BEST MANAGEMENT PRACTICES (BMPS) FOR POLLINATOR PROTECTION IN FIELD CORN

NATIONAL CORN GROWERS ASSOCIATION

DEVELOPED IN PARTNERSHIP WITH THE HONEY BEE HEALTH COALITION

HONEY BEE HEALTH COALITION

February 15, 2020

ACKNOWLEDGMENTS

Special thanks to the Technical Working Committee (listed below),
and the many stakeholders who provided their time to develop this guidance.

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Jason Weirich	MFA Inc.

Thank you to the following for contributing to and reviewing this edition's section on habitat on pages 13-16: Peter Berthelsen (The Bee & Butterfly Habitat Fund), Barbara Bloetscher (Ohio Department of Agriculture), Robert Curtis (Almond Board of California), Nicole Hasheider (National Corn Growers Association), Jerry Hayes (Bee Culture Magazine), Lauren Maul (United Soybean Board), Norm Poppe (Applewood Seed Co.), Robert Sears (Eastern Missouri Beekeepers Association), Billy Synk (Project Apis m.), Dale Thorenson (U.S. Canola Association), Diane Wilson (Applewood Seed Co.).

Additional thanks to the Honey Bee Health Coalition for facilitating the development of these best management practices and the inclusion of data and diverse perspectives.

Please note that the recommendations contained herein are provided by NCGA and the Technical Working Committee (listed above) and do not necessarily represent the views of Coalition members. For more information about the coalition visit:
https://honeybeehealthcoalition.org/about-the-coalition/

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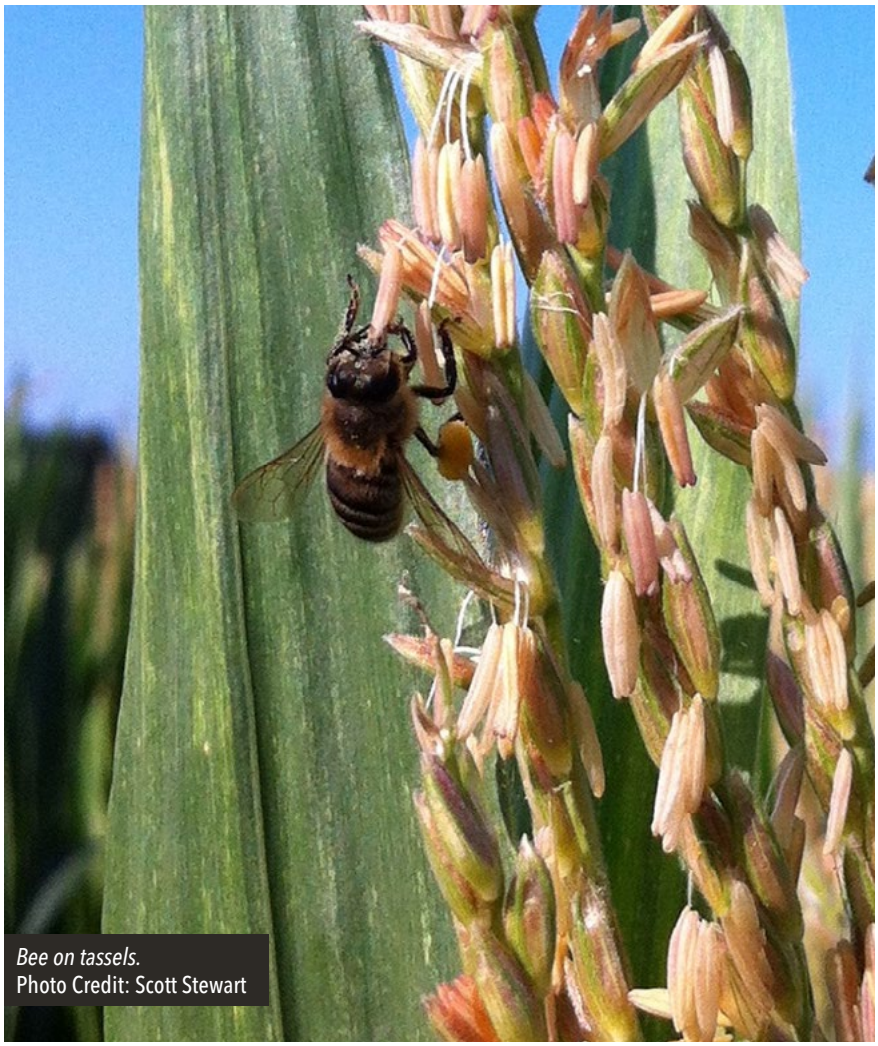
INTRODUCTION

Corn Production

Field corn (*Zea mays* a.k.a. dent corn; hereafter referred to as "corn") is grown on more acres than any other crop in the U.S. (Bigelow and Borchers 2017). Since 2005, approximately 83 million acres of corn have been harvested on average each year in the U.S. (USDA-NASS 2018b). In 2017, corn was planted in all 48 of the contiguous states; acres planted ranged from 2,000 acres in Rhode Island to 13.3 million acres in Iowa (USDA-NASS 2018b). Much of the U.S. acreage is concentrated in the Midwest "Corn Belt", but other areas of substantial corn production occur throughout the U.S., including in the Mississippi River Delta, the western Plains, and along the Atlantic Coast. Production practices such as irrigation, tillage, and fertility can vary dramatically from region to region; while much of the Corn Belt acreage is non-irrigated, irrigation is widely used within the Mississippi River Delta and western Plains. Corn as a percentage of land cover also varies dramatically from region to region; while production regions in the south typically have a more diverse mix of crops and other land covers (USDA-NASS 2018a), corn (often grown in rotation with soybean) might make-up over 40% of the landscape in many of the high production areas of the Corn Belt.



Bee on tassels.
Photo Credit: Scott Stewart

Pollinator Abundance and Diversity in Corn

Corn is wind pollinated and does not benefit from insect pollination; however, a diverse array of pollinators are found within cornfields. Corn pollen, while of low nutritional value to honey bees (Höcherl et al. 2012), can still be an important component of pollinator diets. This is especially true in areas where corn makes up a high proportion of the landscape and other food sources for bees are limited. Pollinators, including 36 different species of bees and 9 species of syrphid flies, were found within Iowa cornfields in a recent study that sampled 3 fields over 2 years (Wheelock and O'Neal 2016). The pollinator communities inhabiting corn and soybean in Iowa were determined to have a high degree of overlap. Many species of native bees were present in both crops, often in greater numbers that honey bees (Wheelock et al. 2016). Similarly, a Michigan study that sampled 10 fields within a single season found 42 species of bees in corn, including many of the same species found in the Iowa study (Gardiner et al. 2010). While the focus of this document is on managed pollinators such as honey bees, many of the best management practices for honey bees will also benefit other pollinators.

Risks to Pollinators

Both managed (e.g., honey bees) and native bees face a variety of environmental conditions that can have a negative impact on their populations, including a loss of habitat or poor availability of nutritious forage, parasites, diseases, and exposure to pesticides (Goulson et al. 2015; Neumann and Carreck 2010). Since 2007, U.S. beekeepers have been surveyed to estimate overwintering losses and, since 2012, total colony losses, by the Bee Informed Partnership (https://bip2.beeinformed.org/loss-map/). These losses vary dramatically by region and year, but are routinely self-reported by beekeepers as higher than the level of annual losses they would consider acceptable. Major reasons for these honey bee colony losses include infestations of *Varroa* mites (*Varroa destructor*) and other pests, a variety of pathogens (many vectored by *Varroa*), and hive management issues (e.g., stresses caused by hive transportation) (USDA 2013).

Potential Impacts of Corn Production to Bees and Other Pollinators

Of the major factors impacting bees and other pollinators, poor nutrition from unavailability of quality food sources and incidental pesticide exposure are the most directly relevant to corn production. Herbicides, fungicides, and insecticides are all used routinely in corn production, and there are several potential routes of exposure to pollinators within and around corn fields. While insecticides pose a greater risk, fungicides and herbicides can also have negative impacts, either through direct toxicity or indirectly through removal of foraging habitat (e.g., flowering weeds). Pollinators might come into contact with pesticides within treated fields, through pesticide drift or runoff into adjacent habitats, from residues following an application, or from pesticide-contaminated water spills near a mixing site. This drift or contamination can occur as a result of soil or broadcast pesticide applications, or as a result of dusts released during planting including dusts generated through the abrasion of pesticide-treated seed coating (a.k.a "dust-off") (Krupke et al. 2012). Apiaries located close to corn fields are at higher risk of exposure from pesticide drift or dust-off, which can result in acute poisoning. Some factors relevant to corn production that could

increase the risk for pesticide poisoning of bees include: an application directly to the field while bees are foraging; an application to blooming weeds and/or cover crops that are being visited by pollinators; drift or dust-off from the treated corn fields onto adjacent areas with blooming plants; bees foraging for pollen from corn that has been treated with a pesticide; bees collecting water that has been contaminated with a pesticide from a corn field; and/or beekeepers and growers failing to communicate about their operations (Hooven et al. 2013).

Bee on tassels.
Photo Credit: Scott Stewart

BEST MANAGEMENT PRACTICES

Season-Long

Perhaps the most important, season-long practice that can protect managed pollinators within cornfields is open communication between growers, applicators/consultants, and beekeepers. Open communication is the basis for understanding where managed pollinators are in relation to corn production and what crop production activities are underway or anticipated. Growers and applicators can take specific steps to reduce potential impacts to bee colonies if they know where these colonies are located, while beekeepers can take specific steps to reduce the likelihood of negative effects from exposure to pesticides if they know that a potentially damaging event (e.g., a broad-spectrum insecticide application) is about to take place in a nearby cornfield.

Practices that growers, applicators, and beekeepers can employ throughout the corn growing season include:

GROWERS AND APPLICATORS

- ***Maintain open lines of communication with nearby beekeepers and local beekeeping associations*** to identify hive locations and inform potentially affected beekeepers of crop management plans. Resources to facilitate this communication include the website FieldWatch® (*https://fieldwatch.com*), which includes tools that allow growers and pesticide applicators to view the locations of registered bee hives (*https://beecheck.org*) and sensitive crops (*https://driftwatch.org*).
- ***Follow label instructions every time a pesticide is used.*** Remember that label restrictions are legally binding. Many pesticide labels have advisory Environmental Hazard statements and/or compulsory directions for use specific to honey bee and pollinator protection. Depending on the product, some of these warnings/restrictions are indicated by a Bee Hazard Icon. However, the lack of a Bee Hazard Icon does not mean that a pesticide is always safe for bees, and pesticides that lack this icon might still have pollinator protection instructions as part of the label.
- ***Take steps to reduce or avoid pesticide drift***, especially onto areas with flowering vegetation and actively foraging pollinators. In particular, check the weather forecast prior to application, and avoid making applications during weather conditions (e.g., high winds and temperature inversions) that make pesticide drift and exposure of non-target organisms more likely. Pesticide-specific instructions for reducing drift are often provided in the pesticide label. Specific steps to avoid drift include:
    - Select spray nozzles that adhere to label recommendations/requirements for particle size and keep them in top working condition through regular cleaning, adjusting and/or replacing.
    - Use the appropriate level of pressure on a well-calibrated and frequently maintained sprayer. Reducing pressure and increasing droplet size (where possible) can reduce drift.

- Use an appropriate boom height and ground speed.
- Shut off the sprayer when making turns at the end of fields and near sources of water.
- Use drift-reducing surfactants/seed lubricants following label recommendations and requirements.
- Use field buffers (i.e., beginning your application a certain distance from the edge of the field) as appropriate, especially if hives or plants that flower are close to the field being sprayed. These are sometimes required or recommended by the label.
- Spray when wind direction is pointed away from non-target areas of concern, e.g. hives and pollinator habitat.
- Note that tank mixing of pesticides can influence drift characteristics. Reference the mixing instructions on each label before including more than one pesticide in the same application.

- Where available, growers should ***refer to their state-specific Managed Pollinator Protection Plan***, or "MP3." A listing of state MP3's can be found at the following link under "Updated State MP3 Inventory" *https://aapco.org/2015/07/01/current-topics/*.
- ***Use insecticides and other pesticides judiciously***, based on locally established recommendations and pest pressure as part of an integrated pest management (IPM) approach. IPM can incorporate preventative as well as reactive control measures, but the use of a control tactic should be informed by an assessment of the actual risk of pest damage, including monitoring of fields for pest presence and density. Specific factors to consider before determining if a pesticide application is appropriate include economic thresholds, field history of pest pressure, cultural practices that might influence pest potential, and environmental conditions. Some techniques that can be used in certain situations to reduce environmental risks from pesticides include:
  - Delay applications if a significant rainfall event is likely
  - Variable rate applications of pesticides
  - Incorporation of pesticides (e.g., granular insecticides)
  - Use methods of insect control for target pests that do not harm bees (e.g., B.t. hybrids)
- Where effective and economical, ***choose insecticides and other pesticides that selectively target the pest of concern***, have residues that remain toxic to bees for shorter durations, and/or have favorable toxicity profiles related to bees and other pollinators. Check the pesticide label for Environmental Hazard statements, particularly those related to honey bees and other pollinators.

- ***Delaying pesticide applications until honey bees and other pollinators cease foraging for the day*** (typically early evening, e.g. 6:00-7:00 PM during summer) can reduce the risk of exposure. This is especially helpful during bloom, and should be considered if a pesticide being used includes a Bee Hazard warning in the Environmental Hazards statement of the label. Note that labels of some pesticides, especially some herbicides, include time-of-day restrictions to prevent drift related to temperature inversions which must be followed. In addition, keep in mind that delaying pesticide applications does not eliminate the risk of exposure due to the residual activity of the pesticide.

BEEKEEPERS

- ***Communicate with growers to understand what is happening in their corn fields***, including when fields are to be planted and if they will use treated seeds, when pesticide applications will occur, and when fields will begin pollinating and blooming. Keep in mind that not all pesticides (including insecticides) pose an equal potential hazard to bees; the extent of exposure and toxicity influence potential risk.
- ***Locate hives in areas with adequate, high quality habitat and away from corn field margins*** whenever possible. Corn pollen is generally less attractive and nutritious to pollinators than, for instance, wildflowers or flowering crops such as soybean, canola, and clover. The availability of higher quality habitat near bee hives may reduce the level of foraging within cornfields. In particular, providing adequate alternative habitat and considering hive location during periods of potentially greater exposure of bees to pesticides used in corn production (e.g., planting and corn pollination) can reduce the likelihood of adverse effects to bees. Where possible, avoid apiary placement near fields prior to the planting period to avoid potential exposure to pesticides abraded from seed.
- ***Always seek landowner permission to place colonies*** and always ensure that each colony is clearly marked with your contact information.
- When hives are located near corn fields, ***use tree lines and other features to protect your bees*** from pesticide drift whenever possible.
- ***Know the land use patterns*** within the foraging range of your hives, and communicate hive locations to growers of corn and other crops who are within this range.
- ***Register hives with the appropriate state apiary agency*** provided that such a program exists in your state. Additionally, the "FieldWatch" website and their "Bee Check" platform (*https://beecheck.org/*) can be used to identify apiary locations to pesticide applicators.
- ***Ensure that hives are properly provided with access to clean water and managed to reduce the impact of stressors*** such as mites (e.g., *Varroa* mites), insect pests (e.g., small hive beetle), diseases (e.g., *Nosema*, American/European foulbrood), and poor forage. Refer to best management practices for bee hives listed in the Resources section of this document, including the Honey Bee Health Coalition's Best Management Practices for Bee Health: *https://honeybeehealthcoalition.org/hivehealthbmps/*.

- ***Follow label instructions when using in-hive pesticides*** for control of pests such as *Varroa* mites. Ensure that any pesticides used in the hive are part of an informed IPM approach, based on local recommendations to reduce the impact of the target pest.
- ***Always maintain consistent, detailed records*** of hive locations, condition, and management activities.
- If acute bee poisoning is suspected, ***directly contacting the grower or applicator*** first may yield positive results. Alternatively, or after a failed personal communication, beekeepers can contact the local state apiary agency or state lead pesticide agencies. (Appropriate contacts for state lead pesticide agencies can be found at: *http://npic.orst.edu/reg/state_agencies.html#map*. If poisoning takes place on Tribal lands, then the Tribal Pesticide Program Council (TPPC; *http://tppcwebsite.org/*) may be able to provide appropriate contact information. Follow state operating procedures appropriately. Refer to the Honey Bee Health Coalition's resources on incident reporting: *https://honeybeehealthcoalition.org/quick-guide/*.

Pre-Planting

Growers must take a number of steps to prepare a field before planting corn. These practices have the goal of achieving a good, uniform stand of corn that is not compromised by competition with weeds, insect or disease pressure, poor soil moisture, or low soil temperatures that inhibit plant development. The first crop protection (herbicide and/or insecticide) application typically occurs pre-plant or shortly after planting but before plant emergence ("pre-emergence") to avoid early season pest competition. Various forms of tillage are often used to create a uniform seed bed, as well as to further reduce weed pressure. In some cases, conservation tillage or "no-till/strip till" production systems are used to reduce soil erosion and compaction or to enhance soil moisture retention. Growers practicing no-till/strip till use a herbicide to kill vegetative matter within the field prior to planting. Fertilizer is often applied to fields prior to planting (either in the spring or fall) to provide adequate nutrients to developing corn plants. In some cases, a cover crop of grass, broadleaf, or mixed species is used to improve soil tilth, reduce erosion, reduce nutrient losses, and in some cases reduce pest pressure. Although some cover crops include flowering forbs and legumes, which provide food sources for pollinators and other beneficial insects, these crops must be terminated either through herbicide application or mechanical destruction, which can occur prior to or, in some cases, shortly after planting.

Pre-planting activities that could impact pollinators include tillage and herbicide applications. Some combination of these factors is vital for corn production; conventional no-till systems depend heavily on herbicides to control weeds, while organic systems that reduce herbicide use typically compensate with increased tillage. While the within-field impacts of these activities are unavoidable, steps that reduce the impact to surrounding vegetation could result in improved wild pollinator habitat. Such steps include:

- ***Minimizing pesticide drift during pre-plant and pre-emergence applications***, particularly into areas with blooming wildflowers and other flowering plants (including trees and bushes) following steps outlined previously.
- ***Note if bees are present on flowering weeds or cover crops within the field to be treated***. Only apply an insecticide during pre-plant activities (e.g., cover crop termination) if the application is justified based on monitoring, field history, or other information suggesting the risk of damage from early season pests. If an insecticide (especially one with a Bee Hazard warning) is needed and weeds or cover crops are flowering in the field, consider delaying the application of the insecticide until flowering plants are no longer present. Alternatively, consider mowing the field to eliminate bloom prior to application.
- ***Implement practices that reduce or eliminate tillage and other ground disturbances*** within and around fields could provide additional nesting sites to native ground-nesting bees.

Planting

Planting is a busy, critical time for growers, who must take advantage of favorable planting conditions once they occur (i.e., sufficiently warm temperatures, adequate but not surplus soil moisture) to finish planting as early in the season as possible to maximize yield potential. Planting date is a major factor in yield potential (Nafziger 1994, Abendroth et al. 2017). Depending on geography and weather conditions, the window of opportunity for a grower to get their corn planted can be narrow, resulting in pressure to get things done quickly. Corn planters place the seed in the furrow using either a mechanical drive or, in most modern planters, using a vacuum-powered air-assist (pneumatic) drive.

Prior to planting, most corn seed in the U.S. is treated with one or more pesticides (i.e., a "seed treatment"), which usually includes an insecticide for control of pests such as corn rootworms, wireworms, white grubs, seed corn maggot, and chinch bug. This treatment is generally made at the seed production plant and includes a base fungicide and insecticide package; options for increased rates of insecticide are often available to target certain pests (e.g., corn rootworms). To facilitate movement of treated seeds through large pneumatic planters and reduce abrasion of treated seeds, seed lubricants (e.g., graphite, talc or synthetic compounds) may be used. Dust released from planters consisting of soil, abrasions of seed coat residues, and seed lubricants may become contaminated with pesticides from seed treatments, and are a potential route of exposure to pesticides for bees and other pollinators. Depending on prevailing winds, this dust can then drift onto blooming plants, come into contact with bees directly while they are foraging, or come directly into contact with hives, leading to acute exposure and possible bee kills (Krupke et al. 2012). The risk of exposure to bees is likely to be greater when planting occurs later in the season, when temperatures are warmer and bees are more likely to be foraging. While the generation of dust at planting time might be unavoidable, steps should be taken to minimize drift of this material towards apiaries and areas where bees may be foraging. Steps to reduce the risk of pesticide exposure to bees during planting include:

- ***Matching the use of pesticide seed treatments to locally appropriate levels of pest incidence and the likelihood of infestation*** based on in-field practices (e.g., manure applications that can favor seed corn maggot incidence). Where possible, select only the pesticide treatment rate that is necessary for control of the target insect(s).
- Where insecticide seed treatments are used, ***refer to The Guide to Seed Treatment Stewardship*** (*https://seed-treatment-guide.com/*) and the summary of the Corn Dust Research Consortium (*https://pollinator.org/assets/generalFiles/CDRC-Executive-Summary-October-2017.pdf*) for recommendations on how to reduce the likelihood of drift of contaminated dust during planting. Specific examples include:
    - Follow manufacturer recommendations for the use of talc and other seed lubricants during planting to minimize planter dust.
    - Communicate with area beekeepers to know where hives will be located during planting season. Identify the location of nearby beehives and/or pollinator foraging areas, observe wind speed and direction, and take steps to avoid drift of planter dust in their direction.

- Clean and maintain planting equipment regularly and carefully before, during, and after planting.
- During planter loading and cleaning, take steps to mitigate the release of dust, clean and properly dispose of dust that is released, and watch wind speed/direction to avoid drift of dust particles.
- Consider new technologies and updates to existing planter setups (e.g., downward deflectors, redirecting planter air exhaust, improved seed lubricants) that can reduce the potential for dust drift
- Handle empty seed bags, bulk containers, and planter hoppers carefully to avoid unnecessary release or spills of planter dust, particularly near flowering plants. Dispose of empty seed bags and other wastes properly according to manufacturer recommendations and label instructions.
- During typical corn planting windows, the most common honey bee foraging sites are often woody shrubs and trees (e.g., apples, crab apples, maples, etc.). Take extra care to avoid drift of planter dust onto these plants. Bee-attractive pollen sources can be vulnerable to drift from this dust if they are within approximately 165 feet (50 meters) of the field being planted.
- When applying insecticides in-furrow at planting for control of corn rootworm and other pests, ensure that materials are handled and applied properly and that equipment has been thoroughly inspected to avoid spills and leaks.
- During corn planting, beekeepers should take the following steps to protect their hives. Also refer to *https://honeybeehealthcoalition.org/wp-content/uploads/2019/01/HBHC_Hive_BMPs_v1.0_reduced.pdf*
    - Communicate with local corn growers regularly to learn their intended rotations and practices at planting. Inform area corn growers of hive locations. This communication should occur prior to planting, as time windows are narrow and communication may become difficult during the planting season.
    - Position hives in areas with high quality habitat away from corn fields that are less susceptible to drift from planter dust whenever possible during the planting season.
    - Supplemental feeding and watering of hives during and immediately after corn planting can reduce the need for bees to forage in potentially contaminated areas and help them to overcome stresses from pesticide exposure.

- Insecticides applied at or near planting for early season pests (e.g., black cutworm, armyworm, etc.) should be made judiciously based on the actual likelihood of pest infestation and established recommendations. Proper management of crop residues and weeds can often help to reduce threats posed by these pests, and should be considered as part of an IPM approach.

Vegetative (V) Stages

Field activities during the vegetative stages of growth (from emergence until pollination begins) include routine applications of fertilizer and herbicides. Occasionally, insecticides are applied to vegetative corn to control pests such as black cutworm, true armyworm, stink bugs, chinch bug, and corn borers.

The potential risk to pollinators within corn fields during vegetative stages is relatively low, as pollinators are unlikely to be foraging within vegetative cornfields unless flowering weeds are present. As always, it is important to take steps to minimize drift away from the target crop when applying insecticides, herbicides, or fungicides, and to avoid pollinator exposure wherever possible using measures outlined in the season-long BMPs. General recommendations to protect pollinators during this stage include:

- ***Insect pests*** such as cutworms, true armyworm, and corn borers can reach damaging levels in vegetative corn. Apply foliar insecticides only when properly informed by IPM decision-making, such as when pest infestations exceed local economic threshold recommendations.
- ***Minimize drift of pesticides onto flowering vegetation surrounding cornfields*** by practicing good drift management as outlined previously.

Bee on tassels.
Photo Credit: Scott Stewart

Pollination (R1-R2)

Once corn reaches pollination, fertilizer and herbicide applications are generally finished. Irrigated fields are watered frequently from pollination through early seed fill. Most pesticide applications that occur during this stage are fungicides, although insecticide applications are sometimes made for pests such as corn borers, western bean cutworm, or Japanese beetle.

While corn is not insect-pollinated, corn pollen can be a food resource for bees and other pollinators, particularly in areas where a high proportion of the landscape is planted to corn and other foraging resources are limited. Therefore, steps should be taken where possible to avoid exposing bees to unnecessary stressors in pollinating corn.

- Fungicide applications are generally more common than insecticide applications during this time period. ***Consider the relative toxicity to pollinators*** (as described in the label) and the need for the material based on environmental conditions and fungal disease risk when choosing to make an application.
- Use insecticides only when densities of a pest species (e.g., western bean cutworm, European or southwestern corn borer, Japanese beetle) and/or damage (e.g., silk clipping) have exceeded an economic threshold based on scouting.
- Because most corn pollination within a field occurs during a relatively tight window (< 1 week), ***consider applying insecticides before or after peak pollination*** where possible. Delaying necessary applications until later in the day for higher risk fields (e.g., by saving fields that are closest to apiaries for later in the day) can also reduce the risk to pollinators.
- Some have concerns that pollen from seed treated field corn may express sub-lethal concentrations that could affect bees. ***Consider placing bees in areas that include higher quality food sources*** while corn pollination is occurring.

Post-Pollination (R3 to Post-Harvest)

The potential risks to pollinators within cornfields after pollination are relatively low, as pollinators are unlikely to be actively foraging within fields unless flowering weeds are present (a rare occurrence in most regions). Foliar applications of insecticides during this period of time are uncommon in most production regions, though fungicide applications to control diseases such as southern rust can be common depending on season and region. General recommendations to protect pollinators during this stage include:

- ***Apply foliar pesticides only when justified by pest infestations*** that exceed local economic thresholds and IPM recommendations. Refer to season-long BMPs for practices to reduce drift and impact to bees.
- If a post-harvest herbicide application is used, ***minimize drift of herbicides onto flowering vegetation*** surrounding cornfields.

Providing Honey Bee Habitat

The practices that have been recommended thus far in this guide help protect bees. One of the best ways that growers and landowners working in corn production can proactively improve honey bee health is by providing pollinator habitat and food sources nearby. Research shows that leaving and establishing flowering plants provides honey bees, native bees, and other pollinators with better nutrition — and healthy bees means a healthier agricultural landscape. An added benefit is that the food sources provided during corn planting and pollination may provide a buffer when pesticide applications are scheduled.

Pollinator habitat can be integrated into existing sustainability efforts — such as field buffer strips and natural habitat restoration — by including pollinator-friendly seed mixes.

In this section, you can learn more about the benefits of pollinator habitat for corn growers, several types of habitat projects, and then how to get started. You'll also find a list of resources with links that can help you connect with resources and programs for your area.

HABITAT BENEFITS FOR CORN GROWERS

Growers and landowners may be eligible to earn payments from a variety of public sector and private sector programs. These include cost-share programs through the USDA Farm Service Agency (FSA) and the U.S. Fish and Wildlife Service (USFWS) as well as state and/or private programs offering seed, technical support, or other conservation incentives for creating and maintaining pollinator habitat. Programs include the Conservation Reserve Program (CRP) as well as local and regional programs with county-specific or temporary financial support. This is a great way to put marginal and non-production land (such as field borders, buffer strips, roadways, railways, and waterways) to use and get paid for conservation practices.

Beyond cost-sharing and potential financial compensation, growers who plant pollinator habitat may also benefit from reduced soil erosion, protected and improved soil and water quality, and enhanced food and cover for other wildlife, according to the USDA Natural Resources Conservation Service (NRCS). Michigan State University researchers note the potential for organic matter accumulation, compaction alleviation, and improved water filtration. Pollinator habitat may also store carbon in the soil and act as a carbon sink by encouraging deep-rooted plants and limiting soil disturbance.

Growers also may be able to earn recognition or a premium for sustainably produced crops and/or access to markets that require sustainability metrics (Muth, 2018; Wratten et al, 2012) such as established pollinator habitat. In addition, many consider pollinator habitat a beautiful addition to the landscape (Wratten et al, 2012).

TYPES OF HABITAT PROJECTS

- ***Enhance off-field areas with forage***
    - Plant diverse wildflower patches that bloom all season long
    - Install hedgerows with blooming shrubs, trees, and/or wildflowers
    - Establish non-crop buffer strips
    - Restore native plants in nearby natural areas
- ***Provide nesting habitat for ground bees***
    - Leave areas of grass or bare soil untilled for ground-nesting bees
    - Leave some tree snags or dead pithy stems for stem-nesting bees
- ***Provide access to clean water***
    - Bird baths
    - Irrigation, ditches, or natural ponds

BEST PRACTICES FOR POLLINATOR PLANTINGS

Because many pollinators and other wildlife have experienced extreme habitat declines, landowners should strive to make their pollinator habitat plantings as constructive as possible. Plantings can be designed to fit the goals, size, and appearance the grower desires. The best planting will depend on budget, size, soil type, climate, weed history, and other factors. A good first step is to speak with field staff at your county USDA office, your Conservation District biologist, the closest Farm Bill biologist, or any of the programs linked below. The following best management practices provide a general overview, and the federal or nonprofit expert you work with will likely provide recommendations specific to your site.

Site Selection and Preparation

To maximize success and minimize long-term maintenance, be sure to spend adequate time on site preparation. This means eliminating existing vegetation and reducing competition from weeds seeds in the soil. Many techniques can be used such as herbicides, grazing, and prescribed fire. A site with existing crop stubble is an ideal choice because of decreased competition from grasses. Consider any herbicides used the previous year that could have a residual effect and prevent pollinator-friendly species from growing. If the site has existing grass, it is recommended to plant soybeans and apply standard herbicide treatments for one growing season to address weeds and improve soil nitrogen. Depending on the techniques used and the season in which you start, proper site planning and preparation could take from six months to one or more years.

Seed Mix Selection

When choosing a seed mix, growers should consider which pollinators they want to attract as well as the soil type, geography, and any species restrictions mandated for conservation goals. Seed mixtures should include a high diversity of species with a variety of bloom periods that will provide pollen and nectar for the entire growing season. Also consider avoiding species that are especially attractive to deer. Talk to your local Farm Service Agency representative or seed dealer to determine the best seed mix for the site and its cost. You can also use a seed calculator that shows each species' planting rate, seeds per square foot, bloom period, and pollinator value.

Planting and Water Requirements

When planting, it's important to have great seed-to-soil contact. This can be done with broadcast seeding on roughened bare soil or in crop stubble, depending on the crop. In areas with heavier crop stubble or existing grass, a no-till drill should be used. Broadcast seeding into lighter crop stubble in the fall is preferred. Some conservation districts have rental tools available for establishing pollinator plantings. Be sure to use the appropriate planting depth for the size of the seeds. Aim for a planting depth of two times the diameter of the seed, and know that a planting depth greater than 1/8" will mean some species will not appear in the planting. When seeds are sown in the fall, they should germinate with normal precipitation in fall and early winter. Winter annuals may provide flowers in time for honey bee colonies in the spring. Monitor seedling growth to determine if supplemental irrigation is needed. Some available seed mixes have low moisture requirements.

Management

Landowners should plan for long-term maintenance and record-keeping, especially if the habitat is supported by an incentive program.

If allowed by the incentive program, mow in the first year when plants are about 24 inches tall to help the pollinator planting become established. Be sure to mow the vegetation no shorter than 10 to 12 inches tall. Mowing to this height removes seed-producing parts of many weeds while minimizing impacts to the pollinator-friendly plants. It's recommended to mow twice in the first year, once in the second, and then only at the end of the season in the following years.

Address any grass encroachment before the grass outcompetes wildflowers. Use an appropriate grass-selected herbicide so that it doesn't negatively impact the forage species. The herbicide is more effective combined with another method such as prescribed fire, grazing, or shredding. Prescribed fire (combined with green fire banks that allow rotation of fire treatments) and grazing also help with wildflower establishment. Combining fire and grazing provides better results. It is highly recommended to do some management of the planting every year.

Pollinator Habitat and Crop Pesticides

If habitat is planted next to crops or water sources, it is important to carefully read and follow pesticide label directions to avoid drift and reduce the risk of exposure to bees. Many pesticides can be used safely when pollinators are nearby as long as label directions are followed.

INCENTIVE AND COST-SHARING RESOURCES

Some websites can provide ideas and photos of successful projects, but they may not have the latest information or a complete list of available resources. It's best to call organizations directly and talk with someone at your closest office.

Don't limit your search to pollinator-specific projects. Some programs are designed for specific habitats, such as riparian restoration or deer habitat, but can still benefit pollinators by adding the right flowering plants.

- USDA Farm Service Agency (FSA):
  - *Conservation Reserve Program (CRP)*
  - *Conservation Reserve Enhancement Program (CREP)*
- USDA Natural Resources Conservation Service (NRCS):
  - Find your closest NRCS contact at: *https://offices.sc.egov.usda.gov/locator/app*
  - *Agricultural Conservation Easement Program (ACEP)*
  - *Conservation Stewardship Program (CSP)*
  - *Environmental Quality Incentives Program (EQIP)*
- Conservation District:
  - Find your district at: *https://www.nacdnet.org/general-resources/conservation-district-directory*
- U.S. Fish and Wildlife Service (USFWS):
  - Find contact info for your region and state at: *https://www.fws.gov/partners/contactUs.html*
  - *Partners for Fish and Wildlife*
- The Bee & Butterfly Habitat Fund
  - *Seed a Legacy Program:* The Seed A Legacy pollinator habitat program is available for private, public, and corporate lands in a 12-state region of the country critical to pollinator health and habitat needs. It offers access to documented, high-quality pollinator seed mixtures for free or at discounted rates to projects that are at least two acres.
- Pheasants Forever
  - Find a biologist: *https://www.pheasantsforever.org/Habitat/findBiologist.aspx*
- Quail Forever
  - Find a biologist: *https://quailforever.org/Habitat/findBiologist.aspx*
- Seeds for Bees
  - Project Apis m. program for California residents: *https://www.projectapism.org/seeds-for-bees-home.html*
- *STRIPS (Science-Based Trials of Row Crops Integrated with Prairie Strips)* at Iowa State University

SUMMARY OF BEST MANAGEMENT PRACTICES

1. **Communication among beekeepers and growers:** This is one of the most important factors in preventing acute poisoning of managed bee hives from exposure to pesticides. When growers and beekeepers are aware of each other's locations, concerns, and management practices, they can take steps to avoid pesticide exposure to hives and foraging bees.

2. **Integrated Pest Management:** Growers should follow recommended economic thresholds and university Extension recommendations to guide pest management decisions and consider multiple strategies for control that include non-chemical options (e.g., resistant varieties, cultural practices).

3. **Always follow label instructions:** When insecticides or other pesticides are used (either by growers, or by beekeepers when managing hive pests or forage), label instructions must be followed. Remember that label restrictions are legally binding under both federal and state/Tribal law.

4. **Practice good hive management:** Poorly managed hives are more susceptible to stresses from parasites, pathogens, other pests, and poor nutrition. Healthy hives with access to plentiful forage and water are more resilient when confronted with additional stresses, including pesticides, than are hives at risk from multiple stressors.

5. **Improve and/or establish foraging areas for bees and other pollinators:** Where possible, include flowering plants in non-crop areas. Avoid pesticide drift onto non-crop areas that include floral resources. Leave areas that include these resources intact whenever possible.

RESOURCES

Communication Between Growers and Beekeepers

FieldWatch – BeeCheck Apiary Registry™:
https://fieldwatch.com

The Bee Understanding Project:
https://honeybeehealthcoalition.org/the-bee-understanding-project/

Managed Pollinator Protection Plans (MP3):
https://honeybeehealthcoalition.org/managed-pollinator-protection-plan-mp3-resources/

BMPs for Other Cropping Systems

Best Management Practices to Protect Honey Bees and Other Pollinators in Soybean Fields:
https://honeybeehealthcoalition.org/soybmps/

Honey Bee Best Management Practices for California Almonds:
www.almonds.com/pollination

How to Reduce Bee Poisoning from Pesticides:
http://catalog.extension.oregonstate.edu/pnw591

How to Protect and Increase Pollinators in Your Landscape:
https://www.canr.msu.edu/publications/how_to_protect_and_increase_pollinators_in_your_landscape

Minimizing Pesticide Risk to Bees in Fruit Crops:
https://www.canr.msu.edu/resources/minimizing_pesticide_risk_to_bees_in_fruit_crops

Protecting Honey Bees from Pesticides:
https://extension.entm.purdue.edu/publications/E-53.pdf

State Managed Pollinator Protection Plans

Inventory of state managed pollinator protection plans:
https://aapco.org/2015/07/01/current-topics/

Honey Bee Health

Honey Bee Health Coalition:
https://honeybeehealthcoalition.org

Best Management Practices for Bee Health:
https://honeybeehealthcoalition.org/hivehealthbmps/

Bee Informed Partnership:
https://beeinformed.org

National Strategy to Promote the Health of Honey Bees and Other Pollinators:
https://obamawhitehouse.archives.gov/sites/default/files/microsites/ostp/Pollinator%20Health%20Strategy%202015.pdf

IPM in Corn

Take Action national and state-specific resources for pest management practices:

https://www.iwilltakeaction.com/resources?p=1

National Corn Growers Association Integrated Pest Management Practices:
www.ncga.com/for-farmers/best-practices/integrated-pest-management-practices

Northeastern IPM Center Resources on IPM and Pollinators:
https://www.northeastipm.org/about-us/publications/ipm-insights/resources-on-ipm-and-pollinators/

Seed Treatments

The Guide to Seed Treatment Stewardship:
http://seed-treatment-guide.com

Corn Dust Research Consortium:
https://pollinator.org/assets/generalFiles/CDRC-FINAL-REPORT-October-2017.pdf

Pollinator Habitat

Honey Bee Health Coalition Focus on Forage:
https://honeybeehealthcoalition.org/focus-on-forage/

The Bee and Butterfly Habitat Fund
http://beeandbutterflyfund.org/

USDA Conservation Reserve Program (CRP):
https://www.fsa.usda.gov/programs-and-services/conservation-programs/conservation-reserve-program/

Environmental Quality Incentives Program (EQIP):
https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/eqip/

Conservation Stewardship Program (CSP):

https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/csp/

Agricultural Conservation Easement Program- Wetland Reserve Easement (ACEP-WRE):
https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/easements/acep/

Prairie Partners Program:
https://www.fs.fed.us/psw/publications/documents/psw_gtr191/psw_gtr191_1190-1194_vercauteren.pdf

Partners for Fish and Wildlife Program:
https://www.fws.gov/partners/

Resource Enhancement and Protection Program (REAP):
http://wren.palwv.org/documents/REAP_Brochure.pdf

Bee Buffer Project:
http://beebuffer.com/

Pollinator Habitat Installation Guides:
https://xerces.org/pollinator-conservation/agriculture/pollinator-habitat-installation-guides/

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