Selecting Cover Crops for California Annual Crop Systems

In California annual crop systems, cover crops are grown in rotation with cash crops and are generally cool-season varieties that are sown in the fall, grow over the winter, and terminated in the late winter or early spring. Cool-season cover crops are followed by summer cash crops, like grains, dry beans, oilseeds, or vegetables. Warm-season cover crops are less common in California because they typically require irrigation. They may be planted into late July, following early summer harvests of small grains or other annual crops. Summer cover crops are generally terminated in early fall and can be followed with a cool-season cover crop or cash crop.

Choosing a Cover Crop

Legumes (Fig. 1A) convert atmospheric nitrogen to plant-available forms through a symbiotic association with bacteria on their roots. Examples include clover, pea, fava, and vetch (cool-season), and cowpea and sunn hemp (warm-season). For optimal performance, seed should be inoculated with *Rhizobia* bacteria, especially in the first year of planting. Legumes can increase their biomass rapidly in warm spring conditions, and some will trellis up other species in a cover crop mix. Their flowers attract beneficial insects and provide food for native bees when the agricultural landscape has few flowers. Legumes, however, are sensitive to excess soil moisture, do not effectively mine nitrate in the soil profile, and are generally not as competitive against weeds.

Grasses (Fig. 1B) can produce abundant above and below-ground biomass that adds carbon to the soil. Examples include wheat, triticale, and oats (cool-season), and millet, sudangrass, sorghum, and teff (warm-season). The fibrous roots can alleviate soil compaction, reduce erosion, and mine nitrate before it leaches below the root zone. Grasses compete well with weeds, and their seed is generally less expensive than legume seed. One challenge, however, is that the rootballs of some species may persist into the next crop cycle and clog irrigation furrows.

Forbs (Fig. 1C) include cover crops in the brassica family, as well as other species like buckwheat, phacelia, and flax. Among the forbs,

Figure 1. A. Vetch is a vigorous cool-season legume that can fix atmospheric nitrogen for use by future cash crops. B. Cayuse oats and other cool-season grasses have fibrous roots that can hold soil in place when rains are heavy. C. Mustard and other cool-season brassicas have properties that may alleviate disease and nematode pressure.

brassicas are the most common cover crops in California and include mustard, radish, rape, and turnip. They have a deep taproot that can alleviate soil compaction and mine water and nitrate from below the crop root zone. Brassicas close their canopy rapidly, outcompeting weeds. Their flowers can attract beneficial insects and provide food for native bees. Chemical compounds in the biomass may contribute to disease and nematode suppression. A challenge with brassicas is that their long stalk can get woody after flower set and clog equipment during termination. Also, if allowed to set seed, brassicas can become a weed in subsequent seasons. Brassicas do not do well in flooded conditions.

Mixes: Mixes are popular because they may provide multiple benefits at once and increase the likelihood of obtaining an adequate stand. During adverse environmental conditions, certain species may succeed over others, like mustards during drought or legumes in low-fertility conditions.

Other Considerations

The carbon to nitrogen ratio (C:N) is important for variety selection and is the relative amount of C and N in cover crop residue. The ratio is important because microbes ideally need a diet of 20:1 to 25:1 for their metabolic functioning. If microbes consume material with a lower C:N than the ideal diet, N will be released into the soil solution during decomposition. If microbes consume residue with a higher C:N than the ideal diet, they will mine nitrate from the soil solution and tie it up in their own cells. Thus, the residue nitrogen is immobilized and not immediately plant-available.

When cover crops are terminated, nitrogen in the plant tissue can be released back into the soil and be available for subsequent crops. Among the common cover crop families, legumes have the lowest C:N ratio (15:1 to 20:1). They rapidly release plant-available nitrogen as they break down, and their residues quickly disappear after incorporation, leaving a 'clean' field. Grasses have the highest C:N among these families; however, if they are terminated before seed set, they decompose more rapidly. Brassicas have a C:N ratio between legumes and grasses (20:1 to 30:1), which enables rapid breakdown. The C:N ratio of species is dynamic and will increase as the plant grows, particularly after seed set. Cover crop mixes that contain species from different groups may help to balance the C:N ratio for a more optimal release of nutrients.

For more on this topic:

- ✓ Companion fact sheet "Cover cropping in California annual crop rotations – benefits and challenges"
- ✓ Cover crop performance and adaptation trials at Plant Materials Centers: https://www.nrcs.usda.gov/plant-materials/cover-crop-performance-and-adaptation-trials
- ✓ UCCE cover crop performance reports: cesutter.ucanr.edu/SacramentoValleyFieldCrops/project_summaries

Agronomy Research and Information Center
http://agric.ucdavis.edu/
UC CE University of California Cooperative Extension
Authors: Sarah Light, Michelle Leinfelder-Miles, Whitney Brim DeForest
2024