10 *Mark Van Horn, Eric Brennan, Oleg Daugovish, and Jeff Mitchell*

Cover Crop Management

pp. 71-78. In Smith et al. (ed.) Cover Cropping for Vegetable Production: A Grower's Handbook, University of California, Oakland, CA.

The benefits derived from growing a cover crop depend on the type of cover crop grown and how it is managed. This chapter discusses a sequence of cover crop management decisions and practices that are generally applicable throughout California. Cover crop management can vary considerably among the different regions of the state; information about regionally specific practices, such as recommended species, varieties, and planting dates, can be found in chapter 11.

Timing

Cool- and warm-season cover crops can be grown in most vegetable production regions of California, although cool-season cover crops are grown more often. The planting date and total length of growing season can impact several cover crop performance factors, such as biomass production, weed suppression, nitrogen fixation, and nitrogen scavenging. This is particularly true with cool-season legumes and legume-cereal mixtures that often produce poor or weedy stands, or fail completely, when they are planted after recommended dates. Conversely, cool-season grass cover crops that are planted too early in the fall may flower prematurely, reducing cover crop biomass production and possibly producing seed that can germinate and become weeds in subsequent crops.

The range of acceptable planting dates is generally greater in the more moderate coastal regions than in the interior valleys. This range is also fairly broad for warm-season cover crops in most of the state because of the relatively long period of suitable conditions and the relatively short growing season required, although water limitations may restrict the timing of warm-season cover cropping in some areas.

Field Preparation and Planting

Field preparation and planting of cover crops typically follow standard practices used with agronomic cash crops. The main objective of these activities is to place the seed at the proper depth (see table 2.1 in chapter 2) with good soil-to-seed contact to promote uniform germination and emergence. Cover crops are usually more tolerant of marginal planting conditions than are vegetable crops. Field preparation activities for cover crops can range from none, such as when using no-till planters (fig. 10.1), to extensive and may include making furrows for irrigation or drainage of the cover crop or subsequent cash crops.

Most cover crops are planted as solid stands with grain drills that place the seed in rows spaced 6 to 10 inches apart (fig. 10.2). Solid stands also can be achieved by broadcasting the seed and incorporating it with

Figure 10.1. No-till grain drill plants a triticale-pea-vetch cover crop into cotton residue. J. MITCHELL

Figure 10.2. Drilled stand of cereal rye. R. SMITH

implements such as harrows or ring rollers, depending on soil conditions and desired seeding depth (fig. 10.3). Broadcasting produces less-uniform seed distribution, seeding depths, and crop stands and thus requires higher seeding rates. Seeding with a grain drill on beds may require adjusting the drill to achieve the proper seeding depth in all rows or using a special planting configuration. For example, certain rows on a grain drill may be plugged to prevent planting in the furrows. Some cover crops, such as cowpeas, can be planted with bean or corn planters in rows spaced farther apart (e.g., 28 to 40 inches), allowing in-season cultivation for weed control.

Cover crop mixtures (fig. 10.4) are usually planted by using seed mixes that are placed in a single seed hopper of the planter (Figure 10.5). However, drills with two seed hoppers can be used if the seeds of the different species do not stay well mixed in a single hopper. Mixtures of species with seeds of very different sizes are commonly planted at a depth that is a compromise among the optimal depths for the different species.

Cover crops that are integrated into conservation tillage rotations can be established using no-till drills that can seed directly into residues using disk openers, coulters, and hydraulic pressure. Cover crops have been established successfully in California after the harvest of tomatoes, melons, corn, cotton, grain legumes, and wheat with either no preplant tillage or after one or two passes with a minimum-till disk.

Seeding Rate

Table 2.1 (chapter 2) gives recommended cover crop seeding rates for generally favorable conditions. However, the actual optimal seeding rate for a given situation can vary considerably depending on many factors. In general, higher seeding rates are needed as conditions become less favorable or more risky for cover crop germination and growth or when high cover crop densities are needed to achieve a specific objective early in the season. Depending on the situation, seeding rates may be only slightly more than the upper end of the range listed in table 2.1 or more than 1.5 times that rate. Using a higher seeding rate is recommended if

- the germination rate is lower than 90%, the minimum rate assumed in table 2.1 (to compensate for low germination rates, divide the recommended seeding rate by the germination percentage, expressed as a proportion; e.g., if the recommended rate is 100 lb/acre and the germination rate is 80%, plant at 100 ÷ 0.80, or 125 lb/acre)
- the thousand kernel weight of the seed is greater than that listed in table 2.1
- the planting method (e.g., broadcast and harrow) does not consistently place seed at the proper depth or spacing
- the planting date is significantly earlier or later than recommended or there is a risk that the germination date of a nonirrigated cool-season cover crop may be

Fig. 10.3. Broadcasting mustard seed on the soil surface from a small, hydraulically driven seed hopper and shallowly incorporating it with a spike-tooth harrow. R. Smith

Figure 10.4. Legume-cereal cover crop mixture seeded with a grain drill. R. SMITH

Figure 10.5. Legume-cereal cover crop seed mix in grain drill hopper. R. SMITH

Figure 10.6. Seeding rate and variety affect how quickly drilled rows of cereal rye provide total ground cover to suppress weed growth between seed rows. R. SMITH

late because of a delayed onset of the rainy season

- the growing season for a cover crop will be very short, and total production will be directly influenced by cover crop stand density
- denser early-season cover crop stands are desired to be more competitive with weeds
- denser early-season cover crop stands are desired to be more effective in absorbing residual soil nitrogen

Cover crop seed typically accounts for a relatively small part (20 to 30%) of cover cropping costs (see chapter 12), but the seeding rate used can have a large effect on some of the beneficial effects of cover cropping. For example, in a long-term cover crop trial, weed densities were six times higher in organic lettuce that had 5 years of a rye-legume winter cover crop planted at 125 versus 375 pounds per acre (E. Brennan, unpublished data). Because the objectives and conditions of cover cropping can vary greatly, growers may want to experiment with different seeding rates in different areas of a field and carefully observe and record the cover crop's performance throughout the season. This information may assist in decision making in future years. Various seeding rates can easily be achieved by adjusting the seeding rate lever on most grain drills or by planting a section of a field two or more times. Because fields are inherently variable it is better to have a number of small test areas than one large one. Important factors that are typically affected by seeding rate and are relatively easy to monitor include the number of cover crop plants per foot of row, weed density (e.g., number of weeds per square foot) and growth, number of days to canopy closure (fig. 10.6), and cover crop height, flowering date, and degree of lodging.

Seeding Rate Calculators

Growers can use simple online seeding rate calculators such as the one at the Government of Alberta's Agriculture and Rural Development Decision-Making Tools Web site (http://www.agric.gov.ab.ca/app19/calc/crop/otherseedcalculator.jsp) to calibrate their planting equipment and determine how to adjust the seeding rate for a cover crop based on factors such as thousand kernel weight, row spacing, and germination rate. These calculators can help you achieve a target plant density and can provide insight into why cover crops perform differently at various rates. Consider the following example, which has a target density of 45 rye plants per square foot. Assume there is 90% germination and 5% seedling emergence mortality. Using the online calculator, a seeding rate of 81 pounds per acre would be required for seed with a thousand kernel weight of 16 grams, whereas a seeding rate of 111 pounds per acre would be necessary for seed with a thousand kernel weight of 22 grams. Note that seeding rate is independent of row spacing, number of acres planted, and seed price, but the calculator will not work unless a row spacing value is entered.

Seeding rate decisions are more complex in cover crop mixtures than in single-species cover crops because some components (typically legumes) of mixtures are often more sensitive to competition as seeding rate increases. Competition between components of a mixture at a given seeding rate can also be influenced by nutrient availability and ambient temperature. For example, the grass component of a grass-legume mixture is more likely to dominate the mixture in a soil with high residual nitrogen than in a soil with low nitrogen.

Nutrient Management, Fertilization, and Inoculation

Cover crops can improve nutrient management in a cropping system by recycling nutrients, reducing losses from leaching and runoff, and adding nitrogen. Nonlegume cover crops such as cereals and mustards are the most effective scavengers of nitrogen that might otherwise leach from the topsoil and pollute ground or surface waters. Legume cover crops can add nitrogen to a cropping system when *Rhizobia* bacteria present in their roots convert atmospheric nitrogen into a form that plants can use in the process of nitrogen fixation (see chapter 5). Cover crop mixtures of legumes and nonlegumes can combine the nitrogen fixing of the legumes with the nitrogen scavenging of the nonlegumes.

Nitrogen fixation can occur only when the strain of *Rhizobia* present in a legume's roots is an effective strain for that particular species of legume. Therefore, legume cover crop seed should always be inoculated with the appropriate strain of *Rhizobia.* Inoculants can be purchased from seed dealers and other suppliers and stored in a sealed container in a cool location until use. Inoculants should be used prior to their expiration dates; once inoculated, seed should be kept out of direct sunlight and planted as soon as possible. It is also possible to purchase preinoculated seed of many legumes. Legume root nodules that have a pink to red color internally provide evidence of effective nodulation and nitrogen fixation (fig. 10.7). Fertilizing legume cover crops with nitrogen is not recommended because nitrogen fixation is inhibited by available soil nitrogen. However, additions of lime or phosphorous fertilizers may improve nitrogen fixation in some situations, such as on soils that are acidic or have low levels of available phosphorous.

Most vegetable-producing soils in California are highly fertile and can produce vigorous cover crops without fertilizers. Therefore, fertilization of cover crops is generally discouraged. However, if a non-nitrogen nutrient deficiency exists, correcting the deficiency prior to planting a cover crop will improve its performance, and the nutrients taken up by the cover crop will ultimately be returned to the soil when the cover crop decomposes. In addition, nitrogen fertilization of a warm-season nonlegume cover crop such as sudangrass may be warranted when it is grown on a nitrogen-deficient soil and the objective is to add large amounts of organic matter to the soil.

Figure 10.7. Nodulation on roots of bell bean. Note the lower nodule, cut open to show the pink color indicating effective nitrogen fixation. R. SMITH

Irrigation

Irrigation can be an important part of successful cover crop management. Pre- or postplant irrigation of cool-season cover crops can help ensure germination and vigorous cover crop growth early in the fall. If used, sprinkler pipe should be removed from the field soon after irrigation is complete to avoid difficulties in removing it later in the season after significant cover crop growth. In-season irrigation of cool-season cover crops is uncommon but may improve cover crop growth in drier locations and seasons. Irrigation is essential for most warm-season cover crops in California, and most species are more productive when they have more water. However, some species (e.g., sorghum, sudangrass, cowpea) can be productive on deep, fertile soils with minimal irrigation if soil moisture levels are initially high.

End-of-Season Management

At the end of the cover cropping season, growers must make a number of interrelated decisions about the timing and methods used in cover crop termination, field preparation, and planting of the subsequent vegetable crop. These decisions may be influenced by the type and purpose of the cover crop; the cover crop's stage of development, biomass, and nitrogen and fiber content; the soil type and soil moisture content; and prevailing weather patterns. For example, with grass cover crops, which can produce large amounts of slowly decomposing, tough, fibrous residue, a grower may terminate the cover crop long before it reaches full vegetative growth to minimize problems associated with managing such residues (fig. 10.8). Some grass cover crops, particularly *Sorghum* species, produce allelopathic compounds that can damage subsequent cash crops if the compounds persist into the crop planting period. In some situations, early cover crop termination may be necessary to perform field operations needed to prepare the field adequately for a subsequent vegetable crop.

Figure 10.8 The grass residue on the right was more difficult to incorporate into the soil than the legume residue on the left. R. SMITH

Table 10.1. Conversion factors for estimating nitrogen content of selected cover crops

Crop common name	Scientific name	Factor
bell beans	*Vicia faba*	10
sesbania	*Sesbania* spp.	10
sunn hemp	*Crotalaria juncea*	11
blackeyed peas (cowpeas)	*Vigna unguiculata* ssp. *unguiculata*	12
berseem clover	*Trifolium alexandrinum*	13
woolypod vetch	*Vicia villosa* ssp. *varia*	16
purple vetch	*Vicia benghalensis*	16

Conversely, if the objective is to maximize the biomass or nitrogen additions from a cover crop, the crop should be terminated during early to mid bloom because biomass and nitrogen accumulation rates are typically highest just before bloom and decrease dramatically at the onset of flowering.

Estimating the Nitrogen Content of a Legume Cover Crop

When deciding how long to maintain a legume cover crop that is being grown for its nitrogen benefit, it can be helpful to estimate the amount of nitrogen in the standing cover crop using the procedure described below. However, the need to prepare the field and plant a cash crop by a certain date or as the weather or soil moisture conditions permit sometimes overrides all other considerations in determining when to terminate a cover crop.

1. Cut and weigh the fresh aboveground cover crop biomass from an area of 16 square feet (e.g., 4 ft by 4 ft) (fig. 10.9). The plants should be free of dew. Flowers may be present, but seed pods should not be. Remove any weed biomass from the sample before weighing.
2. Use the appropriate conversion factor from table 10.1 and the equation below to estimate the number of pounds of nitrogen per acre contained in the cover crop. For cover crop mixtures, separate the components of the mixture, individually weigh and calculate the nitrogen contribution of each component, and add the individual contributions for the total nitrogen contribution.

Fresh weight (lb) × Conversion factor = Nitrogen in cover crop (lb/ac)

3. Repeat this procedure several (e.g., 5 to 10) times over the field to get an idea of the average amount of nitrogen in the cover crop and the amount of variability in the field.

Terminating the Cover Crop

Growers can use a number of methods to terminate a cover crop and prepare and plant the field to the following cash crop. Mowing is important in most strategies because residues are managed more easily and decompose more rapidly when shredded into fine pieces with a mower (fig. 10.10). Flail mowers are preferable to rotary mowers because they cut the cover crop into finer pieces and distribute them more evenly on the soil surface. Usually, the mowed residue should be incorporated as soon as possible. However, this is not always feasible, and in a wet year it may be worthwhile to mow a cover crop to prevent seed set by the cover crop or weeds even if residue incorporation will be delayed until the soil dries sufficiently.

A typical sequence of operations includes mowing, disking two or three times, and making beds. When large amounts of fibrous residues are present, such as is common with grass cover crops, making several additional passes with a disk or moldboard plow may be needed to prepare the field adequately for planting vegetables. In such situations, a spader may be a useful alternative to more conventional implements. Spaders travel at slow speeds (e.g., 1/4 to 3/4 mph) but can incorporate residues thoroughly in a single pass (fig. 10.11). They can be particularly useful for smaller-scale diversified vegetable operations that often have areas that are too small to be disked effectively, regardless of the type and amount of cover crop residue involved. A minimum-till disk can preserve preexisting beds and may be an option for reducing tillage if low or moderate amounts of residue are present. Other minimum-till options for managing cover crops include using various rollers, crimpers, and stalk choppers (fig. 10.12) to convert cover crops into surface mulches that may be followed by strip tillers that till only a narrow band on the bed top for planting or transplanting the vegetable crop. However, for cover crops species that must be killed completely before planting the subsequent crop, rolling, crimping or chopping may not be adequate in all situations.

Figure 10.9. The nitrogen content of this cover crop was estimated in the field using the materials shown and the procedure described in the text. M. Van Horn

Figure 10.10. Mustard cover crop mowed with a flail mower prior to disking. R. Smith

Figure 10.11. A spader incorporates standing cover crop of mixed legumes in one pass. M. Van Horn

Figure 10.12. Front-mounted roller-crimper flattens rye cover crop while rear-mounted seeder plants cotton. J. MITCHELL.

References

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