian® fall rye, Hy Octane triticale, ColdSnap™ annual ryegrass will all work well. Legumes impact nutrient scavenging very little, but adding N in sugar beet crops could be an added bonus.	Use small grains prior to long season vegetable crops (90 - 120 days); utilize summer annual grasses prior to short season vegetables (60 - 90 days).	**Winter Grains: SF 142, SF 165, SF 167** Fallow acres - spring cereals and summer brassica mixes. Continuous grain - plant legumes and brassicas as time will allow for many options. **Spring Grains: SF 125, SF 142, SF 150** Depending on how much time exists in fall, there may be limited time to plant non-cereal grain options to scavenge excess nutrients.
SF 101, SF 102, SF 160, SF 175 Two options best equipped for deeper rooting are annual ryegrass and brassicas (if time allows). Fall rye is better than nothing, but not the best option.	Plant ColdSnap™ annual ryegrass when conditions allow for earlier seedings. Small grains will help break up hard pans, but to a lesser degree.	Plant ColdSnap™ annual ryegrass and brassicas, but only if the following cash crop is a different family of the cover crop to break up pest and disease cycles.	**Winter Grains: SF 142, SF 160, SF 165, SF 167** Fallow ground - use grasses that will be easier to manage (ryegrass, summer annuals). Continuous grain - brassicas planted in summer will reach max growth quickly. **Spring Grains: SF 125, SF 150, SF 160, SF 165, SF 167** When time allows, choose a brassica crop (radish and turnips).
SF 140, SF 125, SF 180 Biomass is the goal and small grains will be needed for maximum growth. Including legumes will add protein and brassicas increase digestibility.	Small grains (Guardian® fall rye, Hy Octane triticale) deliver forage in beet rotations. Legumes enhance the protein content while supplying nitrogen for the growing grasses.	Several options exist for forage production in front of vegetable or fruit plantings. Be cognizant of any adverse effects the biomass/residue could have on the following crop.	**Winter Grains: SF 142, SF 160, SF 165, SF 167** Fallow acres - plant grasses like ryegrass and summer annuals; as well as legumes and brassicas. Continuous grain - brassicas and summer annuals will grow quickly in short summer windows. **Spring Grains: SF 125, SF 150, SF 165, SF 167** Utilizing grasses like summer annuals can generate good tonnage; adding brassicas or overwintering legumes can boost biomass and forage quality.
SF 101, SF 102, SF 150 Small grains are the key ingredient for reducing competition. Plant higher rates if that's the main objective.	Small grains (Guardian® fall rye, Hy Octane triticale) offer the biomass needed for competition against weeds. Legumes can help as well, however N will need to be managed prior to beet planting.	Grasses and small grains (Guardian® fall rye, Hy Octane triticale, barley, ColdSnap™ annual ryegrass) will provide suitable weed suppression. Consider nutrient available following grasses to next crop.	**Winter Grains: SF 142, SF 160, SF 165, SF 167** Fallow acres - grasses like ryegrass and summer annuals; as well as legumes and brassicas. Continuous grain - brassicas and summer annuals will grow quickly in short summer windows. **Spring Grains:** To maximize weed suppression, plant heavy biomass cover crops early. Brassicas and legumes will help without compromising spring cereal grain planting.
SF 160, SF 180, SF 175 For SCN control, the best defense is controlling winter annuals. Annual ryegrass has shown very positive results.	Image Nematode Radish works well to control beet cyst nematode. Image is not only a non-host, but this radish encourages early cyst egg hatch that results in lack of food and eventual control.	Depending on the cash crop, any number of cover crops may provide some level of nematode control and/or suppression. For individual recommendations, please contact La Crosse Seed.	The use of summer annual grasses has shown the ability to limit nematodes in small grains (root lesion and cereal cyst). Current research with certain brassica varieties has shown promise and may be available from La Crosse Seed soon.
leftover residue. For example, residue left from small grain cover crops in the Midwest may hold onto more moisture in early spring. These residues have the potential to help supply moisture to cash crops later in the summer too, as long as the residue doesn't impede cash crop establishment. Cover crops that use the least amount of moisture for establishment are millets, winter and spring barley, berseem and red clovers, cowpeas and field peas.			
Sequestering nitrogen and capturing any nutrients is key. Select mixes that provide this and other benefits as well.	Concentrate on small grains as the base to eliminate any added concerns of increased pest pressure and N management. Other species (like nematode radish) are available depending on the objective.	Select the right cover crop to provide the residue/ mulch desired. Consider how the cover crop will be successfully terminated and the vegetable will be paired into that residue.	It's all about time... With winter grains, one has a limited summer and fall for establishment. Spring planted small grains offer the flexibility of using overwintering species, but spring control/termination should be planned. Small grain cover crops may initiate a "green bridge" that could lead to added disease pressure.

FREQUENTLY ASKED QUESTIONS

1 MANAGING NITROGEN AFTER GRASS COVER CROPS. How much nitrogen is available after a grass cover crop and when might it be available is a common question... with no easy answer. The rate and extent of nitrogen release from the decomposing grass cover crop depends on many factors, including the stage of the plant when it is terminated, the carbon to nitrogen (C:N) ratio and weather. Plants in the vegetative stage have higher nitrogen concentrations than those in the reproductive stage and will decompose faster. The C:N ratio determines the general timing of nitrogen release from these residues. High C:N ratio cover crop residues (greater than 25:1), will first immobilize (use and deplete) nitrogen from the soil or recent fertilizer nitrogen additions. Only after some time will the nitrogen begin to be mineralized (or released back to the soil). When managing grass cover crops (ryegrass, cereal grains), it is best to terminate the cover crop while it is still in the vegetative stage if the plan calls for the following cash crop to be a grass, such as corn. If the cover crop reaches the reproductive phase before termination, there will be more nitrogen immobilized (or used) after termination and an additional application of starter nitrogen fertilizer will be needed. Not all nitrogen scavenged by the cover crop will be available the next season, so overall fertilizer nitrogen rate should not be reduced by the amount of N kept from leaching (some of the scavenged nitrogen goes toward building soil organic matter too). Grass cover crops, while in the vegetative stage, have C:N ratios around 10:1 to 15:1 and release nitrogen rapidly after termination. Roughly 50% of the nitrogen in the above-ground biomass will be available over a time window of around 1 to 2 months, depending on the weather.

Nitrogen Mineralized/Immobilized

Material	C:N Ratio
Rye Straw	82:1
Wheat Straw	80:1
Oat Straw	70:1
Corn Stover	57:1
Rye Cover Crop (Anthesis)	37:1
Pea Straw	29:1
Rye Cover Crop (Vegetative)	26:1
Mature Alfalfa Hay	25:1
Ideal Microbial Diet	24:1
Rotted Barnyard Manure	20:1
Legume Hay	17:1
Beef Manure	17:1
Young Alfalfa Hay	13:1
Hairy Vetch Cover Crop	11:1
Soil Microbes (Average)	8:1

2 PINPOINTING NITROGEN CREDIT FROM COVER CROP LEGUMES. Legumes are widely used as cover crops, because they contribute additional nitrogen to the cropping system. Hairy vetch can accumulate significant biomass in the spring and thus produce a large amount of nitrogen (up to 100 - 200 lbs. N at flowering). Winter peas can produce as much as 1 - 3 tons of DM/acre and fix up to 150# N/acre. Research shows crimson and balansa clovers yielded as much as 100 - 130 lbs. N/acre. Remember, as with any legume, the amount of nitrogen fixed will be maximized only after that legume is left to persist long enough to reach bud stage. These estimates are assuming biomass is maximized and growing conditions for these legumes are matched to their growing season. Many variables exist that affect N production (including when these species are terminated) – this is only a guide.

Nitrogen Fixing Differences Between Legumes

Harvesting the plant for grain and/or forage removes a HUGE portion of the N that was fixed. More than half of the harvested N can be recovered, however with the right cropping and/or livestock system. Also, assume that only 50% of this N will be available.

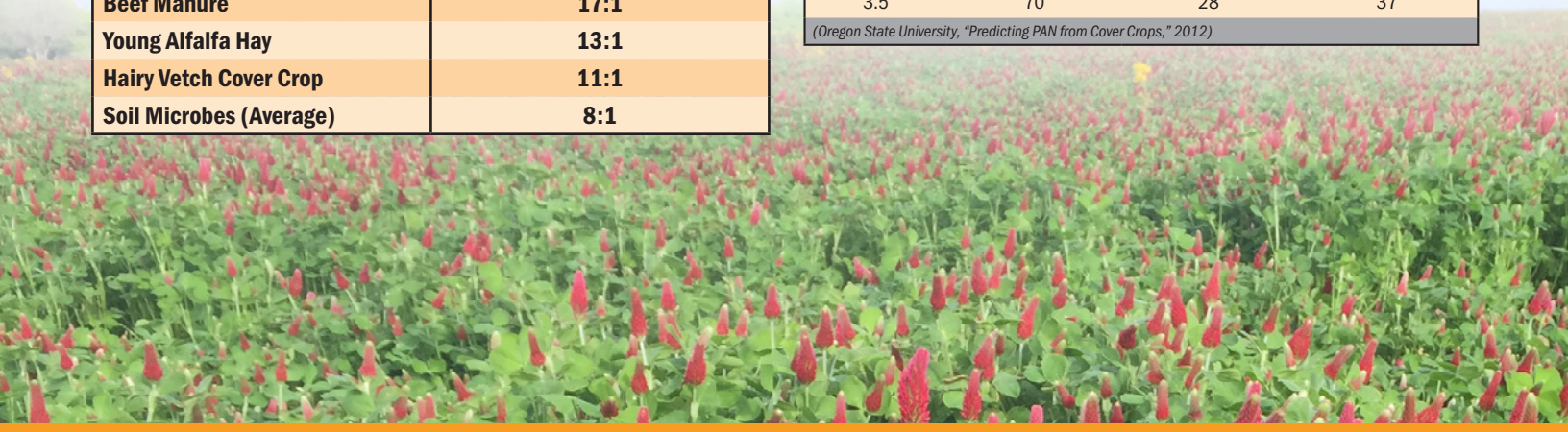
Crimson Clover	70 - 150 lbs
Balansa Clover	60 - 100 lbs
Berseem Clover	60 - 120 lbs
Red Clover	70 - 150 lbs
Hairy Vetch	90 - 180 lbs
Winter Peas	90 - 150 lbs
Sunn Hemp	80 - 125 lbs (summer/early fall)
Cowpeas/Field Peas	90 - 150 lbs (summer/early fall)

The total N as a % of dry matter is a good predictor of plant available nitrogen (PAN). Many nitrogen concentration estimates from the Midwest show crimson clover to have about 1.5 – 2.4 % N/ton of DM, while winter peas and hairy vetch average between 2.5 – 3.5 % N/ton of dry matter. Estimates are taken from fall-seeded legumes harvested in April the following spring. Actual N concentrations will vary greatly depending on region and the maturity and condition of the cover crop.

Estimating Plant Available Nitrogen Release

% N in DM	lbs N/DM Ton	4 wks PAN/DM Ton	10 wks PAN/DM Ton
1.0	20	<0	0
1.5	30	3	9
2.0	40	7	14
2.5	50	12	20
3.0	60	19	28
3.5	70	28	37

(Oregon State University, "Predicting PAN from Cover Crops," 2012)



3 COVER CROPS AND FALL-APPLIED NH3. Cover crops with vigorous growth and a good root system will take up nitrogen left in the soil in the fall and more nitrogen next spring if the cover crop overwinters. Once sequestered by the cover crop, that nitrogen is less likely to be leached or lost through erosion and/or tile lines. The breakdown and release of cover crop nitrogen to the next crop is a biological process that depends largely on the weather. Fall cover crops can help take up fall-applied nitrogen, thus keeping it safe from loss and holding it until the corn crop is up and growing next spring. However, fall uptake of nitrogen will be limited if the cover crop is planted and establishes after the harvest of the previous crop. Since most fall nitrogen is applied only after soil temperatures reach 50°F, this typically offers only a few weeks of uptake. Applying NH3 into growing cover crops can cause damage to roots, and when soil temperatures are already cold and getting colder, it's not likely that those damaged roots will be able to take up much of the nitrogen before soil temperatures cool to a point where root growth is slowed. Uptake of fall-applied nitrogen increases as soils warm again in the spring, therefore grass cover crops need to be terminated prior to milder spring temps and increased growth. So, while cover crops can have beneficial effects on fall applied nitrogen retention, it should not be expected that they will greatly increase the amount of that nitrogen available for the subsequent cash crop.

4 FERTILIZING COVER CROPS. Commercial fertilizer and manure often provide benefits to a newly seeded cover crop. Single species stands or mixes that include legumes aid in nitrogen production, generating available nutrients for the following cash crop. Clovers and legumes will benefit from adequate phosphorus and potassium levels. Brassicas respond very favorably to nitrogen treatments and grasses establish quicker and produce more forage tonnage when additional nitrogen is applied, however additional nitrogen can increase the likelihood of potential nitrate concerns in that forage (see page 8 & 15 for more info on fertilizing cover crops for forage). Different cover crops may demand different nutrients for maximizing production. For example, white clovers respond to calcium, and rapeseed benefit from sulfur applications. All indicators seem to suggest that adding fertilizer will provide an advantage when planting a cover crop. Conversely, if sequestering all available nitrogen and other nutrients is the objective, supplementing the stand with commercial fertilizer or manure is not needed. **KNOWING THE GOAL** will dictate if adding fertilizer makes sense.

5 WHERE CAN INFORMATION ON HERBICIDE ROTATIONAL RESTRICTIONS BE FOUND? Most herbicide labels do not list the species that are used for cover crops or fall forages (like radish, turnips or cereal rye). These species often fall under the "*OTHER CROPS*" section on the herbicide label, which means they can fall into rotational windows of up to 18 months, or the maximum rotational period. Keep in mind these restrictions, though lengthy, are meant to protect the succeeding crop as well as livestock consuming the next crop. The grower should always know the herbicide label is a legal document meant to protect the grower from himself and protect the herbicide company if a cover crop fails to germinate or is injured by herbicide residues still present in the soil. It's a good agronomic practice to know the recent herbicide history before making cover cropping decisions, but understand that the published rotational periods of these herbicides can be conservatively long. Some universities have started research to more accurately pinpoint the potential residual effects toward cover crops of the common pesticides used today. Included on the Soil First® website (soil1st.com) is information on performing a soil herbicide bio-assay – a test that will quickly show if herbicide residues are present and potentially limiting cover crop establishment.

Bio-Assay Kit

6 WILL THE ROOTS OF COVER CROPS DAMAGE TILE DRAINAGE SYSTEMS? Not typically. Using cover crops can favorably impact the nitrate concentration and load traveling through our tile drainage systems. It can be argued that reducing nitrate and other nutrient leaching by utilizing cover crops makes even more sense where subsurface tile drainage is in place. Yet, the roots of some of the most common cover crop species, like radish and annual ryegrass, can be so aggressive that they approach the same depth (if not deeper) in the soil profile where tiles lines are placed. Cover crop root mass in the tile lines haven't caused a complete blockage. Most cover crop roots we've witnessed in tile lines shared at least a couple of these circumstances or conditions:

1. **Shallow tile lines.** Where tiles sit less than 30" deep, expect some finer taproots to reach that depth – remember – taproots that penetrate into subsoils are a good thing!
2. **Older or uneven tile lines.** These may not slope correctly and thus retain water longer – cover crop roots will find that water!
3. **Broken tile.** Conditions are perfect for root penetration anytime soil gets into the tile.
4. **Earlier planted cover crops that overwinter.** The longer growth period (maybe aided by milder temperatures) allows for deeper root penetration than normal.

7 WHICH COVER CROPS SERVE AS HOSTS TO INSECTS OR DISEASE? Cover crops can play an increasingly important role with managing pests. The right cover crop system can not only minimize the reliance on pesticides but also create positive changes with one's overall farming practices. A list of cover crops and other common Midwestern species and how they interact with some of the common diseases and insects facing farmers today can be found at soil1st.com.

8 MANAGING ARMYWORMS AND OTHER PESTS FOLLOWING GRASS COVER CROPS.

Cover crops and green manures can harbor insects, diseases and nematodes that could be harmful to subsequent cash crops. Armyworms, cutworms and other pests can present additional management considerations after grass cover crops like annual ryegrass and cereal grains and even some legumes (crimson clover, hairy vetch) due in large part to residues left on the soil surface.

Female armyworms lay eggs in grassy fields (like cover cropped fields), and the young caterpillars attack corn from mid-spring through early summer. Armyworms can also move into corn from surrounding wheat fields, in which case the damage usually occurs primarily along field edges. There are a number of labeled insecticides available for armyworm, and many growers may include that along with their burndown application, however control has been marginal as armyworm populations may not be sufficient yet to warrant the cost of the application. The best recommendation is to scout fields often after corn planting. Although it may be difficult to find armyworms (as they hide in corn whorls during the day), inspecting their damage is much easier. Refer to your local threshold recommendations to determine when and if to apply an insecticide. Foliar applications have proven to be successful if your scouting program suggests it's needed.

The occurrence of both slugs and voles seem to increase with the introduction of no-till and cover crops, too. It's important to understand that many of the growing practices that leave residue on the surface could lead to an environment that enhances the habitat of these pests. For those growers practicing no-till or reduced tillage, it's important to have solutions that don't result in additional deep tillage (however some minimal tillage may be necessary in some situations). Moreover, steps can be taken to reduce the occurrence of slugs and voles when cover crops are part of the cropping system.

- Cover crops can give slugs an alternative forage source and keep them away from cash crops
- Plant cash crop early – the quicker establishment results in less feeding from slugs as the crop will be too large for feeding
- Keep roadsides and ditches/waterways mowed in the spring – this will decrease the protection voles have, especially when vole breeding is heavy and numbers are growing
- Plan on controlling or terminating cover crops 3 - 4 weeks prior to planting to decrease the residue favored by voles
- In the case of both slugs and voles, make sure the seed slot is closed and firm to reduce the incidence of feeding directly on the seed (and it may mean placing the seed a bit deeper in the soil than usual)

Early cover crop termination and effective residue management at planting time are ways to reduce the risk of pest damage. Insecticide applications may be required if planting into a standing cover crop or within 3 - 4 weeks of that cover crop being terminated. On the other hand, surface residues create a more diverse plant/soil ecosystem versus conventional tillage systems and often attract beneficial insects too. Many approaches exist to manage cover crops and their interactions with potential insects harmful to cash crops. In the case of nematodes and diseases, the message is simple - select products to meet your goals, plan early and manage accordingly.

9 WHY DO RADISH HEAVE & THEN SMELL SO BAD?

No matter the variety, all radish will heave. Remember, the tuber is not doing the work or breaking up hard pans and cycling nutrients... it's the taproot. By the time the plant begins to push back out of the ground, the taproot has already been established in the ground and is continuing to grow downward. Another reason radishes heave so much is largely due to their high water content (>90%)...the same reason most brassica plants do not work well in silage systems.

Whether the radish stand is winterkilled or controlled with herbicides or tillage, the decomposing plants give off an odor, a gas (methyl mercaptan) and it's completely harmless. Mercaptan is the odorant added to natural gas to give it its distinct smell. This odor is typically short-lived (depending on temperature and winter climate, the smell often exists for a few days up to a couple weeks).

10 HOLES OR SOCKETS LEFT FROM BRASSICA/ROOT CROPS.

Across a large part of the country, most brassica crops like radish die and decompose during the winter. Typically, there is ample time for the sockets they leave behind to catch water and sediment, and thus "fill in" to a point where no-till planting can occur without issue. However, if radishes are thinly planted and/or have limited competition for space, larger sockets can form which may take longer to fill in – which can cause issues if the plan includes no-till planting. Once brassicas are killed by cold temperatures, a layer of decomposing residue remains on the soil throughout most of the winter and into the spring. This provides some erosion control, but even more so, runoff is reduced and captured because of the infiltration made possible by the open holes. If additional erosion control efforts are needed, adding a small grain or other grass with the radish will further reduce surface and wind erosion in the late winter and early spring.

11 WHICH COVER CROPS ARE THE MOST SALT TOLERANT?

In many parts of the country, soil salinity can be a major obstacle to overcome. While most plants avoid salinity, some actually tolerate salt-affected soils. Salt tolerance of plants varies greatly during plant development and throughout the different growth phases of the plant. For example, sugar beets have high salt tolerance during vegetative growth, but are more sensitive to salinity during germination. Whereas corn in comparison is salt-sensitive during growth. Research from North Dakota and California suggests the best cover crops for salt-affected soils are:

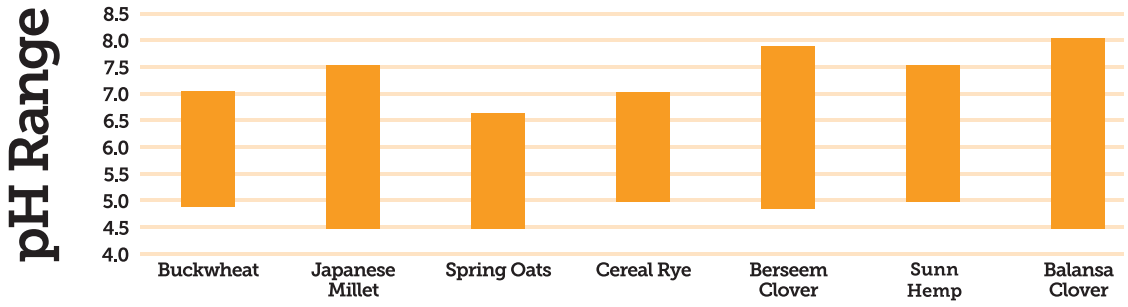
- Sugar Beets
- Winter Canola
- Berseem Clover
- Barley
- Rapeseed
- Woollypod Vetch

The major factor responsible for the formation of salt-affected soils is the redistribution of salts within the soil, with water as the primary carrier. In arid regions, the salt levels in soils can be very high because of limited or reduced leaching. Where rainfall is high, most salts are leached out of the soil. Cover crops along with crop rotation are an important tool for managing soil salinity. Cover crops that transpire water will use excessive soil water and work toward maintaining or lowering water tables, reducing the evaporation that brings salts to the surface.

(USDA/NRCS, Idaho 2010; NRCS, North Dakota 2011; University of California, Davis, 2001)

12 WHICH COVER CROPS TOLERATE LOW AND HIGH pH ENVIRONMENTS?

Several cover crops will grow in low pH soils- a challenge for the Corn Belt and areas where fruits and vegetables, like blueberries and strawberries, are grown. Most of these same species have high water use requirements. The chart below identifies crops with a wider range of tolerance to both acidic/alkaline soils.



	Buckwheat	Japanese Millet	Spring Oats	Cereal Rye	Berseem Clover	Sunn Hemp	Balansa Clover
Highest pH Level	7.0	7.5	6.5	7.0	7.8	7.5	8.0
Lowest pH Tolerance	4.8	4.5	4.5	5.0	4.8	5.0	4.5

(Cornell University, 2012; SARE)

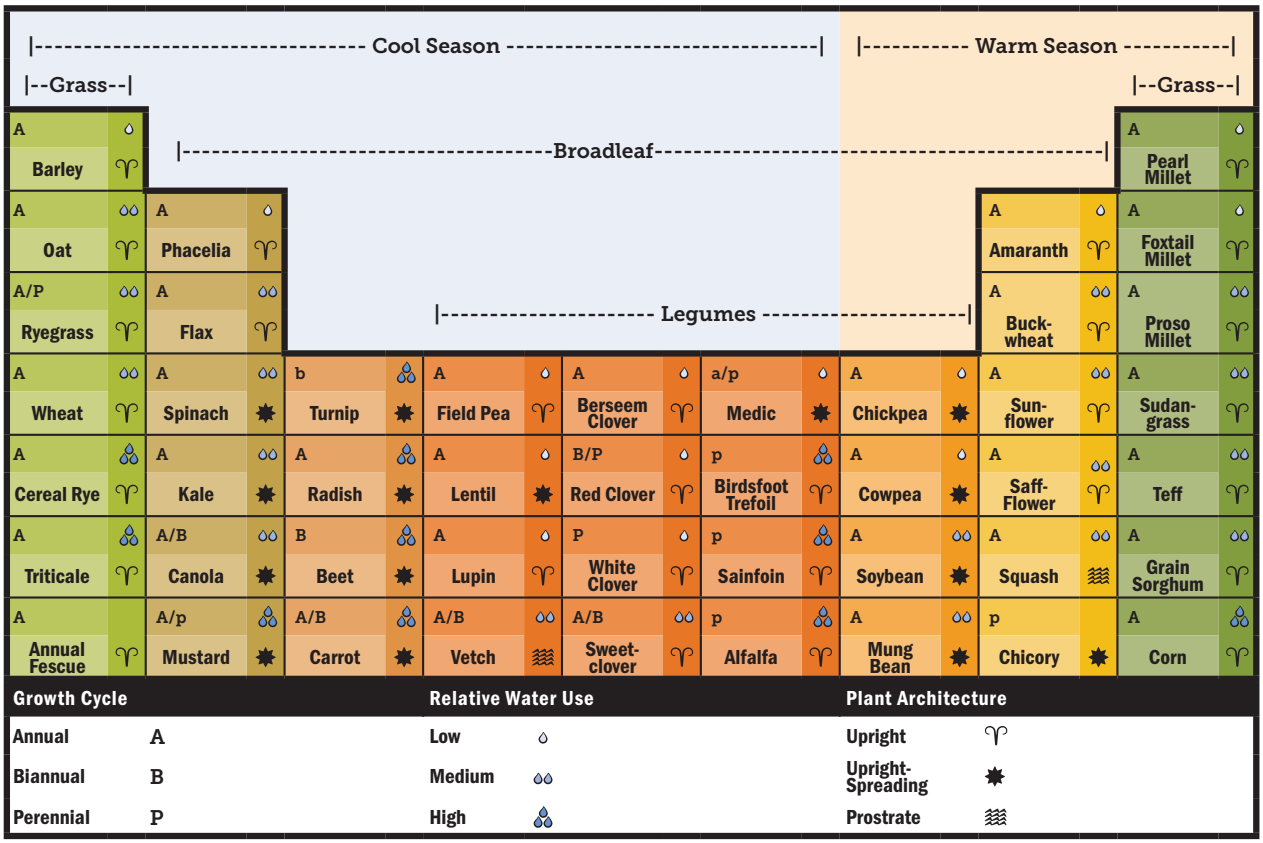
13 WHICH COVER CROPS USE THE LEAST AMOUNT OF WATER TO GERMINATE AND ESTABLISH?

This question arises in areas where historically rainfall amounts have been lower and dependence on irrigation for cover crop establishment is a real economic concern. Below are a few common cover crop options that produce enough biomass to increase water-holding capacity and slow down evaporation, all while establishing with a low water input:

- Winter and Spring Barley
- Field Peas and Cowpeas
- Berseem, Red, and White Clovers
- Pearl and Foxtail Millets

Our information comes from many regions across the country where we've researched what has worked versus what has struggled in low water environments. Recently, USDA-ARS published a Cover Crop Chart – v. 2.0 that also identifies those species that have a low 'relative water use'.

Cover Crop "Periodic Table"



14 **CONSIDERATIONS ON COVER CROP SPRING BURNDOWN.** Below is a chart derived from the University of Wisconsin and Penn State University, with a few additional options our group has added based on experience in the field. We encourage you to visit our DIRT library on our website, where you'll find many useful tips on everything cover crops and management.

Cover Crop Termination Chart

		Winter kill	Rolling / Crimping	Mowing	Tillage	Herbicide	Cover Crop Growth Stage	Herbicides for Termination
Brassicas	Radish / Turnips	*	No	No	Yes	Yes		Glyphosate / Paraquat
	Canola / Rapeseed							
	Mustard							
Legumes	Crimson Clover	*	No	No	*	Yes		Glyphosate; 2,4-D + Dicamba
	Winter Pea	*	No	Yes	*	Yes		Glyphosate + 2,4-D; Paraquat + 2,4-D
	Hairy Vetch	No	Yes (Full Bloom)	No	Yes, but 2 passes may be needed	Yes	Yes (Pre or Mid- Bloom)	Glyphosate + 2,4-D or Dicamba; Paraquat + 2,4-D
Grasses	Annual Ryegrass	*	No	No		Yes	< 6 - 8"	See Page 14
	Winter Barley	No	Yes, at Milk or Dough Stage	Yes		Yes	Prior to Boot Stage (<18")	Glyphosate 4.5 lb ae Per Gal; 22 fl. oz Per Acre
	Winter Triticale							
	Winter Wheat							
	Cereal Rye							

*Varies based upon region and climate

Taken from University of Wisconsin & Penn State University

DRILL & SEEDING CHART

	Planting Window (weeks before frost)	Seeding Depth (Inches)	Drilled (7.5" Rows Seeding Rate lbs/acre)	Comparable Seed on Drill Chart	Can Use Small Seed Bed Box?	Precision Planting (PP) 4" In-Row Spacing. Refer to Bag Label For Seeds/Lb.	(PP) 15" Rows 4" in-row lbs/acre	Seed Spacing	Vacuum Pressure (psi)	Plate
SF 101 Cover Starter Rye + Soil First® Select Radish	3 to 10	1/4" to 1"	30 to 35	Wheat	No	Kinze Brush Meter w/ Backing Plate (60 Cell Soybean Plate)	60 (5" in-row)	-	-	-
SF 102 Cover Starter + Rye + Crimson Clover + Soil First® Select Radish	3 to 10	1/4" to 1"	30 to 35	Wheat	No	Kinze Brush Meter w/ Backing Plate (60 Cell Soybean Plate)	60 (5" in-row)	-	-	-
SF 120 Extender Hy Octane Triticale + Fixation Balansa Clover + Soil First® Select Radish	3 to 10	1/4" to 1"	35 to 40	Wheat	No	Kinze Brush Meter w/ Backing Plate (60 Cell Soybean Plate)	60 (5" in-row)	-	-	-
SF 125 N-Hancer Spring Oats + Soil First® Select Radish + Fixation Balansa Clover + Peas + Crimson Clover	3 to 10	1/4" to 1"	35 to 40	Oats	No	Kinze Brush Meter w/ Backing Plate (60 Cell Soybean Plate)	20 (5" in-row)	-	-	-
SF 140 Multi-Purpose Winter Triticale + Soil First® Select Radish + Vivant Brassica + Forage Collards + Peas	3 to 10	1/4" to 1"	35 to 40	Wheat	No	Kinze Brush Meter w/ Backing Plate (60 Cell Soybean Plate)	60 (5" in-row)	-	-	-
SF 142 Classic Crimson Clover + Soil First® Select Radish	3 to 10	1/4" to 1/2"	12 to 15	Alfalfa	Yes	Kinze Brush Meter w/ Backing Plate (60 Cell Milo Plate)	8 (1.5" in-row)	1.5" in-row	18	Large Sugar Beet (720220)
SF 150 Field Fit Spring Oats + Soil First® Select Radish + Turnips	3 to 10	1/4" to 1"	40 to 50	Oats	No	Kinze Brush Meter w/ Backing Plate (60 Cell Soybean Plate)	20 (5" in-row)	-	-	-
SF 160 Rooting ColdSnap™ Annual Ryegrass + Soil First® Select Radish	3 to 10	1/4" to 1/2"	15 to 20	Tall Fescue (reduce by 25%), Crested Wheat Grass (reduce by 15%) or Annual Ryegrass	No	Kinze Brush Meter w/ Backing Plate (60 Cell Milo Plate)	12 (2" in-row)	-	-	-
SF 165 Late Grazer Pearl Millet + Soil First® Select Radish + Sunn Hemp	After last frost in Spring/ 8 weeks prior to first-frost date in Fall	1/4" to 1"	20 to 25	Wheat	No	Kinze Brush Meter w/ Backing Plate (60 Cell Soybean Plate)	12 (4" in-row)	4" in-row	20	Large Sugar Beet (720220)
SF 167 Summer Grazer Sunn Hemp + Sorghum Sudangrass + Soil First® Select Radish		1/4" to 1"	25 to 30	Wheat	No	Kinze Brush Meter w/ Backing Plate (60 Cell Soybean Plate)	12 (4" in-row)	4" in-row	20	Large Sugar Beet (720220)
SF 175 AccuSpread Coated ColdSnap™ Annual Ryegrass + Coated Crimson Clover + Soil First® Select Radish	3 to 10	1/4" to 1/2"	20 to 25	Tall Fescue (reduce by 25%), Crested Wheat Grass (reduce by 15%), or Annual Ryegrass	No	Kinze Brush Meter w/ Backing Plate (60 Cell Milo Plate)	12 (2" in-row)	-	-	-
SF 180 Shifter ColdSnap™ Annual Ryegrass + Fixation Balansa Clover + Soil First® Select Radish	3 to 10	1/4" to 1/2"	20 to 25		No	Kinze Brush Meter w/ Backing Plate (60 Cell Milo Plate)	12 (2" in-row)	-	-	-
Guardian® Fall Rye	4 weeks prior to first killing frost to 6 weeks after	3/4" to 1"	30 to 50	Wheat	No	Kinze Brush Meter - 60 cell Soybean Plate (2" in-row) White - Wheat Plate	50	-	-	-
Hy Octane Winter Triticale		3/4" to 1"	30 to 50	Wheat	No		50	-	-	-
ColdSnap™ Annual Ryegrass	3 to 10	1/4"	15 to 30	Tall Fescue (reduce by 20%), Crested Wheat Grass (reduce by 10%) or Annual Ryegrass	Yes	Kinze Brush Meter w/ Backing Plate (60 Cell Milo Plate)	10 (1.5" in-row)	-	-	-
Soil First® Select Radish	3 to 10	1/4"	8 to 12	Alfalfa (reduce by 10%)	Yes	Small Sugar Beet Plate				
Crimson Clover	3 to 10	1/4"	10 to 15	Crimson Clover	Yes	Not Rec.	Not Rec.	1.5" in-row	18	Small Sugar Beet (720220)
Winter Peas	3 to 10	1"	30 to 80	Soybean	No	Soybean Plate	9	4" n-row	20	60 Cell Soybean (720265)
Hairy Vetch	2 to 10	1"	15 to 30	Vetch or Sorghum	No	Small Sugar Beet Plate	9	4" in-row	16	Large Sugar Beet (720220)

PLANTING METHODOLOGY

DRILL OR TRADITIONAL/AIR SEEDER

Using a drill or seeder to plant cover crops and green manures ensures the best seed-to-soil contact and an ideal environment for the quickest germination. Clearly, this is not an option until the standing crop has been removed or harvested. The best methods for seeding covers require sufficient planning to ensure its success.

Considerations:

- Keep in mind changing field conditions that may alter seeding depth and seed spacing
- Make sure your drill is calibrated correctly, knowing the various sizes of cover crop seeds
- As a rule of thumb, use the largest seed in your blend as the indicator for calibration - see drill chart on the previous page

AERIAL/SURFACE SEEDING

When aerial seeding, consider the ideal planting window for the cover crop being planted. For example, radishes typically need 800-900 Growing Degree Days (GDD), or at least 4 - 6 weeks and preferably 8 - 10 weeks of growth prior to winter termination. That planting period needs to be taken into account so it coincides with the proper maturity stage of the crop in the field. Moisture or irrigation is critical when surface seeding to make up for the lack of seed-to-soil contact. When time could be a hurdle, aerial and "over-the-top" seedings offer a worthy alternative.

Considerations:
Assuming seeding intervals match, the ideal time to aerial seed into our traditional cash crops are as follows:

CORN	When at least 50% of sunlight can penetrate to the soil surface
SOYBEANS	Leaf senescence typically, but that depends to some degree on row width and soybean architecture. Delaying applications into soybeans decreases seed-to-soil contact and increases the risk of poor moisture retention needed for maximizing germination.
SUNFLOWERS	Back of the seed head turns yellow

When crop stage and the seeding calendar do not align, always weigh on the side of earlier applications, especially when a moisture event is forecasted or irrigation can be planned. It's better to have the cover crop seed in the field to begin the germination process vs. planting later where the seed may have to compete with excess cash crop residue.

For other crops, concentrate on sunlight infiltration to the soil surface. Sunlight and moisture are the limiting factors for bare surface applications.

BROADCAST APPLICATIONS

Most broadcast applications occur after cash crop harvest and are followed with a culti-packer or light tillage pass to encourage better germination. A common practice is combining cover crop seed and fall fertilizer to increase efficiency when time may be an obstacle in the fall. It's not uncommon for growers to attach seeders directly to their tillage equipment, eliminating a trip through the field. Whereas moisture isn't as critical for establishment versus an aerial application, any tillage will decrease soil moisture, lessen soil microbe activity and slow gains in soil structure.

Considerations:

- A common mistake is burying the seed too deep. Take extra caution to keep tillage depth shallow. Most cover crop seeds only need to be placed between ¼" - ½" deep.
- Due to the width and variance of some broadcasters, a double-spread pattern may be needed to guarantee even spreader distribution.
- Rule of thumb: increase seeding rates by 20 - 25% or more to guard against imperfect seed bed environments.

FROST SEEDING

Frost seeding works well during the late winter months (usually February - March) taking advantage of the upcoming freeze-thaw cycles. Legumes like red clover are commonly frost seeded into small grain or perennial fields, but many cereal cover crops can be frost seeded as well to get a jump start on early spring growth.

PURITY & GERMINATION AFFECT SEEDING RATES

PLS (PURE LIVE SEED) EXAMPLES			
Seed Purity %	**90% Germ**	**85% Germ**	**80% Germ**
99.50	89.55	84.58	79.60
99.00	89.10	84.15	79.20
98.00	88.20	83.30	78.40
97.00	87.30	82.45	77.60
95.00	85.50	80.75	76.00
90.00	81.00	76.50	72.00
85.00	76.50	72.25	68.00
80.00	72.00	68.00	64.00
65.00	58.50	55.25	52.00

PRECISION/ROW-CROP PLANTERS

Precision planters allow for the precise seeding of cover crops, while making it an option to plant subsequent cash crops exactly in the same location using today's technology. Row-crop planters guarantee consistent seeding depth and seed spacing (assuming seed plates and other planting equipment is used properly).

INTERSEEDING

Interseeding cover crops into cash crops (like V3 - V6 corn) lengthens the growing time for cover crop seeding. Besides the benefit of earlier establishment, improved nutrient cycling and greater biomass for grazing are further advantages of getting covers seeded roughly 60 - 90 days ahead of typical plantings. Interseeding implements are becoming more available, however most interseeded acres we've witnessed have been seeded using broadcast equipment, many alongside a fertilizer application. Interseeding continues to gain traction, especially in northern areas where the post-harvest seeding window is reduced by colder temperatures and unpredictable weather.

SLURRY MANURE SEEDING

Mixing cover crop seed and slurry manure can be effective assuming the proper equipment is used – a tank and delivery system with the proper tines and/or coulters. It's important to inject the seed into the soil vs. surface applications. Not all types of seed work well in this system and can tolerate the high salinity and/or ammonia of the manure slurry. Rainfall or irrigation after seeding can minimize the effects that the slurry might put on the seed. Cover crops typically being seeded with manure are grasses and other nutrient scavengers that lessen runoff and leaching.

OTHER SEEDING METHODS

We've seen many methods work across the country. Don't be afraid to try something that makes sense. For example, growers across the Midwest and western states are affixing seed boxes to their combines (some on the rear of the machine to get spread within the residue, and others on the combine head). Ultimately, whatever method is chosen, the goal should be getting cover crops seeded in a timely, agronomic way that increases the likelihood for success.

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