Southern Cover Crops

2016 CONFERENCE FACT SHEET

Choosing and Managing Cover Crops to Support Beneficial Insects for Pest Control and Pollination

Nancy Adamson (Xerces Society & USDA-NRCS ENTSC), Patryk Battle (Living Web Farms, Mills River, NC), and Mark Schonbeck (Virginia Association for Biological Farming)

Fig. 1. Carlene Chase of UFL talking about sesame and other covers she is studying--planted at the Center for Environmental Farming Systems 2,000-acre field research and outreach facility at Cherry Farm in Goldsboro, NC. Inset: Sesame flower with native long-horned bee.

Befriending Farm Allies with Cover Crops

Cover crops support many insects and other arthropods beneficial for agriculture, in addition to improving soil, crop, and watershed health. Our most important crop pollinators are bees. Native bees, the European honey bee, and many natural enemies of crop pests benefit from diverse diets and need pollen and nectar resources when crops are not in flower. Natural enemies of crop pests include predatory and parasitoid wasps, scarab-hunting wasps (Japanese beetle predators), syrphid flies (aka hover or flower flies), tachinid flies, fireflies (actually beetles), ladybird beetles (aka ladybugs), checkered beetles, ground beetles, tiger beetles, flower beetles, soldier beetles, rove beetles, green and brown lacewings, ambush bugs, big-eyed bugs, damsel bugs, minute pirate bugs, predatory stink bugs, mantids, spiders, harvestmen (aka daddy longlegs), predatory mites, and nematodes.

Enhancing & Protecting Diversity to Support Healthy Insects & Plants

Conservation biological control maintains ecological relationships between predators and prey. The goal is to keep prey populations below economic thresholds without eliminating them entirely (Naranjo et al. 2015). If pests are eliminated, predators die out or leave the field. When any disturbance knocks out both groups, predators take much longer to return than pests (prey). Cover crops, green fallow, residue cover, diverse perennial borders, and hedgerows all provide nectar and pollen, habitat, and refuge from disturbance when annual crops are harvested, allowing natural enemies to recolonize the next crop. Many predators and parasitoids of crop pests depend on nectar and pollen at some stage of their life, while consuming insects at other stages. Pollen and nectar resources can directly benefit crops by enhancing predator fecundity (eggs layed in pest populations) and larval performance, as shown in Lundgren's meta-analysis of ladybird beetle research (Lundgren 2009).

Growing cover crops through their flowering period before termination supports pollinators, predators, and parasitoids over an extended period, and reduces the need for pesticides (Ellis and Barbercheck 2015). Cover crop biomass, soil benefits, and weed suppression also peak at full to late bloom. In the long growing seasons of the South, growing cover crops to this stage is compatible with cash crop production and can enhance yields and quality. In cooler climates, including the higher elevations of the Appalachian region, there is a tradeoff between cover crop biomass and cash crop yield because of the short growing season and risk of too-slow soil nutrient mineralization with heavy cover crop residues. In warmer regions, growing cover crops to late flowering is a win-win-win (triple win!) in terms of maximum biomass and organic input, maximum weed suppression, and maximum beneficial habitat. If reseeding is of concern, till or flail mow prior to full seed set (other termination techniques like roll-crimping may not adequately stop seed maturation).

Fig. 2. Kale and other brassicas left to flower can provide late fall or winter sources of nectar and pollen for bees and other beneficial insects, while also providing soil benefits (USDA 2015). Native bees like mason bees (top) and introduced bees like the European honey bee (bottom) that pollinate spring crops such as apple, peach, and blueberry need alternate nectar and pollen sources.

Cover crops with conspicuous, shallow-throated flowers like buckwheat, crimson clover, sunflower, vetch, phacelia, and sesame provide accessible floral nectar and pollen. Cowpeas, sunflower, kenaf, and some other covers also attract and support beneficial insects with extrafloral nectaries. Flowering rye, oats, and other cereal grains provide pollen that sustains predators such as ladybugs, minute pirate bugs and soldier beetles, and habitat for spiders. Some covers harbor aphids or other pest species, but these become vital alternate prey for predators, so that the predators stay in the field to protect the next production crop. In addition, many ground-dwelling predators (spiders, ground and rove beetles, big-eyed bugs, minute pirate bugs) require cover for habitat, which living, frost-killed, roll-crimped, or mowed cover crops can provide.

Fig. 3. Pollinators and other insects need pollen and nectar resources before and after production crops are blooming. Clockwise from top left: Bumble bee on buckwheat; green sweat bee on lacy phacelia; bumble bee on pinkeye purple hull cowpea; and honey bee on crimson clover.

SARE's *Cover Cropping for Pollinators and Beneficial Insects* booklet and SARE's Cover Crops Learning Center (URLs in reference list) include details on utilizing single species and cover crop mixes to support pollinators and other beneficial insects.

Table 1. Common cover crops especially good for beneficials

Warm season	Buckwheat, cowpea, sunflower, sorghum sudan, lablab, sunn hemp, partridge pea, sesame
Frost-hardy legumes	Clover (crimson, red, white); vetch (hairy, common, lana, purple), sweetclover
Other cool season	Tillage radish and other crucifers, cereal grains (rye, oats, barley, wheat) , lacy phacelia (new for the region)
Sample Mixes	Spring—Oats, barley, mustard, field pea Summer—Buckwheat, cowpea, sunflower, sorghum-sudan Fall—Lacy phacelia, tillage radish, clover, oats Winter—Rye, vetch, crimson clover, canola

Fig. 4. Parasitoids & Predators. Clockwise from top left: *Aphidius* wasp laying egg in tomato aphid (brown aphid mummies previously parasitized); cross-striped cabbage worm killed by braconid wasp larvae (pupating here in white chrysali); anchor bug eating a bean beetle larva on bean; and wasp at cowpea extrafloral nectary.

Related Farmscaping Methods to Support Farm Allies

Timing of Plantings. When a cover crop must be terminated prior to flowering, try leaving strips of cover every 10-20 rows. Choose varieties or species that flower early or quickly such as 'Abruzzi' rye, crimson clover, lana (woolypod) vetch, and buckwheat.

Insectary vs. Trap Crops. Insectary plantings are aimed at attracting and sustaining beneficial insects with food (nectar, pollen, and/or prey), habitat, and refuge from pesticides or harvest (adjacent to crop fields or between crop rows). While trap crops are designed to draw pests away from production crops, they can function as insectaries—providing prey to maintain predator populations when production crops are harvested—if not treated with pesticide or if left uncut between successive annual production crops.

Field Border, Hedgerow, and Beetle Bank Enhancements. Adding annual cover crops, herbs, or annuals for cut flowers (Fig. 5 and 6), or simply leaving areas unmown wherever possible on a farm can enhance diversity of flowering species or habitat niches throughout the growing season and over winter, while maintaining refuge for predators, including ground beetles that feed on weed seeds. Protecting ground beetles that consume weed seeds can, in turn, reduce weed pressure and the need for herbicides, reducing costs and potential harm to other beneficials. Herbs, cut flowers, and crops grown for seed production, can support beneficial arthropods and other wildlife, while providing additional income (Brooker *et al.* 2015). For many farmers, birds

that feed on insects throughout the farm and on seeds of cut flowers or herbs are an added benefit (for pest control, for those who enjoy bird-watching, and for agritourism).

- *Edible annual herbs*: Basil, borage, calendula, cilantro, dill, fennel, onion, tulsi (holy basil)
- *Annual or short-lived cut flowers*: Zinnia, Plains coreopsis, blanket flower, alyssum, cosmos, bachelor's buttons

Fig. 5. Edible annual herbs are excellent sources of pollen and nectar for a huge diversity of insects, and provide additional farm income. Clockwise from top left: Bumble bee on borage, soldier beetle on onion, leafcutter bee on basil, assassin bug on dill.

Fig. 6. Annual and short-lived perennial flowers are especially valuable nectar and pollen sources in the heat of summer and in fall for migrating butterflies. Left to right: Soldier beetle on lacy phacelia (photo by Patryk Battle), syrphid fly on coreopsis, sunflower bee on zinnia.

Reducing Mowing and Tilling. Leaving unmown and untilled areas when possible is one of the easiest ways for farmers to enhance diversity and support pollinators, predators, and parasitoids. Common native meadow species on farms that, when left unmown, support many beneficials include fleabane, groundsel, wingstem, sunflowers, goldenrods, milkweeds, native grasses, and sumacs.

Timing of and Reducing Pesticide Use. Using integrated pest management to reduce pesticide use helps avoid pest outbreaks. When cover crops or other field crops must be treated with insecticides, fungicides, herbicides or other chemicals, avoid times when insects are most active. While the active ingredients of herbicides may not harm insects, "stickers" that help these chemicals stick to the waxy cuticle of leaves also penetrate the waxy cuticle of insect exoskeletons. Though grasses do not need insect help for pollination, many insects consume grass pollen, including corn pollen. Avoid spraying corn or other grasses when in flower in order to reduce harm to beneficial insects, spiders, and any alternate prey populations.

Conclusion

Enhancing plant diversity with cover crops and reduced pesticide use supports insect diversity on farms. This helps reduce the likelihood of pest outbreaks by maintaining healthy populations of both predators and prey (pest species). Bee pollinators depend on flowers for all their food. Predators and parasitoids eating a mix of prey, pollen, and nectar are healthier and more effective. Learning to recognize pest species as potential allies (prey for natural enemies) can help farmers develop strategies that maintain covers wherever possible within and around crops.

References & Resources

Bianchi, F.J.J.A., C.J.H. Booij, and T. Tscharntke. 2011. Sustainable pest regulation in agricultural landscapes: A review on landscape composition, biodiversity and natural pest control. Proc. R. Soc. B 273: 1715–1727. DOI: 10.1098/rspb.2006.3530

Blake, R.J., B.A. Woodcock, D.B.Westbury, P. Sutton, and S.G. Potts. 2013. Novel management to enhance spider biodiversity in existing grass buffer strips. Agric. and For. Entomol., 15(1):77–85. DOI: 10.1111/j.1461-9563.2012.00593.x

Blubaugh, C and I. Kaplan. 2015. Tillage compromises weed seed predator activity across developmental stages. Biol. Control. 81:76–82. DOI:10.1016/j.biocontrol.2014.11.007

Brooker, R.W., A.E. Bennett, W.F. Cong, T.J. Daniell, T.S. George, P.D. Hallett, C. Hawes, P.P. Iannetta, Jones, H.G., Karley, A.J. and Li, L. 2015. Improving intercropping: A synthesis of research in agronomy, plant physiology and ecology. New Phytol., 206(1):107–117. DOI:10.1111/nph.13132

Ellis, K.E. and M.E. Barbercheck. 2015. Management of overwintering cover crops influences floral resources and visitation by native bees. Environmental Entomology, p.nvv086. http://mysare.sare.org/wp-content/uploads/991080gne12-037%20final%20pub.pdf

Fiedler, A.K., D.A. Landis, and S.D. Wratten. 2008. Maximizing ecosystem services from conservation biological control: The role of habitat management. Biol. Control, 45(2):254–271. DOI:10.1016/j.biocontrol.2007.12.009

Forehand, L.M., D.B. Orr, and H.M. Linker. 2006. Insect communities associated with beneficial insect habitat plants in North Carolina. Environ. Entomol. 35 (6):1541–159. http://dx.doi.org/10.1093/ee/35.6.1541

Laubertie, E.A., S. D. Wratten, and J.L. Hemptinne. 2012. The contribution of potential beneficial insectary plant species to adult hoverfly (Diptera: Syrphidae) fitness. Biol. Control, 61(1):1–6. http://www.sciencedirect.com/science/article/pii/S1049964411003537

Lee-Mader, E., A. Stine, J. Fowler, J. Hopwood, and M. Vaughan. 2015. Cover Cropping for Pollinators and Beneficial Insects http://www.sare.org/Learning-Center/Bulletins/Cover-Cropping-for-Pollinators-and-Beneficial-Insects.

Lundgren, J.G. 2009. Nutritional aspects of non-prey foods in the life histories of predaceous Coccinellidae. Biol. Control, 51(2):294–305. http://dx.doi.org/10.1016/j.biocontrol.2009.05.016

McGuire, A. 2013. Mixing the perfect cover crop cocktail. Center for Sustaining Agriculture and Natural Resources. Wash. State Univ. http://csanr.wsu.edu/cover-crop-cocktail/

Mizell, R. F. 2015. Many plants have extrafloral nectaries helpful to beneficials. Univ. of Florida Extension. http://edis.ifas.ufl.edu/in175

Naranjo, S., P. Ellsworth, and G. Frisvold. 2015. Economic value of biological control in integrated pest management of managed plant systems. Annu. Rev. Entomol.. 60:621–645. http://www.annualreviews.org/doi/full/10.1146/annurev-ento-010814-021005

Parolin, P., C. Bresch, N. Desneux, R. Brun, A. Bout, R. Boll, and C. Poncet. 2012. Secondary plants used in biological control: a review. Int. J. Pest Manage., 58(2):91–100. http://dx.doi.org/10.1080/09670874.2012.659229

Riechert, S. E. and T. Lockley. 1984. Spiders and biological control agents. Annu. Rev. of Entomol. 29:299–320. http://www.annualreviews.org/doi/pdf/10.1146/annurev.en.29.010184.001503

Smith, M.W., D.C. Arnold, R.D. Eikenbary, N.R. Rice, A. Shiferaw, B.S. Cheary, and B.L. Carroll. 1996. Influence of ground cover on beneficial arthropods in pecan. Biol. Control 6(2):164–176. DOI: 10.1111/wre.12175

Tavares, J., K.H. Wang, and C.R. Hooks. 2015. An evaluation of insectary plants for management of insect pests in a hydroponic cropping system. Biol. Control, 91:1–9. DOI:10.1016/j.biocontrol.2015.07.004

Tschumi, M., M. Albrecht, J. Collatz, V. Dubsky, M. Entling, A.J. Najar-Rodriguez, and K. Jacot. 2016. Tailored flower strips promote natural enemy biodiversity and pest control in potato crops. J. of Appl. Ecol. DOI: 10.1111/1365-2664.12653

Tillman, P.G., and J.E. Carpenter. 2014. Milkweed (Gentianales: Apocynaceae): A farmscape resource for increasing parasitism of stink bugs (Hemiptera: Pentatomidae) and providing nectar to insect pollinators and monarch butterflies. Environ. Entomol., 43(2): 370–376. http://dx.doi.org/10.1603/EN13175 370-376

Tillman, P.G., A. Khrimian, T.E. Cottrell, X. Lou, R.F. Mizell III, and C.J. Johnson. 2015. Trap cropping systems and a physical barrier for suppression of stink bugs (Hemiptera: Pentatomidae) in Cotton. J of Econ. Entomol. 108(5):2324–2334. DOI: http://dx.doi.org/10.1093/jee/tov217

Tooker, J.F., and L.M. Hanks. 2000. Flowering plant hosts of adult Hymenopteran parasitoids of Central Illinois. Ann. of the Entomol. Soc. of Am. 93:580–588. http://dx.doi.org/10.1603/0013-8746(2000)093[0580:FPHOAH]2.0.CO;2

USDA 2015. Attractiveness of agricultural crops to pollinating bees for collection of nectar and/or pollen. http://www.ree.usda.gov/ree/news/Attractiveness_of_Agriculture_crops_to_pollinating_bees_Report-FINAL.pdf (last accessed 30 August 2016)

Wallingford, A.K., T.P. Kuhar, P.B. Schultz, and J.H. Freeman. 2011. Harlequin bug biology and pest management in Brassicaceous crops. J of Pest Manage. 2(1):1–4. DOI: 10.1603/IPM10015

Wells, L. 2013. Clover management in pecan orchards. Univ. of Georgia Cooperative Extension. http://extension.uga.edu/publications/detail.cfm?number=B1360

Wyland, L.J., Jackson, L.E., Chaney, W.E., Klonsky, K., Koike, S.T. and Kimple, B. 1996. Winter cover crops in a vegetable cropping system: Impacts on nitrate leaching, soil water, crop yield, pests and management costs. Agric., Ecosyst. & Environ., 59(1):1–17. DOI:10.1016/0167-8809(96)01048-1

Zehnder, G. 2013. Farmscaping: Making Use of Nature's Pest Management Services. *Clemson University, Clemson*. http://www.carolinafarmstewards.org/wp-content/uploads/2012/12/3-Zehnder-Farmscaping-Making-Use-of-Natures-Pest-Management-Services.pdf

Other Resources

ATTRA - A National Sustainable Agriculture Assistance Program https://attra.ncat.org

Biological Control of Pecan Weevils in the Southeast http://www.sare.org/Learning-Center/Fact-Sheets/Biological-Control-of-Pecan-Weevils-in-the-Southeast

Carolina Cover Crop Connection https://www.facebook.com/groups/carolinacovercropconnection/

Extrafloral Nectaries http://www.extrafloralnectaries.org/

eOrganic, the organic agriculture community of practice with eXtension, webinars, videos, and articles worth exploring http://eorganic.info

Living Web Farms (huge collection of farming videos and podcasts for all to enjoy and learn from) http://livingwebfarms.org/

SARE Cover Crops Learning Center http://www.sare.org/Learning-Center/Topic-Rooms/Cover-Crops

SARE's Adding Cover Crops to a No-till System video http://www.sare.org/Learning-Center/Multimedia/Videos-from-the-Field/Adding-Cover-Crops-to-a-No-Till-System

Symbiont Biological Pest Management. Dr. Richard McDonald http://www.drmcbug.com/

USDA PLANTS Database Cover Crops http://plants.usda.gov/java/coverCrops

USDA & US Forest Service webinars http://conservationwebinars.net/

Virginia Association for Biological Farming (VABF) at http://vabf.org/ and info sheets including a few on cover crops can be found at http://vabf.org/information-sheets/

Wild Farm Alliance "works to empower farmers, connect consumers, and protect wild nature" http://www.wildfarmalliance.org/

Xerces Society Conservation Biological Control http://www.xerces.org/conservationbiocontrol/

Xerces Society Habitat Assessment Guides http://www.xerces.org/pollinator-conservation/habitat-assessment-guides

Xerces Society Pollinator Conservation Resource Center http://www.xerces.org/pollinator-resource-center/

This product was developed with support from the Southern Sustainable Agriculture Research and Education (Southern SARE) program, which is funded by the U.S. Department of Agriculture—National Institute of Food and Agriculture (USDA-NIFA). Any opinions, findings, conclusions or recommendations expressed within do not necessarily reflect the view of the Southern SARE program or the U.S. Department of Agriculture. USDA is an equal opportunity provider and employer.