

# Annual Cover Crops in Florida Vegetable Systems Part 2: Production<sup>1</sup>

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## Introduction to Part 2

Cover crops are crops grown for a purpose other than harvestable yield, and they are a very diverse group. They are annuals, perennials, tropical (unlikely to survive at temperatures lower than 10°C), temperate (can survive temperatures to 2°C), erect or prostrate.

Matching suitable cover crop species to objectives and regional conditions is critical. Once producers select a main objective, the next step is to choose a cover crop species that will fit into the farming system. To help producers make informed decisions about cover crops and Florida production systems, this publication discusses management practices for annual cover crops, from seed selection to termination.

This publication is the second part of the three-part series, Annual Cover Crops in Florida Vegetable Systems. This series includes EDIS Publication HS1143 Part 1: *Objectives: Why Grow Cover Crops?* (<http://edis.ifas.ufl.edu/HS387>) and EDIS Publication HS1142 Part 3: *Species Selection and Sourcing* (<http://edis.ifas.ufl.edu/HS390>).

## 2a. Species Selection

Annual cover crops are most often used in intensive vegetable rotations since perennial species, such as rhizomatous perennial peanut (*Arachis glabrata* Benth) and the stoloniferous perennial peanut (*A. pintoi* Krapovikas and W. C. Gregory), may take several months to a year to fully establish (Abdul-Baki et al., 2002; Rouse and Mul-lahey, 1997).

In selecting a cover crop, producers should consider the objective the cover crop is intended to accomplish, the amount of time between vegetable crops, and the time required to prepare the soil for planting and for residues to be fully worked into the soil. When annual cover crops are selected, producers must estimate planting and killing dates to complement primary (cash) crop rotation.

The subtropical Florida climate provides opportunity to use forages, tropical legumes, and -- in the northern part of the state -- winter annual cereals and legumes. A number of EDIS publications are available to assist producers to select a cover crop. These publications are summarized in Table 1. Table 2 provides a summary of cover crops used in Florida and recommendations for their management.

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Producers south of Tampa (South Florida) typically plant cover crops in May and June and retain the cover crops in the field through August since few vegetable crops are in production during these summer months. Although the summer climate may be unsuitable for vegetable production due to the high temperatures and heavy precipitation, a number of cover crop species are well adapted for these conditions. Producers north of Ocala (North Florida) can produce cover crops during summer months as well as winter months (November through March). For most systems, cover crops remain in rotation for 60 - 90 days between vegetable rotations, but some benefits can be observed after 30 days. General management guidelines for cover crops in Florida are presented in Table 2. Planting dates are suggested for North Florida; South Florida planting dates would be around two to three weeks earlier, depending on conditions.

Summer annual cover crops are frequently planted to provide a partial nitrogen source for a fall vegetable crop and to reduce the risk of soil erosion. The most widely used tropical legume green manures in tropical and subtropical regions are *Crotalaria juncea* L. (sunn hemp), *Glycine max* L. (soybean), *Indigofera* spp. (indigo), *Mucuna* spp. (velvet-bean), *Vigna unguiculata* Walp. (cowpea), *Cajanus cajan* (L.) Millsp. (pigeon pea) and *Sesbania* spp. (Cherr et al., 2006). Sorghum sudangrass [*Sorghum bicolor* x *S. bicolor* var. *sudanense* (Piper) Stapf.] and its relatives are good candidates for summer plantings due to their ability to survive periodic flooding. Another nonlegume used throughout the state is pearl millet [*Pennisetum glaucum* (L.) R. Br.]. This grain crop is well adapted to sandy soils with poor fertility, and it performs well in drought conditions (Figure 1).



Figure 1. Summer cover crop of pearl millet in mid-bloom Credits: D. Treadwell

Winter annual cover crops are typically planted as a “catch crop” to uptake nutrients remaining in the soil following the harvest of a vegetable crop in summer or early fall. Erect species, such as cereal rye (*Secale cereale* L.), can serve as a wind-break, as well as a physical support for vining legumes.

Temperate species used in the northern part of the state include rye, ryegrass (*Lolium multiflorum* Lam.), wheat (*Triticum aestivum* L.) and oats (*Avena sativa* L.). These winter annual cereal grains have well developed root systems that are capable of utilizing soil N from profiles lower than vegetable crops. Red clover (*Trifolium pratense* L.) Southern Belle released by the Florida Agricultural Experiment Station in 2002 may be a good candidate for a winter cover crop throughout Florida due to its high biomass and early flowering, as well as its adaptation to the cool temperatures, low precipitation and low light of Florida winters.

**Polycultures.** Two or more species can be planted concurrently (polycultures) to achieve multiple objectives or to reduce the risk of crop loss. Polyculture plantings require additional planning, but can be beneficial. For example, combining vining types, such as legumes, with tall cereal grains allows for the potential of increased biomass and improved weed control due to the structural support the cereal grain provides for the legume. Production constraints of polycultures typically involve extra equipment, as some seed drills may not be able to seed two or more species of different seed sizes in the same pass. Thus, additional passes or an alternate method of planting, such as broadcasting, may be necessary. In general, using a drill to plant cover crops is the recommended method. Drilling results in a better stand than broadcasting because seeds are protected from predation of birds and small animals, as well as from the high temperatures and dry conditions on the soil surface. If broadcasting is necessary, seeds should be lightly incorporated with a tillage implement designed for minimal soil disturbance, such as a tine or basket weeder. In addition, producers should ensure the method and timing of kill is appropriate for both or all species included in the mix.

## 2b. Planting

**Preplant Soil Fertility.** Cover crops are rarely fertilized since they have no immediate cash return. However, objectives for growing cover crops are best achieved when the crops produce sufficient biomass. If there is no recent soil test for the land where the cover crops are to be grown, it may be worth the added expense to submit a soil sample to ensure sufficient nutrients are available for growth.

**Inoculation.** In the context of cover cropping, inoculation is the act of adding live cultures of soil bacteria to legume seeds prior to planting. Typically, these soil bacteria belong to a group known as rhizobia. Some rhizobial species are available in different strains, and the strains differ in their ability to form a beneficial, symbiotic relationship with a given legume crop. Some of these strains are able to enter into a root hair of a leguminous plant such as bean, pea, sunn hemp, etc. and cause the plant to form a nodule, in which the rhizobial species multiplies. Within the nodule, the rhizobial bacteria employ enzymes that convert atmospheric nitrogen gas (N<sub>2</sub>) into ammonium ions, ammonia and amino acids, which can be used by the legume. The legume, for its part in this symbiotic relationship, supplies the bacteria with organic acids (mainly the dicarboxylic acids, malate and succinate), as carbon and energy sources, as well as supplying some proteins and sufficient oxygen to support nitrogen fixation and other vital processes.

It is important to acquire the appropriate rhizobial strain for the species of legume being planted. The nitrogen-fixing efficiency of legumes will typically improve when inoculated with the appropriate rhizobial type, especially if the legumes are planted to a field that has not received a legume seeding in more than 5 years. Poor stands of legume cover crop may result if seeds are not properly inoculated with appropriate inoculum for the species. Failure to achieve an adequate stand may result in increased weed occurrence. For recommended inoculants, see Edis Publication HS1142 *Annual Cover Crops in Florida Vegetable Systems Part 3: Buying and Sourcing* (<http://edis.ifas.ufl.edu/HS390>).

Inoculant is more effective when applied to the seed with a sticking agent, such as corn syrup, sugar, milk, or a commercially available sticking agent. First, coat the seeds with the sticking agent. If using sugar, a 10% solution of sugar and water is sufficient. Next, add the inoculant and mix well. Mixing in small batches improves the distribution of inoculum. If the seeds are not planted within 48 hours, they should be inoculated again (SAN, 2007). If seeds are pre-inoculated, increase the seeding rate since the inoculum coating can account for up to 30% of the total seed weight (SAN, 2007).

**Seeding Methods.** Cover crop seeds may be treated with a fungicide, be untreated, or be certified organic. Untreated and organic seeds may be susceptible to soilborne diseases, such as *Fusarium* spp. and *Pythium* spp. (Chellemi, 2002). Most cover crop seeds can be drilled or broadcasted. However, seeds for many of the legume species planted in Florida are too large for a seeding plate and must be

broadcasted. To achieve a good stand, provide adequate moisture until plants are established.

Additional University of Florida-Institute of Food and Agricultural Sciences (UF-IFAS) extension publications on the subject of cover crop production are available electronically, including the following: EDIS Publication SSAGR150 *Planting Dates, Rates and Methods of Agronomic Crops* (<http://edis.ifas.ufl.edu/AA127>) (Whitty and Chambliss, 2005) and EDIS Publication SL242 *Cover Crop Benefits for South Florida Commercial Vegetable Producers* (<http://edis.ifas.ufl.edu/SS461>) (Li *et al.*, 2006; Rich *et al.*, 2003).

## 2c. Seasonal Management

Cover crops can be beneficial or detrimental to the production system, depending on how they are managed. Living mulches are cover crops that are planted concurrently with a vegetable crop. If cover crops are incorporated while alive, they are called green manures. Cover crops can be chemically or mechanically killed and incorporated or left on the surface as a mulch (conservation tillage).

In some cases, periodic mowing of cover crops during the season may facilitate an increase in total seasonal biomass production or an increase in the concentration of phytotoxins. For green manure applications, practices that produce high quality material and abundant biomass are most desirable. Nitrogen concentrations are generally higher in leaves and secondary branches than in main stems. Increasing the ratio of succulent foliage to woody stems can be accomplished by increasing row width to induce more secondary branching or by cutting the main stem. In Homestead FL, sunn hemp was seeded at 56 kg ha<sup>-1</sup> on April 15 and produced 20 mT•ha<sup>-1</sup> of dry biomass in 10 - 12 weeks (70 - 84 days) (Abdul-Baki *et al.*, 2001). However, sunn hemp has large, woody stems and can be difficult to incorporate without proper equipment. An alternative is to mow the sunn hemp once during the season at approximately 12 inches above the soil. This practice reduces apical dominance and increases the number of primary and secondary branches, which tend not to become woody. The result is improved residue quality, including an increase in percent N since the increase in secondary branches is accompanied by additional leaves and the racemes of flowers, which form at the terminals of the branches (Abdul-Baki *et al.*, 2001).

## 2d. Termination

**When to Terminate.** The timing of cover crop termination is dictated by the intended purpose of the cover crop, as well as production constraints. Additionally, the methods used to terminate and manage residues can have a substantial impact on the soil and cropping system. If the objective is N provision, timing of kill is very important. When legumes are used, the maximum amount of nitrogen that can be accumulated by the plants will occur at midbloom or when one half of the inflorescence is fully expanded and the other half of blooms are in bud (Creamer *et al.*, 1995). Under these conditions, nitrogen and carbohydrates are translocated from storage organs to the inflorescences, but these nutrients have not yet been acquired in seeds.

Producers should resist the temptation to terminate cover crops before adequate biomass has accumulated. Sufficient biomass is necessary for effective weed suppression, accomplished when cover crops successfully compete with weeds for water, nutrients, and light. Cover crops also suppress weeds through physical or mechanical interference with weed germination and establishment, as when surface mulch is used in row middles or for conservation tillage.

If early termination of the cover crop in spring or fall is necessary due to short breaks in the rotation, select species that accumulate biomass quickly, such as buckwheat. Other cover crop species with the potential for rapid biomass accumulation include rye 'FL401', sunn hemp, cowpea and sorghum.

**Decomposition and Mineralization Rates.** The timing and method of cover crop termination are important management decisions that can maximize post-termination benefits from use of cover crops, including increased organic matter, improved water retention and nitrogen contribution. Decomposition and mineralization are biological processes influenced by many factors, including the following:

- Soil temperature
- Soil moisture
- Cover crop carbon-to-nitrogen ratio
- Size of cover crop residue pieces
- Depth of incorporation of residue

Many different organisms decompose plant material, including beetles, mites, fungi, and bacteria. Winter annual cover crops terminated in early spring will decompose slower than summer annual cover crops terminated in the heat and humidity of August. This difference is because

decomposition is a biological process that increases in speed with temperature and moisture. In addition, the smaller the cover crop pieces, the faster the rate of decomposition. Ideally, producers should time cover crop termination so that plant residues are visible in the soil, but are small (less than 2 inches in length), moist, flexible, and evenly distributed in the soil throughout the planting area.

Once cover crops are terminated, the rate of decomposition can be manipulated by varying the size of residue pieces by varying the number of times the residue is disked. Soil organisms transform organic forms of nitrogen from cover crops to a plant-available form that crops can use. First, organic nitrogen is *mineralized*, or converted to ammonium ( $\text{NH}_4^+$ ) by fungi and bacteria. Next, *nitrification* takes place as the conversion of  $\text{NH}_4^+$  to  $\text{NO}_2^-$  then to  $\text{NO}_3^-$  by soil bacteria in the genera *Nitrosomonas* spp. and *Nitrobacter* spp. Nitrification occurs optimally when soil temperatures are between 77°F and 95 °F (25°C and 35 °C) although some nitrification will take place over a wide range of temperatures. Nitrification is reduced when temperatures are greater than 104 °F (40 °C) and less than 41 °F (5 °C) (Havlin, *et al.*, 1999). In general, microbial activity in the soil is greatest when the soil-moisture levels are between 50% and 70% of water-holding capacity (Linn and Doran, 1984). When the soil is very dry (less than 15 bars), soil microbes are unable to acquire sufficient moisture for basic metabolic functions and become inactive, thereby reducing the rate of nitrification and plant-available nitrogen in the soil solution (Stark and Firestone, 1995 and Seneviratne *et al.*, 1998).

To optimize the amount of nitrogen available to a subsequent crop, producers should decrease, as much as possible, the time between cover crop termination and crop planting. Once organic nitrogen is transformed to nitrate, nitrate in the soil solution can, following a heavy rain event, quickly move downward in the profile of Florida sandy soils. Loss of nitrogen in this way is likely to occur following a summer cover crop since, in Florida, precipitation in August is higher than in other months.

**Methods of Termination.** Producers have a variety of options for terminating cover crops. Chemical options for cover crop termination include paraquat dichloride (sold with the trade names Gramoxone, Firestorm) and glyphosate (sold with the trade names Touchdown, Roundup, Durango, Gyphomax, etc.). These materials are used most effectively after mowing cover crops. Both herbicides are labeled for preplant use on vegetables. However, paraquat has a 3-day waiting period before planting certain vegetable crops, so be sure to read the label carefully. Producers are

encouraged to contact their county extension office for questions regarding appropriate use of chemical herbicides following a cover crop.

Most producers rely on mechanical methods to terminate a cover crop. The method of termination should be based on the producer's objectives for utilizing plant residues. For example, different kill methods would be used to create plant mulch on the soil surface for weed suppression than if the cover crop was intended to improve soil physical properties.

The effectiveness of mechanical kill depends on the cover species, growth stage of the cover, equipment selection and, to some degree, climatic conditions at the time of kill. In an Alabama study, the effectiveness of a roller-crimper to kill cover crops of cereal rye, black oat and wheat was compared to use of labeled rates of the herbicides paraquat or glyphosate (Ashford and Reeves, 2003). Cereal grains terminated with a roller-crimper and half the herbicide rate averaged a 94% kill compared to the full herbicide rate treatment. When cereal grains were killed in the soft-dough growth stage, they were killed as effectively with a roller-crimper as with the full rate of herbicides (95% mean kill across mean methods).

Equipment typically used in killing cover crops includes mowers, undercutters, roller-crimpers, and plows. Rotary cutters, such as Bush Hog (Selma, AL), are composed of free-swinging blades designed for medium-duty applications, such as grass, corn stalks and light brush. The cut material is severed at the base and may be cut again as the material is moved under the deck. The result is surface mulch cut in relatively long sections and generally distributed across a wider area than the width of the deck.

Producers wanting more control over distribution or size of the material may opt to use a flail mower. Flail mowers (Figure 2) consist of vertical swinging blades, and in some models the direction of the rotation can be reversed for a controlled, rear-discharge of plant material. Additionally, when a flail mower is used, plant biomass is cut in smaller, more homogeneously sized pieces, so incorporation and decomposition occur more rapidly and consistently throughout the bed compared to when a rotary cutter is used.

Because the meristematic area of monocots (grasses) is close to the crown of the plant, the mower blade must be set very low to cut the growing area and terminate growth. Air temperatures that are sufficiently hot (several consecutive days above 90°F) can facilitate termination of temperate



Figure 2. Flail chopper mowing a winter cover crop of annual hairy vetch and rye. Credits: D. Treadwell

grass cover crops following an aggressive mowing. Should dicots continue growing after mowing, a second mowing with the blade set to remove the growing tips should be sufficient to kill the cover crop, especially if high temperatures are present.

Undercutters using V-shaped blade cutters were popular in the 1940s and 1950s. Researchers at Ohio State University designed and tested an updated version that features a long blade that runs just below the soil surface to sever roots of cover crops just below the ground (Creamer et al., 1995). On the surface, a rolling basket is located to the rear of the blade to flatten the severed crop. The advantage of this implement is that kill can be achieved without cutting the cover crop's above-ground foliage. This method of kill is suitable for producers who desire slowly decomposing surface mulch for weed suppression. The undercutter is most effective on deep-rooted winter annuals.

Undercutters are less successful with biennial and perennial species, such as perennial ryegrass, red clover and fescue. Similar to the undercutter, roller-crimpers kill cover crops by crushing and crimping stems (Figure 3), thereby preventing the flow of nutrients and water through the vascular system. Roller-crimpers come in a variety of styles and sizes (Figure 4) and cost from \$500 for a used or handmade model to \$5,000 for a new factory model. To view a short video of a roller-crimper designed by University of Florida researchers, click on [View Roller-Crimper Video](#).

Many producers have made their own roller-crimper using weighted drums with welded-angle iron strips running horizontally or in a spiral. However, tractor drivers sometimes have to reduce their speed if vibration becomes excessive when these roller-crimpers pass over the cover crop. Designs that feature a spiral blade or a short and



Figure 3. A) Roller-crimper designed by Alligood and Treadwell, terminating sunn hemp in Gainesville, FL, at mid-bloom. B) Terminated sunn hemp immediately following rolling and crimping. Credits: D. Treadwell

staggered straight-blade system reduce vibration and are as effective as the long-straight-blade system in killing cover crops (Raper *et al.*, 2004). Rolling stalk choppers, such as the Buffalo stalk chopper made by Fleischer (Columbus, Nebraska), are a popular choice for killing cover crops. Parallel linkage allows smaller roller units to float independently, an advantage on uneven land. One disadvantage of these rollers is that plant material can wrap around the wheel bearings, but the addition of a protective cover around the bearing can correct this problem.

In a study of three methods of kill of summer cover crops in North Carolina, undercutting killed 95% of five of the six broadleaf species tested and killed two of five grass species tested (Creamer and Dabney, 2002). However, effective termination depends on the maturity stage of the cover crop, as well as the method of termination. Mowing was effective on all the broadleaf covers, but did not kill immature grasses. Only nearly mature German foxtail millet and mature Japanese millet did not regrow after mowing. Rolling with a roller-crimper was effective on German and Japanese millet and on mature buckwheat.



Figure 4. Roller-crimpers designed to terminate cover crops for reduced tillage systems. Top: Roller-crimper designed by D. Treadwell and M. Alligood, Horticultural Sciences Department, University of Florida 2006. Bottom: Roller-crimper designed by R. Raper, USDA-ARS-NSDL Conservation Systems Research, Auburn, AL Credits: Top: D Treadwell. Bottom: R. Raper

## Summary

In summary, cover crop management requires preplanning, but the resulting contributions to the farming system can be beneficial. A plan for cover crop planting, mowing and termination is needed to avoid delays and costly errors. If you are new to cover crops, experiment with a few well selected species in an area large enough to accommodate the equipment you plan to use before implementing cover crops on the whole farm.

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Table 1. EDIS publications available to assist vegetable growers in selecting a cover crop

| Title   | Author and year of publication     | IFAS Pub # | Internet address  |
|---|------------------------------------|------------|---|
| <i>Cover Crops</i>  | Newman. <i>et al.</i> , Aug. 2007  | SSAGR66    | <a href="http://edis.ifas.ufl.edu/aa217">http://edis.ifas.ufl.edu/aa217</a> |
| <i>Cover Crop Benefits for South Florida Commercial Vegetable Producers</i>   | Li <i>et al.</i> , June 2006       | SL242      | <a href="http://edis.ifas.ufl.edu/ss461">http://edis.ifas.ufl.edu/ss461</a> |
| <i>Minor Use Summer Annual Forage Legumes</i>   | Newman and Chambliss, May 2007     | SSAGR48    | <a href="http://edis.ifas.ufl.edu/ag156">http://edis.ifas.ufl.edu/ag156</a> |
| <i>Inoculation of Agronomic Crop Legumes</i>  | Wright <i>et al.</i> , June 2008   | SSAGR154   | <a href="http://edis.ifas.ufl.edu/aa126">http://edis.ifas.ufl.edu/aa126</a> |
| <i>Burndown of Ryegrass Cover Crops Prior to Crop Planting</i>  | Ferrell <i>et al.</i> , April 2007 | AG275      | <a href="http://edis.ifas.ufl.edu/ag275">http://edis.ifas.ufl.edu/ag275</a> |
| <i>Selected Legumes Used As Summer Cover Crops</i>  | Rich <i>et al.</i> , Aug. 2003     | ENY688     | <a href="http://edis.ifas.ufl.edu/in483">http://edis.ifas.ufl.edu/in483</a> |
| <i>Guide to Using Perennial Peanut as a Cover Crop In Citrus</i>  | Rouse <i>et al.</i> , April 2001   | HS805      | <a href="http://edis.ifas.ufl.edu/ch180">http://edis.ifas.ufl.edu/ch180</a> |
| <i>2007 Fall Forage Update</i>  | Blount <i>et al.</i> , Oct. 2007   | SSAGR84    | <a href="http://edis.ifas.ufl.edu/aa266">http://edis.ifas.ufl.edu/aa266</a> |
| <i>Bahiagrass: A Quick Reference</i>  | Newman, Dec. 2007                  | SSAGR263   | <a href="http://edis.ifas.ufl.edu/ag271">http://edis.ifas.ufl.edu/ag271</a> |
| <i>Annual Ryegrass</i>  | Blount <i>et al.</i> , Jan. 2005   | SSAGR88    | <a href="http://edis.ifas.ufl.edu/ag104">http://edis.ifas.ufl.edu/ag104</a> |
| <i>White Clover</i>   | Chambliss and Wofford, Feb. 2006   | SSAGR54    | <a href="http://edis.ifas.ufl.edu/aa198">http://edis.ifas.ufl.edu/aa198</a> |
| <i>Limpograss (Hemarthria altissima) Overview and Management</i>  | Newman <i>et al.</i> , Aug. 2009   | SSAGR320   | <a href="http://edis.ifas.ufl.edu/ag330">http://edis.ifas.ufl.edu/ag330</a> |
| <i>Stargrass</i>  | Mislevy, Feb. 2006                 | SSAGR62    | <a href="http://edis.ifas.ufl.edu/ag154">http://edis.ifas.ufl.edu/ag154</a> |
| <i>Reduction of the Impact of Fertilization and Irrigation on Processes in the Nitrogen Cycle in Vegetable Fields with BMPs</i> | Cockx and Simonne, Sept. 2003      | HS948      | <a href="http://edis.ifas.ufl.edu/hs201">http://edis.ifas.ufl.edu/hs201</a> |

Table 2. General guidelines for cover crop management in Florida.

| Cover Crop                 | Scientific Name                               | Objective <sup>2</sup> | Planting Dates <sup>1</sup> | Seeding Rate (lbs/A) |         | Cost +/- (\$)/A | Days to Maturity |
|----------------------------|---|------------------------|-----------------------------|----------------------|---------|-----------------|------------------|
|                            |   |                        | North Florida               | Broadcast            | Drilled |                 |                  |
| Aeschynomene* <sup>3</sup> | <i>Aeschynomene americana</i> L.              | F, N, Sn, W            | Mar-Aug                     | 20*                  | 15*     | 70              | 50               |
| Alfalfa*                   | <i>Medicago sativa</i> L.                     | F, N, W                | Mar-May<br>Sep-Nov          | 15*                  | 10*     | 60              | 42               |
| Alyceclover*               | <i>Alysicarpus ovalifolius</i>                | F, N, W                | Mar-May                     | 20*                  | 15*     | 80              | 120              |
| Buckwheat                  | <i>Fagopyrum esculentum</i> M.                | P, Sd, Si, W           | Mar-Nov                     | 75                   | 60      | 60              | 55               |
| Corn                       | <i>Zea mays indentata</i>                     | F, Sn, W               | Mar-Aug                     | 60                   | 25      | 45              | 100              |
| Cowpea Iron Clay*          | <i>Vigna unguiculata</i> L.                   | F, N, Sn, W            | Mar-Aug                     | 120                  | 80      | 60              | 75               |
| Crimson Clover*            | <i>Trifolium incarnatum</i> L.                | F, N, Sn, W            | Mar-May<br>Sep-Nov          | 25                   | 20      | 30              | Per <sup>4</sup> |
| Daikon Radish              | <i>Raphanus sativus</i> L. H. Bailey          | Sw                     | Mar-May<br>Sep-Nov          | 30                   | 25      | 65              | 35               |
| Millet, Japanese           | <i>Echinochloa frumentacea</i> Link           | F, Sn, W               | Mar-May<br>Sep-Nov          | 30                   | 25      | 20              | 75               |
| Millet, Pearl              | <i>Pennisetum glaucum</i> L.                  | F, Sn, W               | Mar-Nov                     | 25                   | 10      | 25              | 80               |
| Lupine (Blue)              | <i>Lupinus</i> L.                             | N, Sn, W               | Sep-Nov                     | 80                   | 50      | 800             | Per              |
| Marigold, French           | <i>Tagetes minuta</i> L.                      | Sn                     | Mar-Nov                     | 1.5                  | 1       | 400             | 100              |
| Oat                        | <i>Avena sativa</i> L.                        | F, K, Sn, W            | Mar-Nov                     | 125                  | 100     | 75              | 65               |
| Perennial Peanut           | <i>Arachis glabrata</i> Berth                 | F, N, W                | Mar-May<br>Sep-Nov          | 80 <sup>5</sup>      | --      | 1200            | Per              |
| Rye (Cereal)               | <i>Secale cereale</i> L ssp. <i>cereale</i>   | F, K, Sn, W            | Jan-Dec                     | 80                   | 60      | 35              | 90               |
| Sesame                     | <i>Sesamum indicum</i> L.                     | Sn                     | Mar-Aug                     | 15                   | 8       | 200             | 100              |
| Sorghum Sudangrass         | <i>Sorghum bicolor</i> L. Moench              | F, N, Sn, W            | Mar-Nov                     | 60                   | 50      | 20              | 60               |
| Soybean*                   | <i>Glycine max</i> L.                         | F, N, Sn, W            | Mar-Nov                     | 80                   | 60      | 100             | 150              |
| Sunflower                  | <i>Helianthus annuus</i> L.                   | W                      | Mar-Nov                     | 60                   | 40      | 25              | 65               |
| Sunn Hemp* Tropic Sunn     | <i>Crotalaria juncea</i> L.                   | N, Sn, Sw, W           | Mar-Aug                     | 60                   | 50      | 120             | 90               |
| Velvet Bean*               | <i>Mucuna deeringiana</i> (Bort.) Merr.       | N, Sn, W               | Mar-Nov                     | 45                   | 40      | 75              | 120              |
| Vetch (Hairy)*             | <i>Vicia villosa</i> Roth ssp. <i>villosa</i> | Sn, W                  | Dec-May<br>Sep-Nov          | 30                   | 25      | 50              | 90               |
| Wheat                      | <i>Triticum aestivum</i> L.                   | F, K, Sn, W            | Mar-May<br>Sep-Nov          | 120                  | 100     | 14              | 75               |

<sup>1</sup> Planting dates: North Florida = North of Ocala. South Florida = South of Tampa.

Planting dates in South Florida are usually about 2 weeks earlier than in North Florida.

<sup>2</sup> All cover crops capture residual nutrients and reduce soil erosion. Objectives are abbreviated as follows: F (forage), K (potassium), N (nitrogen), P (phosphorus), Sd, Si, Sn, Sw (suppresses disease, insects, nematodes and weeds), W (wildlife habitat).

<sup>3</sup> Inoculate seed with appropriate rhizobial species for best results.

<sup>4</sup> Per (perennial)

<sup>5</sup> Bushels of rhizomes per acre