Southern Cover Crops
2016 CONFERENCE FACT SHEET

Cover Crop Mixture Selection and Management

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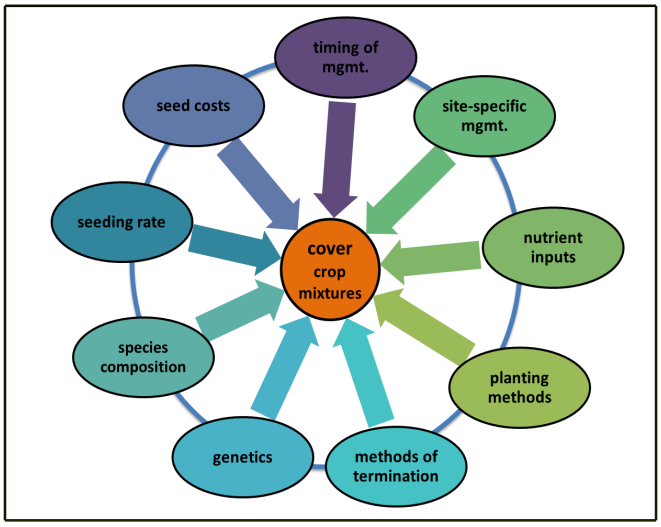

Fig. 1. Cover crop mixture selection and management determines the extent to which the cover crops provide ecosystem services.

Cover crops are multifunctional tools that can provide a variety of ecosystem services such as cycling and retaining nutrients (e.g. nitrogen) in the cropping system, stabilizing the soil to prevent erosion, adding organic matter to improve soil health, suppressing weeds, and serving as habitat for beneficial organisms both below- and aboveground. Some cover crop species are better at providing a given ecosystem service than others. For example, cereal rye is an excellent choice for decreasing erosion because it rapidly creates solid ground cover. It does not, however, fix nitrogen for a following cash crop. In contrast, hairy vetch does add nitrogen to the system, but is not a good choice for fall erosion control because it is slow to establish and provide ground cover. The use of cover crop mixtures allows producers to reap the benefits of multiple cover crop species at the same time, maximizing the number of ecosystem services provided in a cropping system.

Cover Crop Species for Inclusion in a Mixture

Cover crop mixtures can be acquired either by buying a mixture already created by seed companies, or by creating a custom blend. When choosing species to include in a custom blend, producers often opt for maximum diversity. This diversity may come in the form of species with contrasting growth habits (i.e. vining hairy vetch plus upright cereal rye); contrasting root growth (i.e. forage radish with large, tuberous taproots plus cereal rye with smaller, more fibrous roots); contrasting levels of winter hardiness (i.e. frost-tender sunn hemp plus winter-hardy crimson clover); and of course, contrasting potential ecosystem service benefits (i.e. Austrian winter pea to fix nitrogen plus annual ryegrass to scavenge residual soil nitrogen). Cover crop mixtures run the gamut from blends containing only two species to blends containing over twenty species. The more species in a cover crop mixture, the more potential ecosystem services can be provided and the more likely it is, in the event of adverse conditions, that at least some cover crops may survive and become established. Multi-species mixtures may also more easily adapt to a variety of soil fertility levels. However, multi-species mixtures can be more expensive than simpler mixtures, may be more difficult to plant evenly due to varying seed sizes, and can be more difficult to manage. In addition, cover crops within a mixture often compete with each other, rendering the species diversity moot if one species outcompetes the others and effectively establishes a monoculture.

Cover Crop Mixture Management to Maximize Ecosystem Services

Cover crops are living organisms that respond to the environment (e.g. soil nitrogen and moisture levels) in varied ways. The interplay between cover crop species in a mixture under differing environmental conditions is complex. Producers and researchers are only just beginning to understand how to optimize cover crop mixtures to maximize ecosystem service provision while minimizing the cost of using the cover crops.

The key to maximizing the ecosystem services provided by a cover crop mixture is to manage the mixture (Fig. 1) so that it produces large amounts of biomass with a moderate C:N ratio (Fig. 2). Choose species based on goals, constraints, and range of tolerance. A cereal rye monoculture produces large amounts of biomass, but also has a high C:N ratio that inhibits nitrogen release to a following

TABLE 1. Results from a two-year study in Pennsylvania examining ecosystem services provided by cover crop mixtures.

	Nitrogen loss prevented (lbs N/ac)	Nitrogen in cover crop biomass (lbs N/ac)	Nitrogen available from cover crop during next corn season (lbs N/ac)**	Yield gain/loss relative to no cover crop (t/ac)
	Year 1 – low residual fertility sites			
Radish, oat, clover, vetch	20	177	14	1.5
Canola, rye, clover, vetch	40	168	4	1.0
8-species cocktail*	32	182	9	1.3
	Year 2 – high residual fertility sites			
Radish, oat, clover, vetch	83	80	-2.3**	0.1
Canola, rye, clover, vetch	91	148	-4.0	-0.1
8-species cocktail*	90	118	-5.7	-0.1

*8-species mixture consisted of soybean, sunn hemp, red clover, hairy vetch, cereal rye, canola, forage radish, and oat; not all cover crops will reliably winter-kill in southern regions
** Negative values indicate nitrogen immobilization

cash crop (Fig. 3). A mixture of 50% cereal rye plus 50% hairy vetch produces a large amount of biomass with a lower C:N ratio and comparable total nitrogen levels, and releases nitrogen more slowly so as to have better synchrony with cash crop nitrogen uptake (Fig. 3). While a hairy vetch monoculture releases even more nitrogen than the mixture, it has a C:N ratio so low that the cover crop mulch rapidly decomposes, releasing nitrogen so quickly that there is a risk of leaching and providing far less weed suppression than the mixture (Fig. 4).

Factors to be taken into account when managing cover crop mixtures include climate, seeding rates of the species in the mixture and planting methods, soil fertility, species growth habit, and termination timing. Cover crop mixtures may be planted at any time when a cash crop is not present (typically in the fall or early spring), or may be interseeded with a cash crop. Climate dictates planting and termination dates, which in turn affect cover crop performance. If a mixture of cereal rye and hairy vetch is planted past the optimal time, hairy vetch may not establish prior to the onset of winter and the cereal rye will dominate the mixture. Highly competitive species such as annual ryegrass and cereal rye may be planted at the low end of recommended ranges in a mixture to allow other species the chance to grow. Not all cover crops are suitable for all planting methods (i.e. aerial seeding vs. drilling), which should be taken into account when planting mixtures. At sites with low residual soil fertility, the legumes in a mix will have a competitive advantage because legumes fix nitrogen rather than relying on soil nitrogen for growth. High residual soil nitrogen (e.g. following corn grown during a droughty summer) will favor the grasses and broadleaves in a mix, to the detriment of legumes. Table 1 illustrates the

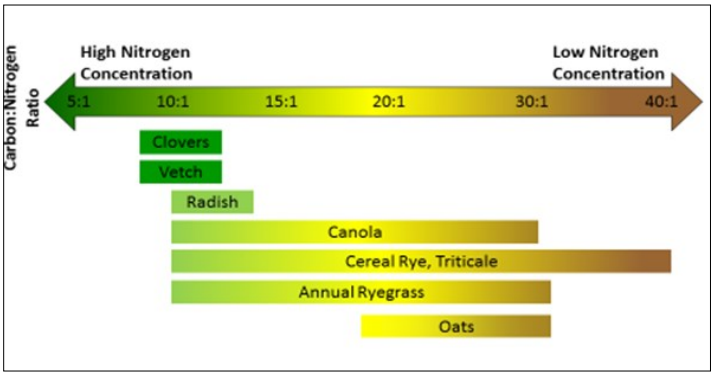

Fig. 2. The C:N ratio of a cover crop mixture is determined by the biomass and C:N ratio of each species. Cover crops with a high C:N ratio (e.g., cereal rye) scavenge N, but can also reduce N supply to the next cash crop. Mixing cover crops with a high C:N ratio with legumes that have a low C:N ratio can create mixtures with a moderate C:N ratio.

differing outcomes when cover crop mixtures are grown at high fertility sites (as in Year 1) vs. low fertility sites (as in Year 2). There were corn yield losses in two of the three mixture treatments and only modest corn grain yield gain in the third mixture treatment in Year 2 because the amount of nitrogen accumulated in the cover crop biomass and inorganic nitrogen supplied to the following cash crop were lower (due to higher C:N ratios) than in Year 1. Seeding rates, planting timing, and planting method can be tailored to fit soil fertility. Vining species such as hairy vetch benefit from the inclusion in mixtures of upright species such as cereal rye, on which they can climb to access sunlight. Grasses in general can act as a nurse crop for the legume components of a mixture, increasing winter survival by aiding fall establishment.

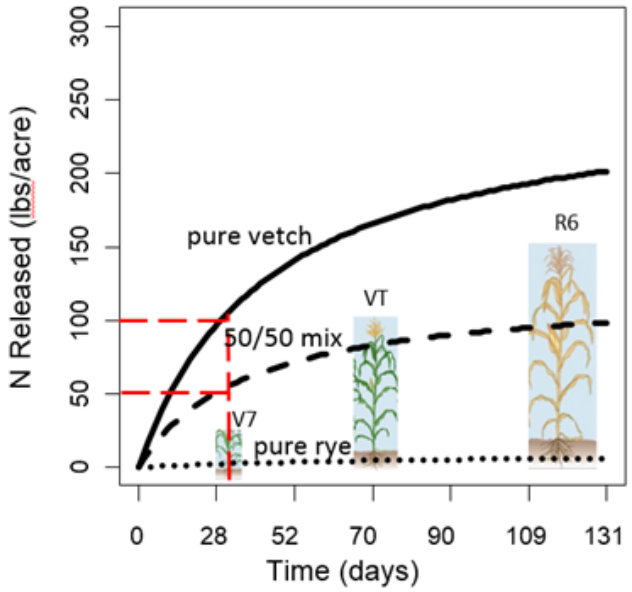

Fig. 3. Contrasting N release from a pure hairy vetch cover crop (solid line), a 50/50 mixture of hairy vetch and cereal rye (dashed line) and a pure cereal rye cover crop (dotted line).

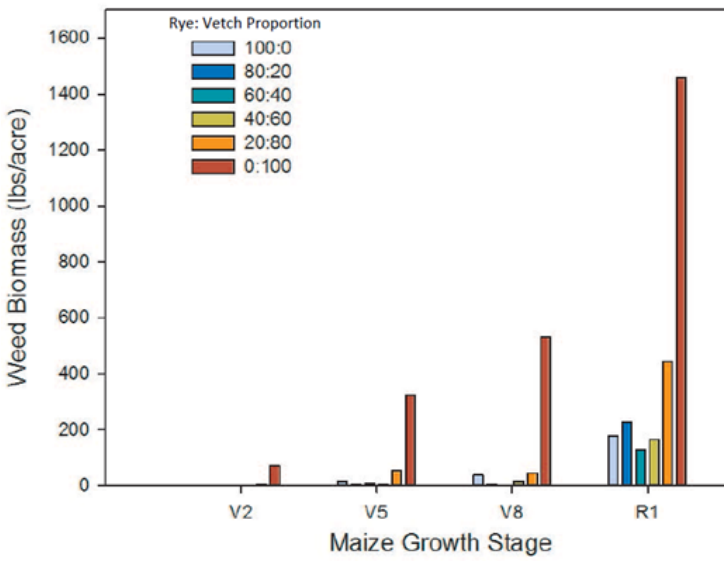

Fig. 4. Cereal rye and cereal rye mixtures with hairy vetch suppress weeds better than hairy vetch alone preceding corn.

Even with careful selection and management, it should be remembered that cover crop mixture performance can vary by site and year (Table 1) due to factors beyond a producer's control. Producers should carefully consider cover crop mixture goals and cropping system constraints, and then experiment to determine which cover crop species in a mixture work best in their systems.

References

Finney, D.M., White, C.M. and Kaye, J.P. 2016. Biomass production and carbon/nitrogen ratio influence ecosystem services from cover crop mixtures. *Agronomy Journal* 108: 39-52.

White, C.M., Barbercheck, M., DuPont, T., Finney, D., Hamilton, A., Hartman, D., Hautau, M., Hinds, J., Hunter, M., Kaye, J., and La Chance, J. 2015. Making the most of mixtures: Considerations for winter cover crops in temperate climates. Available at: http:/articles.extension.org/pages/72973/making-the-most-of-mixtures:-considerations-for-winter-cover-crops-in-temperate-climates.

Poffenbarger, H.J., Mirsky, S.B., Weil, R.R., Kramer, M., Spargo, J.T. and Cavigelli, M.A. 2015. Legume proportion, poultry litter, and tillage effects on cover crop decomposition. *Agronomy Journal* 107: 2083-2096.

Using cover crop mixtures to achieve multiple goals on the farm. 2014. Available at: https://www.youtube.com/watch?v=VymsPJXlwXo

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