Cover Crop Selection and Management for Agronomic Farming Systems

Jeremy W. Singer, Research Agronomist, USDA-ARS National Soil Tilth Laboratory

Tom C. Kaspar, Plant Physiologist, USDA-ARS National Soil Tilth Laboratory

Cover crops can extend the season of active nutrient uptake and living soil cover and thereby reduce nutrient losses in water and sediment. The conversion of the prairies or other native vegetation ecosystems to summer annual grain crops resulted in a shortening of the season of living plant cover and nutrient uptake. Summer annual grain crops, like corn and soybean, accumulate water and nutrients and provide living cover for only about four months (mid-May to mid-September), whereas in natural systems, some living plants are actively accumulating nutrients and water whenever the ground is not frozen (at least 7 months; April-October). As a result, soil nutrients in summer annual cropping systems are susceptible to losses in part because there are periods during each year when active plant uptake and soil cover are absent.

Cover crops are literally "crops that cover the soil" and may be used to reduce soil erosion, reduce nitrogen leaching, provide weed and pest suppression, and increase soil organic matter. Winter cover crops are planted shortly before or soon after harvest of the cash crop and are killed before or soon after planting of the next cash crop. Cereal grains, such as oat, winter wheat, barley, winter triticale, and winter rye, are excellent cover crops because they grow rapidly in cool weather, withstand moderate frost, and their seed is relatively inexpensive or can be produced on site. Many varieties of winter rye, triticale, and wheat can overwinter in the upper Midwest and continue growing in the spring. These winter-hardy cover crops must be killed with herbicides or tillage prior to planting corn or soybean. Oat, barley, spring wheat and triticale, some rye, and winter wheat are not winter-hardy in the upper Midwest. Because the non-winter-hardy cereal grains do not survive the winter, they do not require killing prior to planting the cash crop. When non-winter-hardy cereal grains are seeded in August after short-season crops or by overseeding, they can produce substantial fall biomass.

Legumes are also used as cover crops and they fix nitrogen as an added benefit. If nitrogen is available in the soil, legumes will take up nitrogen rather than fixing it. Legumes, however, usually do not grow as well as cereal grains during the fall and winter months, they accumulate less soil nitrogen than cereal grains, their seed is relatively expensive, and most must be killed with tillage or herbicides in the spring. Grasses (such as annual ryegrass) and brassicas (such as oilseed radish, oriental mustard, and forage radish) are also potential cover crops. Cool-season grasses and brassicas grow well in cool weather, but winter hardiness is species and location dependent. The brassicas have been shown to suppress nematodes, some diseases, and winter annual weeds. Seed costs are higher and seed is usually more difficult to obtain than cereal grain seed.

Living mulches are defined as cover crops planted either before or with a cash crop and maintained as living ground cover throughout the growing season. Often the living mulches are perennial species and are maintained from year-to-year. Ideally, the growth of the living mulch

is suppressed when the cash crop is growing and increases as the cash crop matures or when it is no longer present. Perennial legumes (such as alfalfa, kura clover, birdsfoot trefoil, crownvetch, and white clover) and perennial grasses (such as orchardgrass, reed canarygrass, and turfgrasses) can be used as living mulches. Currently, living mulch systems are being used in vineyards and orchards, but their use in agronomic systems is mostly experimental. The main issue with living mulches is that the living mulch competes with the cash crop for water and nutrients, which can reduce crop growth and yield.

Because cover crops increase surface cover, anchor residues, increase infiltration, and reduce both rill and interrill erosion, they reduce phosphorus and pesticide losses and movement associated with soil erosion. Also, cover crops begin growth, water use, and nutrient uptake earlier in the spring and then continue later into the fall than most annual grain crops. This extended period of water use and nutrient uptake normally reduces the volume of drainage water and leaching losses of nitrate and dissolved phosphorus. Reductions in nitrate load using a rye cover crop ranged from 13% in Minnesota to 94% in Kentucky. A study in Indiana reduced nitrate loads by 61% with a reduction in fertilizer nitrogen rates and a winter wheat cover crop following corn. Effectiveness of cover crops varies with growth of the cover crop, weather, and management of the cash crop. More growth of the cover crop will result in greater reductions in nitrate leaching, but growth of cover crops can be limited by cold temperatures, water stress, nutrient availability, and delays in establishment. Similarly, lack of precipitation and soil freezing may eliminate or greatly reduce nitrate leaching losses and reduce the impact of the cover crop. Lastly, reducing nitrogen fertilizer rates and applying nitrogen fertilizer closer to the time of crop uptake will also reduce nitrate leaching and the impact of the cover crop.

In Iowa, rye and oat cover crops reduced rill erosion following soybean in a no-tillage system by 79% and 49%. Losses of P to surface waters, which are linked to sediment losses, might be reduced by a similar amount relative to no-tillage. Reductions in total P losses ranged from 54% to 94% from research experiments using cover crops. However, the effects of cover crops on soluble P in runoff are variable and do not always result in reductions. There is evidence that soluble P can be lost in runoff flowing over plant residues. However, plant water use and infiltration would be expected to increase with cover crops, which should reduce the volume of runoff.

Corn yields may be reduced following winter-hardy cereal grain cover crops that are killed immediately before corn planting. Yield reduction can be minimized by killing cover crops more than 14 days prior to corn planting and using starter fertilizer. Corn yields following an oat cover crop, which dies when the ground freezes in the fall, or a legume that overwinters, are not reduced. Soybean yields are not reduced following cereal grain cover crops unless low soil water content limits soybean germination and emergence.