Cover Crops as Beneficial Insect Habitats:
Observations from a Demonstration Organic Market Farm

BY GEORGE KUEPPER
About the Author

George Kuepper is the Horticulture Manager at the Kerr Center for Sustainable Agriculture. He has over 30 years of experience with sustainable and organic agriculture.

Since 2008 he has directed the development of the Kerr Center’s organic horticulture program, the Cannon Horticulture Project and its bio-extensive system. He has also managed the center’s horticulture interns, taught in the center’s Beginning Farmer and Rancher program and conducted a series of heirloom vegetable variety trials.

The Cannon Horticulture Plots
The Kerr Center maintains a market garden-scale unit called the Cannon Horticulture Plots. It is our research, demonstration, and teaching site for sustainable organic market farming.

Activities at the Cannon site have included beginning farmer trainings, heirloom vegetable trials, heirloom seed production, bio-intensive gardening, a Native American “three sisters” garden, and numerous student intern projects.

The principal demonstration and teaching tool, however, is the bio-extensive management system—designed to build and maintain the soil, reduce insect and disease pests, and suppress weeds.

Bio-extensive systems rely chiefly on crop rotations that make generous and creative use of cover crops. Many, if not most, of the cover crop species we use also function as habitat for honey bees, native pollinators, predatory insects, spiders, and beneficial parasites. While we have not been managing cover crops for habitat in truly consistent ways, we are struggling to do so and have a few observations to share.

A System Built on Cover Crops
We characterize a bio-extensive system as one in which the grower rests (i.e. removes from crop production) a significant portion of rotated crop land each year, in order to achieve one or more agronomic benefits, such as weed control, disease suppression, or soil improvement. This is commonly done by planting warm-season cover crops, instead of a commercial crop. In bio-extensive management, we use cover crops to serve multiple objectives including, but not limited to, nitrogen fixation, carbon sequestration, erosion protection, soil disease management, weed suppression, nutrient capture, and beneficial insect habitat. We generally plan for three kinds or seasons of cover crop use: winter (off-season) cover cropping, summer green fallow, and short-season cover cropping.

Winter cover cropping is routine practice on most organic market farms; it certainly is on ours. Short-season cover crops are those that are inserted between crops and winter cover crops, when land might otherwise be bare – for example, establishing a cover crop in the early summer, before planting pumpkins or squash for fall harvest. Green fallow – a less familiar and more novel application – involves growing cover crops throughout the summer season, instead of the usual commercial crops. Growers use green fallow primarily to build soil organic matter and to smother difficult weeds. Figure 1 features the Cannon rotation, including when we schedule planting of winter and green fallow cover crops.
Management Considerations

You will find a wide range of cover crops on the Cannon site. Winter covers include a variety of cool-season annuals, among them several clovers, vetches and winter peas; small grains; and brassicas that include mustards, turnips, and radishes.

Summer-season covers include sorghums, millets, crotalaria, sesbania, cowpeas, lablab, soybean, sunflower, buckwheat, and sesame. To varying degrees, all of these provide some habitat for pollinators and biocontrol agents. (A few, however, are far better than others.) All seem to deliver the greatest benefit when flowering. Our challenge has been to prolong the flowering stage of these various species as much as possible, while capturing as much of the other agronomic benefits that cover crops can provide.

SELECTING COVER CROPS We select our cover crops – kinds, species, cultivars – based on a number of criteria including soil protection, nitrogen fixation, biomass production, allelopathic effect, and others; beneficial habitat is only one factor, which may or may not have priority. Some examples include:

- When growing green fallow crops, we select primarily for ability to smother weeds and generate biomass. When legumes are used, we choose those that have long growing seasons. For example, we prefer cowpea varieties, like ‘Iron and Clay’ or ‘Red Ripper,’ which mature late, thereby maintaining a dense leaf canopy throughout much of the summer. By contrast, ‘Pink-Eye Purple-Hull’ flowers, sets seed, and sheds its leaves much earlier, losing its ability to suppress weeds. The late maturation of ‘Iron and Clay’ or ‘Red Ripper,’ coupled with mid-summer mowing (part of current green fallow management) often results in the ‘Iron and Clay’ or ‘Red Ripper’ varieties not flowering at all, and thus contributing very little as habitat for beneficial insects.
• We like to grow a number of brassica species as part of our winter cover mixes. These include tillage or oilseed radish, mustards, turnips, and rape. Seeded in fall, these cool-season cover crops produce early spring flowers that support honeybees and other early-emerging pollinators. In this instance, we are planting these species with beneficial habitat as a priority. Unfortunately, while we strive to keep one or more of the brassicas in our winter blends, we do not include it when early vegetables follow in rotation. There are two reasons for this, the first being that early spring vegetables commonly include brassica crops, such as cabbage, broccoli, and collards, and planting brassicas back-to-back invites the buildup of soil-based plant diseases. Secondly, winter brassicas are habitat for the vegetable weevil (Listroderes costirostris obliquus), which readily infests and destroys many early spring vegetables, going dormant only when temperatures warm.

• Our best opportunities for growing beneficial habitat seem to occur during those brief time-windows when we use short-season cover crops. These time-windows typically occur before fall crops are planted, or after spring crops are harvested, when the land might otherwise remain bare. In these instances, we are accustomed to using either buckwheat or ‘Pink-Eye Purple-Hull’ cowpeas. When flowering, both cover crops attract an abundance of beneficial insects, though the species composition they draw differs. Buckwheat attracts many more bees and flies, while Polistes wasps dominate in cowpea fields.

**TERMINATION SCHEDULING** While some growers mow, plow in, or otherwise kill their cover crops without much thought to timing, experienced farmers recognize that there is much more benefit from well-timed termination. This is especially true when terminating nitrogen-fixing legumes.

When terminating legumes, growers generally obtain the maximum amount of fixed nitrogen between one-tenth bloom and full bloom and before seed set. We use this as our guide and try to delay termination until full bloom to give beneficial insects a bit more access time. On occasion, we have opted to leave a narrow strip of cover crop untouched, where flowering can proceed to seed set. This leaves much less habitat, but extends the time that some flowers are available. It works best for us to use such strategies when green fallow follows the cover crop.

Annual grasses, such as those we use as cover crops, are not readily acknowledged as attractive to beneficial insects. This is somewhat surprising since we have observed pollinators and other beneficial insects on pearl millet and annual sorghums during flowering.

Recommended termination time for grasses – to ensure no viable seed production and resulting weed problems – is between boot stage and early dough. At boot stage, the seed head is located in the lower stem of the plant, not yet emerged and only visible by peeling away the whorl of leaves. At early dough, seeds are set but still quite soft.
when squeezed with your fingers. Intervening stages include flowering, which is followed by the milk stage. In the milk stage, squeezed kernels express a milk-like sap. If the seed head is allowed to emerge and shed pollen, it will provide some food benefit for beneficials before flowering ends and seeds set.

In the aforementioned instances, which refer to pure stands of legumes or grasses, there are opportunities to delay termination for a brief time, thereby increasing the habitat benefits. It is more complicated, by contrast, when the grower uses blends of legumes and grasses, several varieties, or even other plant families, like the brassicas. Optimizing habitat benefits in such circumstances can be much more challenging.

**MANAGING GREEN FALLOW** To date, we have primarily grown summer grasses as green fallow. These include pearl millet, and several annual, grassy sorghums including sudangrass, sorghum-sudangrass, and shallu (also called Egyptian wheat). We have begun to integrate legumes but our experience is incomplete and we will limit our comments, here, to the annual grasses.

Following spring establishment of millet or sorghum, we allow these green fallow grasses to grow vegetatively, mowing or flash grazing them once or twice during the summer months. Whether mowing or grazing, we strive to leave tall stubble and encourage the plants to re-grow, before a final short mowing or grazing, followed by incorporation in late summer or early fall. The timing of these practices seldom permits flowering, unless it occurs just before final termination. This is rare since we must allow additional time for the biomass to decompose in the soil before planting winter cover crops.

A strategy we have begun to explore that should permit late flowering of green fallow grasses entails delaying final mowing/grazing until the milk or early dough stage, foregoing tillage, and over-seeding with small seeded winter covers like clovers and mustard. Low winter temperatures will kill any green fallow grass remaining. The grass residue will serve as protection for the soil and nurse the emerging winter cover crop. We have successfully done this more than once, but need to repeat it several times to satisfy ourselves that it will meet our needs.

**LIVING MULCH** Living mulches are cover crops grown among individual crop plants or between rows, to achieve beneficial habitat and other agronomic benefits, while not adversely affecting crop yield or quality. Successful living mulches are challenging to find. We found one combination that worked exceptionally well, especially as beneficial insect habitat.

The crop we were growing was sweet potatoes. Following our first light cultivation for weeds, we immediately seeded the inter-rows with buckwheat. The buckwheat quickly outgrew any weeds and produced a superb beneficial insect habitat that we allowed to fully flower and go to seed.

Buckwheat is compatible with sweet potatoes because its growing season is brief. Before it can compete with the crop it goes to seed, thins out, and is overwhelmed by spreading sweet potato vines. The living mulch does not adversely affect sweet potato yield or quality in our estimation.

![Figure 4. A green fallow stand of sorghum-sudangrass.](image-url)
It is generally not wise to allow cover crops to go to seed, as they might become weeds in subsequent crops. However, since the subsequent summer crop following vegetables in our system is always green fallow, its re-emergence is an added benefit!

Unfortunately, our plantings have not been sufficient in number and diversity. We plan to remedy this by adding at least one more flowering plant to the summer refuge, and designing refuges that serve the spring and fall seasons.

**ANNUAL PLANT REFUGES** Each growing season, we dedicate at least one narrow field-length strip for annual beneficial habitat crops. We maintain such small refuges in our system each year because our cover crops have multiple priorities, most of which supersede habitat function. Therefore, they cannot truly be depended upon to meet that need. The species we have customarily used are sunflower and sesame, both of which grow well in southeastern Oklahoma and attract a diversity of insects.
A Few Resources

Cover Crops:
The most comprehensive guide we are familiar with is: Managing Cover Crops Profitably, edited by Andy Clark, as Book 9 in the SARE Handbook Series. It can be downloaded for free from: http://www.sare.org/Learning-Center/Books/Managing-Cover-Crops-Profitably-3rd-Edition Print copies are available from SARE for $19.00. Call 301.779.1007 to order.

Also worth noting:

Feed the Soil by Edwin McLeod. This 1982 book is rich in specifics about cover crop species. It is currently out of print but can be found occasionally in the used book markets.

Overview of Cover Crops and Green Manures by Preston Sullivan. An ATTRA publication, it is available at: https://attra.ncat.org/attra-pub/summaries/summary.php?pub=288

Midwest Cover Crops Field Guide, 2nd ed. 2014. Produced cooperatively by the Midwest Cover Crops Council and the Purdue Crop Diagnostic Training and Research Center. Copies are available for $5 plus shipping. See: https://ag.purdue.edu/agry/dtc/Pages/CCFG.aspx

Beneficial Insect Habitat:
We strongly recommend the Xerces Society books by Eric Lee-Mäder et al., Attracting Native Pollinators and Farming with Native Beneficial Insects, published in 2011 and 2014, respectively. Visit Storey publishing at www.storey.com/ or call 800.441.5700.

Also see:
Manage Insects On Your Farm, by Miguel Altieri et al. Book 7 in the SARE Handbook Series. It can be downloaded for free from: http://www.sare.org/Learning-Center/Books/Manage-Insects-on-Your-Farm Print copies are available from SARE for $15.95. Call 301.779.1007 to order.

Farmscaping for Biological Control by Rex Dufour. An ATTRA publication, it is available at: https://attra.ncat.org/attra-pub/summaries/summary.php?pub=145

Notes
2. Buckwheat (Fagopyrum esculentum) is not related to wheat; it is not even a grass. It is a broadleaf, herbaceous plant, a member of the Polygonaceae family, making it a relative of rhubarb, as well as knotweed and smartweed.
3. We, as well as other growers, use the term “brassica” to include radishes, which are not in the Brassica genus, but are in the family Brassicaceae.
4. As seeds set, plants transfer nitrogen and minerals into them, stripping leaves and stems of much of their fertilizing value.