Practical guidelines for establishing, maintaining and assessing the usefulness of insectary plantings on your farm

This manual provides some steps for the planning, establishment, maintenance, evaluation and adaptation of insectary plantings. The mechanisms by which insectary plantings can help natural enemies of crop pests and other beneficial arthropods are complex, and their effectiveness can vary greatly from site to site depending on the specific situation. For this reason, it is especially important that insectary plantings are planned and assessed on a case-by-case basis, and integrated into whole-farm plans for pest management and other farm operations. The recommendations provided in this manual are aimed at agricultural settings in the Pacific Northwest, but much of the information applies to other regions and settings in a general sense.

Introduction

Insectary plants are most commonly described as plants that readily provide nectar and pollen food sources in a form that is attractive to natural enemies of crop pests. These plants can also provide alternate prey or host food and shelter to the natural enemies in some instances, but this handbook will focus on the floral resources. It is also important to note that other beneficial insects, such as pollinators, as well as some pest insects, can also receive benefit from insectary plants.

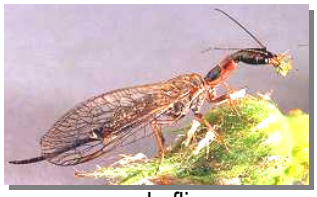
If carefully selected, these floral and extra-floral resources contained in insectary plantings can potentially attract, retain, and/or enhance the reproduction, longevity and effectiveness of a wide range of natural enemy groups, examples of which are pictured on the right.

Many species of beneficial insects that require food and shelter for their survival and effectiveness may not meet their full potential in agricultural landscapes where these resources are lacking. It may be difficult to determine how limited natural enemies are in a given situation, and what the causes of those limitations may be, but well-chosen insectary plantings can at least serve as supplemental resources, and may contribute to population increases when planted on a large enough scale.

soldier beetles

ladybird beetles

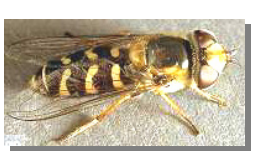
soft-winged flower beetles



snakeflies

lacewings

predatory wasps



hoverflies

minute pirate bug

big-eyed bug

parasitoid tachinid flies

parasitoid wasps

Getting Started – Planning for Insectary Plantings

Insectary plantings that are well thought out can maximize the benefits to natural enemies and minimize the benefits to pest species (Pfiffner & Wyss 2004, Quarles & Grossman 2002). Although certain rules of thumb can help guide the planning process (see box below), it important to first collect information on and/or consider some biological and farm management factors when planning for insectary plantings.

Some basic steps in this process can include:

1) **Looking to see which key natural enemies and pests are present in and around crops, fields and farm areas of interest.** It is important to first correctly identify these organisms. Some references that are good for the identification of species and key groups of pests and beneficials in this region are Beers et al. 1993, Stoltz et al. 1003, Berry 1998, and Capinera 2001 (see 'References' pages 9-10). Basic recommendations for monitoring, sampling, collecting and identification are given on page 5. See Appendices I & II for farm monitoring forms.

2) **Learning more about the biology of these specific organisms and what they need to thrive.**
Here is a table suggesting some relevant questions to ask and how to get answers to those questions:

Which of these natural enemies attack which pests at which times, and what are their dispersal abilities?	References which are good for local natural enemies species include Hoffman et al. 1993, Flint et al. 1998, Capinera 2001, and Weeden et al. 2004; or ask a local official.
Are there different requirements for nectar and pollen foods (or other habitat types) among these organisms? [also see 'rules of thumb' text box below]	This information is more difficult to find for each species, but some good general descriptions of plant food requirements are included in Dufour 2000, Bugg 2001, and Jervis & Kidd 1996.
Are there different preferences among these organisms for various species and arrangements of insectary plants?	Information of this type exists in some specific cases, eg. Colley & Luna 2000 and al Doghairi 1999, but can vary (eg. Cowgill 1993a). Additional observation may be needed, using App. I.

3) **Creating an inventory of existing habitat and plant resources in and around the farm.** This can be accomplished with a brief visual survey and organizing the informationinto a map (eg. Wrysinkski 2002). See Appendix II for the types of resources to look for in a given plot, field, farm section, farm or landscape on a map.

4) **Matching up the habitat and resource requirements of the organisms to what actually is present.** Appendix II is a form which helps match insect needs with what is actually present in the location being monitored.

5) **Making a plan to add the lacking resources and habitat by selecting the appropriate plant species and planting configurations.** Insectary plantings need to be tailored to the specific agricultural system (Pfiffner & Wyss 2004, Gurr et al. 1998). Also see Appendix III for ecological, agronomic and economic questions to consider.

Insectary Plant Planning – Some Rules of Thumb:

If time or resources do not allow for the type of systematic insectary plant plan suggested above, then the following general guidelines or strategies can help serve as a guide for insectary plant planning.

1. provide continuous bloom
2. bigger, closer and more interconnected patches of resource are better than small patches
3. maintain a diverse range of flower types, colors, plant architectures, and perennials & annuals
4. native and traditional varieties can be better than the newer, sometimes nectarless varieties
5. nectar in flowers with long, narrow corollas is accessed primarily by insects with long mouthparts such as bees, butterflies and some flies, so florets with small, shallow corollas (such as in umbels) are generally better for smaller beneficial insects with shorter mouthparts

Types of Insectary Plantings

Insectary plants can be included in cropping systems in many different configurations. They can be broken down into the following categories based upon similarities in management. More information on the establishment and maintenance procedures specific to each of these types are given on the following page.

In plantings within the current crop field or orchard in strips or smaller blocks:

Strip insectary plantings of coriander and agastache, Persephone Farms, OR

Block insectary planting of alyssum, Stahlbush Island Farms, OR

In plantings outside of the crop field, among hedgerow plants, or as perennial or annual plantings in crop margins:

Annual border planting of phacelia in front of a hedgerow in New Zealand

In cover crops:

Flowering buckwheat cover crop, Persephone Farms, OR

In selectively managed weed patches:

Volunteer mustard left in field until seeding, Persephone Farms, OR

Type	Defined	+ / -	Selected Examples & Resources
Insectary plantings *within* the current crop field or orchard:	Can be included in a crop field in larger strips, smaller blocks, or as individual companion plants interspersed throughout the crop field.	**Advantages:** Zone of influence right in with the crop plants. **Disadvantages:** Can take some crop land out of production. Smaller blocks and individual insectary plants can be difficult to manage & assess in the crop field.	More hoverflies near a strip of coriander & *Phacelia tanacetifolia* in New Zealand wheat (Lovei et al. 1993) Dill and coriander strips increased predation of colorado potato beetle eggs in eggplant (Patt et al. 1996) Natural enemies fed on border insectary plants and moved into the crop fields (Long et al. 1998) Increased parasitoid activity in apple plots with undersown buckwheat in New Zealand (Stephens et al. 1998) Strips of coriander increased number of hoverlfies in cabbage in Japan (Morris et al. 2000) Increased hoverflies in UK barley (Sutherland et al. 2001) Increases of a leafroller parasitoid in vineyard areas with buckwheat strips (Berndt et al. 2002) More parasitoid activity in wheat (Tylianakis et al. 2004)
Insectary plantings *outside* of the crop field:	Annual or perennial plantings along the crop field borders such as in hedgerows, or in larger areas further away from the crop field as in 'set aside'.	**Advantages:** Increases function of 'unused' areas. **Disadvantages:** May have extra work with weed control during establishment . Zone of influence may be out of range for poorly dispersive beneficials.	Borders of sown wildflowers increased hoverfly numbers in adjacent UK wheat fields (Harwood et al. 1994) Increased hoverflies and parasitoids in UK wheat fields with *P. tanacetifolia* borders (Holland et al. 1994) Decreased aphids and increased predators in wheat fields near insectary strips in Germany (Hausammann 1996) Inreased hoverfly numbers in UK wheat fields bordered by *P. tanacetifolia* (Hickman & Wratten 1996) Increased parasitoid activity in Californai lettuce close to borders of sweet alyssum (Chaney 1998) Increased parasitoid activity near sown wildflower strips in cabbage fields in Switzerland (Pfifner et al. 2003) Hedgerow methods and how to guides (Kimball & Lamb 1999, (Earnshaw 2004, Hobbs & McGrath 1998)
Insectary plantings in *cover crops*:	Insectary plants as cover crops can be included in annual or perennial crop systems either between crop seasons, or sown under the crop or orchard during the season.	**Advantages:** Other benefits, eg. weed & erosion prevention, as well as nutrients. **Disadvantages:** My not be present at the right time between seasons, or may act as sink within-season. Undersown covers can be difficult to manage.	Survey of insectary cover crops in Pecans found sesbania, buckwheat, showy partridge pea & hairy indigo to have the most natural enemies (Bugg & Dutcher 1989) Increased hoverfly numbers in German apple orchards undersown with a 17 flower mix (Vogt et al. 1999) Reduced leafhoppers and thrips in California vineyards in conjunction with well-timed mowing of buckwheat and sunflower covers (Nicholls et al. 2000) Local cover crop guide (Sattell & Dick 1998) Cover crop methods & how to guide (Bowman et al. 1994)
Insectary plants in selectively managed *weed patches*:	Certain weed species left to flower outside of crop fields can provide floral resources that are just as valuable to beneficials.	**Advantages:** Saves some work in the establishment of insectary plants. **Disadvantages:** Requires careful timing to avoid seeding.	Source-sink effects of weeds (Bugg et al. 1987) Increased hoverfly egg-laying at and near unsprayed weed headlands in UK wheat (Cowgill et al. 1993b) Increased numbers of hoverflies at & near flowering weed field margins in Switzerland (Frank 1999) A review on weeds for beneficials (Nentwig 1998) A comprehensive review of arthropod interactions with weed in agriculture (Norris & Kogan 2000)

Monitoring & Evaluating the Effectiveness of Insectary Plantings

The overall effectiveness of insectary plantings ideally should be evaluated by looking at their relative attractiveness to pest and beneficial species, their effect on these species in other parts of the farm, and the cost vs. benefit of their establishment and maintenance.

Information about the relative attractiveness to floral visitors can be collected by using the tear-out-and-copy form in Appendix I. Information about the effect of insectary plants relative to other parts of the farm can be collected by using the tear-out form in Appendix II.

When making this assessment, remember that these plants can also enhance natural enemies through the provision of alternate hosts and shelter, so observing and recording actual feeding visits to flowers can help to determine if the floral resources are being used.

This information can then be used to compare effects such as:

1) relative amount of different insects visiting insectary plantings before and after planting
2) natural enemy and pest activity near to and far from insectary plantings in crop areas
3) visitation to and effects of different species, densities or arrangements of insectary plantings
4) visitation to control plots, or other locations of interest in and around the farm

The information gathered from each of these two forms can then be fed into an overall cost/benefit evaluation, a guide table is included in the tear-out form in Appendix III.

Practical considerations for sampling, sorting and identifying arthropods

For monitoring visitors to insectary plantings, the best method is visual observation of the relative amount of each species visiting the flowers, with some sweep net collection of those small or hard-to-identify species for later identification with a magnifying glass.

If monitoring is to be done over multiple years, it is useful to make a reference collection of those species that are not readily recognized; for detailed methods, see Schauff 2004.

For monitoring insects in the canopies of crop plants, weeds and other vegetation, sweep nets and beating branches over a cloth work well for ‘hidiing’ and fast-moving arthropods, but there are also many types of traps specific to certain arthropod types, see Flint et al. 1998 for details.

Some insect types can also be monitored by their droppings or feeding remains of prey and vegetation.

Initial monitoring attempts will yield a large number of species and types that will be difficult to identify down to species immediately. Consider prioritizing the monitoring of those species and types that are 1) known to be, and 2) appear to be relatively important in the system or farm area of interest.

Appendix I, Field monitoring form for the evaluation of insectary plantings

This form is to be used for individual insectary plantings of interest. The information on this form can be used to keep a record of the attractiveness of the insectary plant species or insectary plant mixes to certain arthropod species.

Insectary plant species _____ **Date** _____ **Time** _____ **Temp** _____

Type of configuration* _____ **Other weather conditions** _____

Approximate size of planting monitored _____ **Approximate #flowers/area** _____

Distance from other insectary planting(s)/habitat _____ **Pest management activities**** _____

pest or beneficial species	pest or beneficial group***	# of adults	# of immatures	feeding on flowers? [y/n]	sampling method

* 'infield planting, field border, conserved weed patch, or cover crop'

** e.g. list the pest management actions taken near that planting

*** Choices for names of beneficial groups include: 'ladybird beetle, syrphid fly, lacewing, tachinid fly, parasitoid wasp, predacious wasp, predacious bug, bee, etc. Choices for names of pest groups in include: 'aphid, true bug, butterfly or moth, etc.

Appendix II, Field monitoring form for comparing amounts of arthropods on different parts of the farm

This form is to be used for individual plots, fields, farm sections, whole farms, or landscapes of interest (as in 'preliminary planning' steps 1, 3, & 4 on page 2.). The information on this form can be used to keep a record of the status of certain pests, beneficials, insectary plants and crop health in these individual locations on a farm map. It can also be used to compare locations for potential 'before and after' or 'near and far' effects of insectary plantings, either in a spreadsheet, or manually.

Location on map _____ **Date** _____ **Time** _____ **Temp** _____

Approx. size of area sampled _____ **Other weather conditions** _____

Crop/veegation type _____ **growth stage** _____

Pest management activities* _____ **Other crop health factors**** _____

If insectary plants are present at or near the location being sampled: **Date planted** _____

Type of configuration † _____ **Approximate # flowers/area** _____

Approximate size of insectary planting _____ **Distance from the insectary planting(s)** _____

pest or beneficial species	pest or beneficial group***	# of adults	# of immatures	other signs of presence or damage? Amount?	sampling method

•e.g. list the pest management actions previously taken at that location

** eg soil fertility, or other conditions that can affect insect numbers

*** Choices for names of beneficial groups include: 'ladybird beetle, syrphid fly, lacewing, tachinid fly, parasitoid wasp, predacious wasp, predacious bug, bee, etc. Choices for names of pest groups in include: 'aphid, bug, butterfly or moth, etc.

† 'infield planting, field border, conserved weed patch, or cover crop'

Appendix III, Planning form for basic cost/benefit assessment

This checklist is to be used for the pre- or post-comparison of insectary plant species, types, or configurations under consideration (as described in 'preliminary planning' step 5 on page 2).

	Indicator	Estimated or observed outcome with plant type: Positive	Neutral	Negative
Organism	Does this plant and/or habitat type fulfill the requirements for nectar and pollen foods or other habitat for the organisms of interest?			
	Does this plant type have an effect on these organisms on other parts of the farm? [see Appendix II]			
	Is this plant type more attractive to these organisms than other plants on the farm? [see Appendix II]			
Timing	Do the insectary plantings provide sufficient floral resources for the organisms of interest at the right times and places in the system? [see Appendix I]			
	Does the insectary planting attract the natural enemy away from the target pest? [see Appendices I & II]			
Agronomic	How competitive is the insectary planting with the crop, or does it harbor other weeds?			
	Is the insectary plant known to serve as an alternate host for crop diseases?			
	Are the plants toxic to livestock or other local animals?			
Economic	Can the insectary plant be harvested and sold as a crop?			
	What are the costs of seed, establishment and maintenance under the specific conditions?			
	How do these costs and availability of insectary plantings compare to other management options?			
	If land is taken out of production with the planting type, what is that cost?			

It may not be possible to obtain exact information relevant to all the factors above, but simply considering those factors can at least help to insure that an insectary planting will be useful. If information is not available in advance for certain aspects that are of a high priority, it may be necessary to carry out some targeted on-site research and/or monitoring to get that information during the first seasons in which the insectary plantings are implemented.

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