## Hawai'i Cooperative Extension Service

HITAHR · College of Tropical Agriculture & Human Resources · University of Hawai'i at Manoa · U.S.D.A. Cooperating

# **VEGETABLE CROPS UPDATE**

Volume 4

November 1994

No. 5

# Insectaries

The Use of Insectary plants as a Reservoir for Beneficials in Vegetable Agroecosystems Hector R. Valenzuela

On our last issue we covered the area of habitat manipulation, in the form of living mulches, for improved management of soil erosion, nutrient cycling, and weed control in the farm. Another important area of habitat manipulation is the encouragement of beneficial populations in the farm through an increased diversity of plants in the agroecosystem. Experimental evidence, in fact<sup>1</sup>, indicates that agroecosystems that have a greater diversity of plant species (which mimic secondary or later successional stages in natural ecosystems) will tend to have less insect outbreaks compared to less diversified systems. Perhaps this partly explains why traditional farming systems throughout the world evolved into complex polycultural systems, involving a mix of edible species planted concurrently in the same field, or in other formats of planting schedules with several space and time combinations.

**Simplified agroecosystems.** On the other hand, modern agriculture consist of very simplified agroecosystems in which one crop is grown over extensive areas year-round, and year after year. As it would be expected this has lead to ecological instability and to the development of frequent pest outbreaks in the field. To solve this, pesticides are applied which often further disrupt the internal ecological interactions by altering arthropod life-cycles, affecting plant physiology and growth, and by destroying populations of beneficials both above and below the ground level. For example, in New York, parasitism of the diamondback moth was 25% greater in fields that received Bt treatments, compared to those that received pesticide sprays toxic to the beneficials<sup>2</sup>. In another example sprayed globe artichoke fields in California, had 8 fewer predatory mite species than unsprayed fields. In addition, in the Sprayed fields<sup>3</sup>. In Florida 90% parasitism of silerleaf whitefly has been determined in some unsprayed fields<sup>4</sup>.

**Trial and error.** The question from the commercial production standpoint is how to incorporate field diversity, without disrupting the already hectic, and labor intensive, farm operations. And secondly, little data is yet available to make sound recommendations. Local organic farmers, do try to use weeds that may have attractive floral nectaries, or that may provide a refuge for beneficials. In our experiments we also often find high levels (40-90%) of parasitism of important pests such as thrips, leafminers or silverleaf whitefly in unsprayed plots, or in unsprayed weedy patches along field borders<sup>5</sup>. However, due to the lack of baseline data, the approach of increasing species diversity in the farm, today, is still based on a trial and error basisbut it always helps to have a good understanding of the life cycles of both pests and beneficials, and their interactions with both commercial crop and weedy habitats in areas close to the farm.

## Local Work

Local insectaries. In Hawaii we are working with Dr. Greg Luther, and Dr. Joe DeFrank on the use of mustards as insectaries or reservoirs of beneficials for control of caterpillars in cabbage. Locally Dr. Ron Mau, and Randy Hamasaki are working on the use of sweet alyssum, as a reservoir for beneficials for control of the melon aphid in wet-land taro. In addition, living mulches and no-till practices may also provide a refuge for beneficials, or act as barriers for insect movement. With that on mind, Cerruti Hooks, a Ph.D student in our lab. will evaluate 12 living mulch species and their effects on beneficial and pest populations in zucchini. The accompanying tables (page 2-6) provide a list of "biological" resources available, which have been reported to act as potential insectaries. Quick starter tips include: learn what beneficials species you want to attract, what plant species may attract that species (what works in one location does not necessarily work in another), learn as much as possible about the biology of your pest and beneficials, keep an open mind, and when possible, use a mix of plant species as an insectary, rather than using a single species.

#### Notes

<sup>1</sup> See References (page 7) No. 8, 12, and 16.

<sup>2</sup> Shelton, A.M. 1993 NY State Vegetable

Conference, pg. 53-55.

<sup>3</sup> Goh, K.S. and W.H. Lange. J. Econ. Entomol. 82:621(1989).

<sup>4</sup> Schuster, D.J. et al. 1993 Proc. Fl. Tomato Institute. pg. 77-106.

<sup>5</sup> Dianne Ullman (pers. comm.) and Schuster, 1993, idem.

#### COOPERATIVE EXTENSION SERVICE · 3050 MAILE WAY · UNIVERSITY OF HAWAI'I · HONOLULU, HAWAI'I 96822

The University of Hawai<sup>•</sup>i at Manoa, College of Tropical Agriculture and Human Resources, Cooperative Extension Service, U.S. Department of Agriculture cooperating in presenting to the people of Hawai<sup>•</sup>i programs and services without regard to race, color, national origin, sex or disability. It is an Equal Opportunity and Affirmative Action Employer.

Insectary plant	Sci. name	Beneficials attracted	Comments	Ref
alyssum sweet	Lobularia maritima	tachinid flies, hoverflies	long bloom period	1,4
alyssum sweet	Lobularia maritima	chalcids	easy to grow, annual	1,
angelica	Angelica sp.	ladybugs, lacewings, sandwasps	attractive foliage	4,
angelica	Angelica sp.	potter, mud-dauber	biennial	
anthemis	Anthemis tincoria	wasps, flies		2,
barley wild	Hordeum leporinum	parasitic mites	provides wind-blown pollen	5,
bean, bell	Vicia faba	parasitic wasps	cover crop in orchards	5,
black locust		lady beetles, lady bugs		1,
buckwheat flowering	Fagopyrum esculentum	hoverflies, minute pirate bugs,	soil improver	1,4
buckwheat flowering	Fagopyrum esculentum	predatory wasps, tachinid flies	till after peak bloom	1,5
buckwheat flowering	Fagopyrum esculentum	lacewings, lady beetles, syrphids	quick to flower, annual	1,
buckwheat wild	Eriogonum spp.	hoverflies, minute pirate bugs		1,
clover bur	Medicago polymorpha	lady beetles but harbors lygus bugs	winter annual	5,
California liliac	Ceanothus spp.	hoverflies		1,
candytuft	Iberis umbellata	syrphid flies	small shrub ground cover	4,
candytuft	Iberis umbellata	- •	long bloom, perennial	
caraway	Carum cavi L.	lacewings, hoverflies, spiders	0 /1	1,
caraway	Carum cavi L.	insiduous flower bugs,		1,
caraway	Carum cavi L.	parasitic wasps		1,
carrot	Daucus carota	big-eye bugs, assassin bugs,	biennial, requires cold	4,5
carrot	Daucus carota	lacewings, parasitic wasps	exposure	
chickweed flowers	Stellaria media	tachinid, hoverflies, wasps, ants	enpositio	3,5
clover, berseem	Trifolium alexandrium	big-eyed bugs, Geocoris punctipes		1,8
clover, arrowleaf	Trifolium vesiculosum	big-eyed bugs, Geocoris punctipes		8
clover, crimsom	Thoman vesteriosam	minute pirate bugs, lady beetle		1,6
clover, crimsom		big-eyed bugs, Geocoris punctipes		1,6
clover, subterranean	Trifolium subterraneum	big-eyed bugs, Geocoris punctipes		1,6,8
clover, white	Trifolium repens	parasitic wasps of aphids, whiteflies	nitrogen fixer, perennial	4,
clover, white sweet	Melilotus alba	tachinid flies, mud-dauber, sand,	nitrogen fixer, excellent	4,
clover, white sweet	Wemotus alba	hornet, yellow jacket wasps, bienn	green manure, biennial	т,
coriander	Coriandrum sativum	tachinid flies	decorative foliage, annual	4,
cowpea	Contailurum sativum	predatory wasps	decorative ronage, annuar	4, 1,
dill	Anethum graveolens	ladybugs, syrphids, wasps, spiders		
evening primeroses	Oenothera lacinata or	ground beetles	attractive yellow flowers	2, 4,
evening primeroses	Oenothera biennis	ground occurs	perennial, biennial	ч,
		lacewings, ladybugs	-	4
evergreen eunonymus fennel sweet	Euonymus japonica	parasitic wasps, predatory wasps	used as hedge plant, perennial warning: invasive plant	4,
fennel sweet	Foeniculum vulgare	syrphids, spider, ladybeetles		1,4,5
	Foeniculum vulgare Indigofera hirsuta		perennial weed	2,
indigo hairy	C C	aphid predators		5,
ivy	Hedera sp.	flower and tachinid flies, braconid	mature vine with bloom	4,
ivy	Hedera sp.	potter, mud-dauber, sand hornet	drought tolerant, perennial	1.5
knotweed common	Polygonum aviculare	big-eye bugs, hoverflies,	summer annual weed	1,5
knotweed common	Polygonum aviculare	parasitic wasps, pirate bugs		1,
knotweed common	Polygonum aviculare	soft winged flower beetles		1,
lettuce wild	Lactuca canadensis	soldier beetles, lacewings, earwigs	easy to control, annual	4,
lettuce wild	Lactuca canadensis	syrphid flies		
marigold 'Lemon gem'	Tagetes tanuifolia	small wasps, spiders		2,

Table 1. List of plants reported to be useful as insectaries for attraction of beneficials in agroecosystems.

		eneficials in agroecosystem	

Insectary plant	Scientific name	Beneficials	Comments	Ref
nay weed	Anthemis cotula	general predators	annual weed, Asteraceae	5,
Aexican tea	Chenopodium amrosioides	stink bugs, ladybugs, assassin bugs	epazote, edible leaves, annual	4,
norning glory	Convolvulus arvensis	syrphid flies, lady bugs	Invasive plant; perennial	4,
nustard, white	Brassica hirta	braconid and ichneumon wasps	fast-growing, annual	4,
at wild	Avena fatua	predatory mites	provides wind-blown pollen	5,
at slender wild	Avena barbata	predatory mites	provides wind-blown pollen	5,
bigweed	Amaranthus sp.	ground beetles	edible weed, annual	4,
inneapple weed	Matricaria matricarioides	general predators	annual weed, Asteraceae	5,
ueen anne's lace		lacewings, predatory wasps,		1,
ueen anne's lace		minute pirate bugs, tachinid flies		1,
attail fescue	Vulpia myuros	predatory mites	provides windblown pollen	5,
ipgut brome	Bromus rigidus	predatory mites	provides windblown pollen	5,
ue	Ruta graveolens	potter wasps	deer resistant, perennial	4,6
ye	Secale cereale	lady beetles		6,
yegrass, annual	Lolium multiflorum	predatory mites	provides windblown pollen	5,
altbrush	Atriplex sp.	potter, sand, and mud-dauber wasps	brackish water tolerant, per	4,
Sesbania	Sesbania exaltata	lady bug beetles, syrphid flies		5,
howy patridge pea	Cassia fasciculata	entomophagous wasps, ants	Trichogramma parasitation	5,7
ilver lace vine	Polygonum aubert	tachinid and syrphid flies	attractive blooming white vine	4,
ilver lace vine	Polygonum aubert		4-6" tendrils are edible, per	
nowberry	Symphoricarpos sp.	flower and tachinid flies	decidous shrub, perennial	4,
oap-bark tree		hoverflies, green lacewings,		1,
oap-bark tree		brown lacewings		1,
owthistle	Sonchus oleraceus	lady beetles	annual weed	3,5
pearmint	Mentha spicata	predatory wasps, flies, spiders		1,
titchwort	Stellaria graminea	tachinid, hoverflies, wasps, ants		5,
ansy	Tanaceum vulgare	parasitic wasps, lady beetles, flies		1,
ansy	Tanaceum vulgare	insidious flower bugs, lacewings		1,
oothpick ammi	Ammi visnaga	hoverflies, minute pirate bugs,	warm season annual	1,5
oothpick ammi	Ammi visnaga	soft-winged flower beetles,		1,
oothpick ammi	Ammi visnaga	tachinid flies		1,
ree of heaven	Allanthus altissima	syrphid, chloropid flies, braconid,	Warning: invasive plant	4,
ree of heaven	Allanthus altissima	potter wasps, lacewings	stress tolerant, perennial	4,
etch, hairy	Vicia sativa	lady beetles, minute pirate bugs		1,5
etch, hairy	Vicia sativa	predatory and parasitic wasps		1,
etch, hybrid	V. sativa x V. cordata	big-eyed bug	cvr. Vantage	8
vheat, spring	Triticum aestivum	generalist predators	cover crop in orchards	5,
vhite sweetclover		tachinid flies, bees, predatory wasps	-	1,
Cosmos 'White sensation'	Cosmos bipinnatus	insidious flower bugs		2,
Cosmos 'White sensation'	-	lacewings, ladybugs, spiders		2,
varrow	Achillea sp.	lady beetles, parasitic wasps, bees	drought resistant, perennial	1,4
arrow	Achillea sp.	tachinid flies, scales, whiteflies	spread by underground roots	

## **References:**

5= Bugg & Waddington. Ag. Ecos. Environ. 50:11(1994) 1= Karen Cicero, 1993. The New 6=Cecil Yancy, 1994, The New Farm, Feb. pg. 20-23. Farm. 15(2):28-33. 7= Altieri 88; 2= Joanna Poncavage, 1991. Organic Gardening. May/June 1991. 8=Bugg et 91 3= Parry Klassen, 1994. Fruit Grower. Vineyards in the Clover big eyed bugs= Geocoris punctipes 4= Robert Kourik, 1992. Garbage. May/June 1992 hover flies= syrphids 3

Table 2. List of beneficial arthropods and plants used to attract them in agroecosystems	used to attract them in agroecosystems	
Beneficial arthropod	Scientific name	How to Attract
Anhid midse	Aphidoletes aphidimyza	dill, mustard, thyme, sweet clover,
Aphid parasites	Aphidius matricariae	anise, caraway, dill, parsley, mustard family,
4		white clover, lemon balm, corn spurry, wild carrot, etiming nettle vorrow.
Assassin bugs	Reduviidae family	Provide shelter
Big-eyed bugs	Geocoris spp.	alfalfa, potatoes, beets, subterranean clover
Braconid wasps	Braconidae family	
	eg. A panteles glomeratus	dill, parsley, wild carrot, corn spurry, mustard, white clover temory beling ethemion pettle various
		WILLE CLOVET, TEILOIT DALIT, SULISTIES INVERT, 2010
Damsel bugs	Nabidae family	
	eg. Nabis americof erus	alfalfa
Ground beetles	Carabidae family	perennial plantings/sods, amaranth, white clover
Lacewings	Chrysoperla & Chrysopa spp.	dill, angelica, corri, sunflowers, and
c		weeds: dandelion, goldendrod
Lady beetles (bugs)	Hippodamia, A dalia spp. etc.	Plants with nectar and pollen flowers: angelica, dill, and
	· · · · · · · · · · · · · · · · · · ·	weeds: dandelion, wild carrot, yarrow.
Mealvbug destrover	Cryptolaemus montrouzieri	NA
Minute pirate buss	Orius sp.	Alfalfa, goldenrod, daisies, yarrow, corn (silken varieties), stinging nettles, clover, vetch, willows,
	-	and other shrubs
Praving mantis	Mantis religiosa (European)	native species
Dredstory mite	Phytoseiulus nersimilis	NA, live mites must be avaialble.
LIVIAL JULIO	Thrinidae family others	Prefer insect prev but will feed on sap and pollen
FIGURION UNITS		for survival. Plant flowers and corn.
	Stonbulinidae family	Plant nermanent heds or internlant strips of rve
Kove beenes	Steputymmeter	or other grains or cover crobs.
	Ctenth control control	Pollen and nextar from carrot and mustard family.
Spidermite destroyer	oremones app.	
Spined soldier bug	Podisus maculiventris	Мациян репланент регелла госоз
Syrphid flies	Syrphidae family	
(hover or flower flies)		Pollen and nectar from dill, fennel, mangold, and parsley,
		weeds eg wild carrot or yarrow.
Tachinid flies	Tachinidae family	Pollen and nectar plants, dill, parsley, sweet clover, Phacelia sp., tennel, buckwheat, and herbs. Weeds:
goldenrod, wild carrot, amaranth		
Tiger beetles	Cicindelidae family	Maintain permanent beds.
Trichograma wasps	Trichogramma minutum	maintain several species: dill, anise, caraway, fennel, and mixture of choner and flowerino weeds
Whitefly parasite	Encarsta tormosa Matocainhus (—Thurblochcomus)	AV1
western predatory mute	$(\sin \pi i) = (\sin \pi i) \sin \pi i$	
	.1.1. Concernent 1001 Concerning Marylinne 1001 no. 46 56	

Ш

Table adapted from: Linda Gilkeson and J. Grossman. 1991. Organic Gardening. May/June 1991 pg. 46-56.

s (r)gweed) big-syed bug ground beetle soybean cotton beer (r) big-syed bug ground beetle soybean cotton bower (r) (sypholics and color bower (r) (sypholics bower (r) (sypholic) big-syed bug ground beetle soybean corton pereralist predator bower (r) (sypholic) big-syed bug ground beetle soybean corton pereralist predator solder corps bower (r) (sypholic) big-syed bug (r) (symbolic) big-syed	table 3. List of weedy of crop specie Weed species	rable 5. List of weedy of ctop species which have been reported as nosis of beheficial populations in agroecosystems. Weed species Main crop	u populations in agroecosystems. Main crop	Comments	Reference
a reprincipida (regived) big-eyed bug other predators, parasites pidlars (coyete brush) over (ty yrphid) a covert (ty syrphid) over (ty yrphid) over (ty yrphid	Amaranthus hybridus (pigweed)	big-eyed bug, ground beetle	soybean	generalist predator	Naranjo 87; Altieri & Let 86
Industry (cov)ce brush)         Inover (1)         Nover (1)<	Ambrosia artemisiifolia (ragweed)	ŝ	soybean, cotton	generalist predator	Naranjo 87; Alt & Let 86, Alt 88
Appendication         Soybean, NA         Soybean, NA         Soybean, NA         Soybean, NA         Source state predator in antrosioides           num antrosioides         big-syed bug, 34 predators         Soybean, NA         Big-syed bug, 34 predators         Big-syed bug, 34 predators           num antrosioides         big-syed bug, 34 predators         Soybean, NA         Big-syed bug, 34 predators         Big-syed bug, 34 predators           domerata         pregram parasitation         soybean, NA         general predators         Big-syed bug, 30 predators         Big-syed bug, 30 predators         Soybean, Coton spn, Vith buckwheat           attensis         present predators         soybean, corn         general predator spcies         Junoud orchard         California BIOS program           attensis         present predators         soybean, corn         general predator spcies         Junot orchard         California BIOS program           attensis         big-sycd bug, 30 predators         soybean, corn         general predator spcies         Junot orchard         California BIOS program           attensis         sopean         predator spcies         NA         Sopean         California BIOS         predator           attensitian         sopean         predator spcies         NA         Sopean         Predator           attencitat         <	Baccharis pilularis (coyote brush)	hover tly	NA	aphid predators	Bugg 93
tim ambrosioides precial predators break cabrage product copes apps (caral) predators precial predators spider and predators spider cereal crops and Croton spp. Trichograma parasitation areasis and anticons appeared predators spider cereal crops and croton spp. Trichograma parasitation cereal crops and croton spin transition and constant cereal crops and cross (wild lettuce) of general predator species and on chand cereal crops and chards of general predator species and control and the control and the control and croton and the control and croton and cross (wild lettuce) of general predators spider control and croton and croton and the control and croton and	Bidens alba (Spanish needles)	big-eyed bug	soybean	generalist predator	Naranjo, Stimac 87
appa actional         hover fly (syrphid)         NA         with buckwheat           text         big-eyed bug. 34 predators         soybean, NA         generalist predator           text         big-eyed bug. 34 predators         soybean, NA         generalist predator           attensis         big-eyed bug. 34 predators         soybean, NA         generalist predator           attensis         big-eyed bug. 30 predators         soybean, com         general predators           attensis         big-eyed bug. 30 predators         soybean, com         general predators           attensis         big-eyed bug. 30 predators         soybean, com         general predators           attensis         big-eyed bug. 30 predators         soybean, com         general predators           attensis         big-eyed bug. 30 predators         soybean, com         general babitats           attensis         big-eyed bug. 30 predators         soybean, com         general babitats           attensis         big-eyed bug. 30 predators         sopteral predators         cereal crops           attensis         big-eyed bug. 30 predators         sopteral predators         cereal crops           attensis         big-eyed bug. 30 predators         sopteral predators         cereal crops           attensis         predators sopt	Brassica juncea	general predators	head cabbage	border crops	Luther, Valenzuela 94.
teal)big-syde bug. 34 predatorssoybean. NAgeneralist predatordomeratim spand Croton spidercereal cropswith com polycultureattensisgeneral predators, spidersoybean. NAgeneralist predatorsattensisgeneral predators, spidersoybean.with com polycultureattensisgeneral predators, spidersoybean.cereal cropswith com polycultureattensispredators, spidersoybean.cereal cropspredatorsattensispredatorsspiderpredatorspredatorsattensispredator speciesNAgeneral predatorsattensisspidercereal cropsspidercereal cropsattensisspidercereal cropsspidercereal cropsattensisspidercereal cropsspidercereal cropsattensisspidercereal cropsspidercereal cropsattensisspidercereal cropsspidercereal cropsattensisspidercereal cropsspidercereal cropsattensisspidercereal cropsNAcereal cropsattensispredacous sarvig. Dratantinoscereal cropspredatorsattensispredacous sarvig. DratantinosNA. Koreacertal predatorsattensispredacous sarvig. DratantinosNA. Koreacertal predatorsattensispredacous sarvig. Dratantinocertal cropspredatorsattensispredacous sarvig. DratantinoNA. Koreacertal crops	Brassica napus (canola) Chenopodium ambrosioides	hover fly (syrphid)	NA	with buckwheat	Bugg 93
Jonneratageneral predators, spidercereal cropslinear island habitatsus sphad Croton spp.general predators, spiderscienal predators, spiderinear island habitatsratensisgeneral predators, spiderscienal predators, spiderannot orchardCalifornia BIOS programcas ubxxillarisbig-syed bug, 30 predators, spidermond orchardCalifornia BIOS programcas ubxxillarisbig-syed bug, 30 predators, spiderannot created cropsaphid predatorscas ubxxillarisbig-syed bug, 30 predators, spiderapad yricecereal cropsaphid predatorscas ubxxillarisbig-syed bug, 30 predatorssovelandgeneral predatorcereal cropsaphid predatorscas ubxxillarisbig-syed bug, 30 predatorssovelandcereal cropsapid yricecereal predatorsiai vaginalisgound beelecereal cropsapid yricecereal cropsinaer island habitatsiai vaginalisgound beelecereal cropsapid yricecereal cropsinaer island habitatsiai vaginalisgound beelecereal cropsinaer island habitatsgeneral predatorsiai vaginalisgound beelecereal cropsinaer island habitatscereal cropsinaer island habitatsiai vaginalisgound beelecereal cropscereal cropscereal cropscereal cropsiai vaginalisgound beelecereal cropscereal cropscereal cropscereal cropsiai vaginalisgound beelecereal cropscereal cropscereal crops	(Mexican tea)	big-eyed bug, 34 predators	soybean, NA	generalist predator	Naranjo 87; Altieri & Whit 79b
m spp and Croton spp.         Trichograma parasitation         soybean         with corn polyculture           atensis         general prediors, spider         amond orchard         aphid prediors, spider           roaddawsis         general prediors, spider         amond orchard         California BIOS program           atensis         pereral prediors, spider         amond orchard         California BIOS program           atensis         pereral prediors, spider         south         California BIOS program           ato spinal         pig-sycd up 3.0 prediators         south         California BIOS program           ato vaginalis         byden, corn         general prediators         south prediators           ato vaginalis         productors         south beelte         cereal crops         general prediators           ato vaginalis         ground beelte         cereal crops         paddy rice         certal crops           atomenosa         productors arwig. D. tatinatum         N.A. Kora         control fall arnyworm           atomenosa         predaccous arwig. D. tatinatum         N.A. Kora         control fall arnyworm           atomenosa         predaccous arwig. D. tatinatum         N.A. Kora         control fall arnyworm           atomenosa         predaccous arwig. D. tateniatum         N.A. Kora         con	Dactylis glomerata	general predators, spider	cereal crops	linear island habitats	Thomas 89; Chiverton 89
atensis general predators, spider acteral crops aphid predators general predators, spider acteral crops anot orchard cashaxillaris veed) big-eyed bug. 30 predators predators spider actors spider and orchard cashaxillaris big-eyed bug. 30 predators spider acteral predators spider and so and better and	Desmodium spp.and Croton spp.	Trichograma parasitation	soybean	with corn polyculture	Altieri 88
roadleaves general general beneficials almond orchard California BIOS program cas ubaxillaris big-eyed bug, 30 predators goidean, corn casta and ensist of general predators spider antus general predators spider predators spider and spider. Pardosa ramulosa general predators spider and spider. Pardosa ramulosa general predators spider and spider. Pardosa ramulosa general predators avery spider. Pardosa ramulosa general predators spider and spider. Pardosa ramulosa ground beetle aground beetle aground beetle aground beetle arxinum predaceous carwig. Dorn taeniatum predaceous carwig. Dorn taeniatum predaceous carwig. Dorn taeniatum predaceous carwig. Dorn taeniatum predaceous carwig. Danna at onnentosa predaceous carwig. Datema at onnentosa predaceous carwig. Pathol predators and predators and predaceous carwig. Pathol predators and paratita at predators and paratita at predators and paratita at a predaceous carwig. Pathol predators and paratita at a predators at transmit at the attema at a predators and paratita at a predators and paratita at a predators at a predator	Festuca pratensis	general predators, spider	cereal crops	aphid predators	Chiverton 89
weed)big-eyed bug. 30 predatorssoybean, corngeneral predatorsnaturssereral predatorsspideranadensis (wild lettuce)spiderspidernardensis (wild lettuce)6 general predators spiderNAgeneral predatorsspider, Pardosa ramulosa6 general predatorsspiderpredatorsnardensis (wild lettuce)6 general predator speciesNAgeneral predatorsspider, Pardosa ramulosaground beetleceral cropsleaf beetle controlnakimumground beetle(early evening primrose)leaf beetlenakimumpredaceous entwig. Duru taeniatumNA, Koreacontrol fall armywormna prodaceous entwig. D. taeniatumNA, Koreacontrol fall armywormna predaceous entwig. D. taeniatumNA, Koreacontrol fall armywormna predaceous entwig. D. taeniatumNA, Koreacontrol fall armywormanacetifolia(fansy)hover flyNAaphid predatorsnover flyseneral predatorsNAaphid predatorsanacetifolia (folly 1. cherry)hover flyNAaphid predatorsanacetifolia (folly 1. cherry)hover flyNAaphid predatorsaponaria (soapbark tree)big-eyed bug. 38 predatorssoybean, NAaphid p	Grasses/broadleaves general Heterotheca subaxillaris	general beneficials	almond orchard	California BIOS program	Klassen 94b
natusgeneral predators, spidercereal cropslinear island habitatsanadensis (wild lettuce)6 general predators spiderNAgeneral predatorsanadensis (wild lettuce)6 general predators spiderNAgeneral predatorsia vaginalisspider, Pardosa ramulosanacimistagound beetlegentinper controli a letimistaground beetle(early vering primrose)leaf beetleanximumpredaccous earwig, Dont taeniatumNA, Korealeaf beetlea tomentosapredaccous mitesNA, Korealeaf beetlenatescifolia(Tansy)hover flyNA, Koreacontrol fall armywormn purpureumnover flyNA, Koreacontrol fall armywormn pupureumnover flyNAapied predatorsn predaccous mitescassava, Nicaraguacontrol fall armywormattenseciolia (holly 1. cherry)NAapied predatorsaponaria (scapbark tree)bis-eyed bugSP predatorssental predatorsspider consNAapild predatorsapiloa (cons purits)bover flyNAapild predatorssetors (folia quoly 1. cherry)bover flyNAapild predatorsapiloa (cons purits)bis-eyed bugSP predatoryapild predatorssetors (folia pusley)bis-eyed bugSP predatoryapild predatorssetors (folia pusley)bis-eyed bugSP predatoryapild predatorssetors (folia pusley)bis-eyed bugSP predatoryapild predatorssetors (folia	(camphorweed)	big-eyed bug, 30 predators	soybean, corn	generalist predator	Naranjo 87; Altieri & Whit 80
anadensis (wild lettuce) 6 general predator species NA general predators paider, Pardosa ramulosa paddy rice interal predators spider, Pardosa ramulosa paddy rice interal predators paddy rice interal predators paddy rice interal predators predators and beetle control carry predators and predaceous earwig. Doru taeniatum predaceous earwig. D. taeniatum predacous earwig. D. taeniatum predacous earwig. D. taeniatum predaceous earwig. D. taeniatum predacous earwig. D. taeniatum predacous earwig. D. taeniatum predacous earwig. Predacous earwig. Predacous earwig. Predacous earwig. Predacors ears. Nicaragua phild predators sobrean. NA spide predator control fall armyworm predacous earwig. Predators sobrean. NA species. Is families? dow sput predators sugarcame predacous earwig. Predators predacous earwig. Predators predacous earwig. Predators sobrean. NA spore control fall armyworm predacous earwig. Predators sobrean. NA spore sobrean. NA spide predator sugarcame predaceous earwig. Predators sobrean. NA spide predator control fall armyworm predaceous earwig. Predators sobrean. NA species. I 5 families? Ja weed species los families? Ja weed species los denory los every and predators sobrean. NA species. I 5 families? Ja dybird beetles, Jacewing predators predacous earwig predators predacous earwig predators predacous earwig predators sobrean. NA species. I 5 families? Ja dybird beetles, Jacewing predators predacous earwig predators predacous earwing predators predacous earwig predator sobrean cont	Holcus lanatus	general predators, spider	cereal crops	linear island habitats	Thomas 89
ria vaginalis spider, Pardosa ramulosa paddy rice leafhopper control laciniata ground beetle ground	Lactuca canadensis (wild lettuce)	6 general predator species	NA	general predators	Altieri & Let 86
I alciniataground beetle(early evening primrose)leaf beetle controla biennisground beetleevening primrose)leaf beetle controla nameminapredaceous earwig, Doru taeniatumNA, Koreacontrol fall armyworma nameerifolia(Tansy)predaceous arriesNA, Koreacontrol fall armyworma nominumpredaceous arriesNA, Koreacontrol fall armyworma nomerifypredaceous earwig, D. taeniatumNA, Koreacontrol fall armyworma nover flypredaceous arriescontrol fall armywormcontrol fall armyworma nover flyhover flyNApredacousa pointid predatorscreated cropsaphid predatorsa pointid (soapbark tree)big-eyed bugSB predatorsa pointid predatorssoybeangeneralist predatora pointid predatorssoybeansendatora printiosagoldernod)big-eyed bugSB predatorbig-eyed bugSB predatory mitescassava, Nicaraguacontrol fall armyworma printiosabig-eyed bugSB predatory mitescassava, Nicaraguaa printiosabig-eyed bugSB predatory mitescassava, Nicaraguabig-eyed bugsugar cane borer, Diatraea sacryatiasoybean, collardscontrol fall armyworma pressi (con spurty)big-eyed bugSB predat	Monochoria vaginalis	spider, Pardosa ramulosa	paddy rice	leafhopper control	Oraze & Grigarik 89
t biennisground beetle(evening primrose)leaf beetlenaximumpredaceous earwig. Doru taeniatumNA, Koreacontrol fall armyworma tomentosapredaceous earwig. D. taeniatumNA, Koreacontrol fall armywormm purpureumpredaceous earwig. D. taeniatumNA, Koreacontrol fall armywormm purpureumpredaceous earwig. D. taeniatumNA, Koreacontrol fall armywormm purpureumpredaceous earwig. D. taeniatumNA, Koreacontrol fall armywormm purpureumpredacous earwig. D. taeniatumNAaphid predatorsanacetifolia (holly I. cherry)hover flyNAaphid predatorsnover flysoapbark tree)big-eyed bugsoybeanaphid predatorsseabra (Florida pusley)big-eyed bugsoybean, NAgeneralist predatorsscabra (conpredacous earwig, predatorssoybean, NAgeneralist predatorsfistulosa (goldernod)big-eyed bug. 58 predatorssoybean, NAgeneralist predatorfistulosa (goldernod)big-eyed bug. 58 predatorssoybean, NAgeneralist predatorsfistulosa (goldernod)big-eyed bug. 58 predatorssoybean,	Oenothera laciniata	ground beetle	(early evening primrose)	leaf beetle control	Altieri & Let, 86
naximumpredaceous earwig. Doru taeniatumcassava, Nicaraguacontrol fall armyworma tomentosapredaceous mitesNA, Koreacontrol fall armywormm purpureumpredaceous mitesNA, Koreacontrol fall armywormm purpureumpredaceous earwig. D. taeniatumNA, Koreacontrol fall armywormm purpureumpredaceous earwig. D. taeniatumNAaphid predatorsm purpureumpredaceous earwig. D. taeniatumNAaphid predatorsnover flycontrol fall armywormNAaphid predatorsanacetifolia(Tansy)hover fly (syrphid)NAaphid predatorsnover flyhover flyNAaphid predatorsapontal (soapbart tee)big-eyed bugsoybeanNAscabra (Florida pusley)big-eyed bugsoybean. NAapnetatorsscabra (Florida pusley)big-eyed bugsoybean. NAgeneralist predatorsscabra (forida pusley)big-eyed bugsoybean. NAgeneralist predatorsscastors (corn spurt) <td< td=""><td>Oenothera biennis</td><td>ground beetle</td><td>(evening primrose)</td><td>leaf beetle</td><td>Altieri &amp; Let 86</td></td<>	Oenothera biennis	ground beetle	(evening primrose)	leaf beetle	Altieri & Let 86
a tomentosa predaceous mites NA, Korea extraflorar nectar m purpureum predaceous earwig, D. taeniatum NA forea extraflorar nectar anacetifolia(Tansy) hover fly (syrphid) NA aphid predators cifolia (holly 1. cherry) hover fly (syrphid) NA aphid predators scibra (Florida pusley) big-eyed bug seneral predators aphid predators aponaria (soapbark tree) hover fly spredators NA aphid predators aponaria (soapbark tree) big-eyed bug seneralist predators aphid predators scabra (Florida pusley) big-eyed bug septentary soybean fistulosa (goldenrod) big-eyed bug septentary neckators big-eyed bug septentary soybean aphid predators scabra (Florida pusley) big-eyed bug septentary neckators fistulosa (goldenrod) big-eyed bug septentary neckators big-eyed bug septentary neckators soybean appid predators scabra (Florida pusley) big-eyed bug septentary neckators big-eyed bug septents soybean appid predators statulosa (goldenrod) big-eyed bug septentary neckators big-eyed bug septentary neckators soybean appid predators big-eyed bug septents and predators and predators appendentors big-eyed bug septents and predators below-ground predators predators predators and predators predators and predators predators and predators a	Panicum maximum	predaceous earwig, Doru taeniatum	cassava, Nicaragua	control fall armyworm	Jones et al 87
m purpureumpredaceous earwig, D. taeniatumcassava, Nicaraguacontrol fall armywormanacetifolia(Tansy)hover flyNAaphid predatorsanacetifolia(Tansy)hover flyseneral predators, spiderNAaphid predatorscifolia (holly 1. cherry)hover fly(syrphid)NAaphid predatorsaptonaria (soapbark tree)hover flyNAaphid predatorsaponaria (soapbark tree)big-eyed bugsoybeanNAaphid predatorsstonaria (soapbark tree)big-eyed bugsoybeansoybeanaphid predatorsstonaria (soapbark tree)big-eyed bugsoybeanNAaphid predatorsaponaria (soapbark tree)big-eyed bugsoybeanNAaphid predatorsaponaria (soapbark tree)big-eyed bugsoybeanNAgeneralist predatoraptostbig-eyed bugsoybean, NAcarsava, grapecontrol fall armywormbicolorbig-eyed bugsoybean, NAcantrol fall armywormbicolorbig-eyed bugsoybean, NAcontrol fall armywormbicolor <td< td=""><td>Paulownia tomentosa</td><td>predaceous mites</td><td>NA, Korea</td><td>extraflorar nectar</td><td>Pemberton, 93</td></td<>	Paulownia tomentosa	predaceous mites	NA, Korea	extraflorar nectar	Pemberton, 93
anacetifolia(Tansy) hover fly anacetifolia(Tansy) hover fly anacetifolia(Tansy) hover fly anacetifolia(Tansy) hover fly (syrphid) and the sendance and the send	Pennisetum purpureum	predaceous earwig, D. taeniatum	cassava, Nicaragua	control fall armyworm	Jones et al 87
ratense general predators, spider cereal crops aphid predators cifolia (holly l. cherry) hover fly (syrphid) NA aphid predators aphid predators aponaria (soapbark tree) hover fly big-eyed bug scabra (Florida pusley) big-eyed bug S8 predators soybean, NA aphid predators soybean, NA generalist predator fistulosa (goldenrod) big-eyed bug. 58 predators soybean, NA generalist predator big-eyed bug. 58 predators soybean, NA aphid predators predaceous earwig, predatory mites cassava, grape control fall armyworm bicolor predaceous earwig mover fly nover fly armyworm sugar came borer, Diatraea saccharalis beak, collards below-ground predators, predators predators, predators below-ground predators, predators predators below-ground predators, predators below-ground predators, predators below-ground predators predators below-ground predators predators predators below-ground predators predators below-ground predators predators below-ground predators predators predators below-ground predators below-ground predators brancing below ground predators brancing below-ground predators bra	Phacelia tanacetifolia(Tansy )	hover fly	NA	aphid predators	Bugg 93
cifolia (holly I. cherry) hover fly (syrphid) NA aphid predators aponaria (soapbark tree) hover fly inje-eyed bug, 58 predators is soybean, NA aphid predators scabra (Florida pusley) big-eyed bug, 58 predators is soybean, NA aphid predators fistulosa (goldenrod) big-eyed bug, 58 predators is soybean, NA aphid predators is sugar cane borer. Diatraea saccharalis sugarcane weedy habitat, aphids id predators indefense, lacewing id predators indefense, lacewing id forcana apple or control fall armyworm aphid predators is soybean, collards is soybean, collards is soybean, collards id predators below-ground predators, predators ind for an extra floral nectar below-ground predators predators predators ind for an extra floral nectar below-ground predators is apple orchard in the orthor in the orthor in the orthor in the orthor indefense i	Phleum pratense	general predators, spider	cereal crops	aphid predators	Chiverton 89
aponaria (soapbark tree) hover fly montania (soapbark tree) hover fly big-eyed bug scabra (Florida pusley) big-eyed bug S8 predators soybean, NA generalist predator fistulosa (goldenrod) big-eyed bug, S8 predators soybean, NA generalist predator big-eyed bug, S8 predatory mites soybean, NA generalist predator big-eyed bug, S8 predatory mites soybean, NA generalist predator big-eyed bug, S8 predatory mites soybean, NA generalist predator big-eyed bug, S8 predatory mites soybean, NA generalist predator big-eyed bug, S8 predatory mites soybean, NA generalist predator bid predator bid predators and parasitoids sugar cane borer, Diatraea saccharalis sugar cane borer, Diatraea saccharalis sugar cane borer, Diatraea saccharalis bid predators and parasitoids soybean, collards weedy habitat aphids below-ground predators, predators predators predators below-ground predators predators below-ground predators breators breators below-ground predators breators breators breators breators below breators breators breators breators breators breators breators breators breators breatore below-ground predators breators breators breators breators breatore below breators breators breators breators breators breators breatore below breators breatore breators breators breators breators breatore below breators breatore below breators breators breatore below breatore breatore below breatore	Prunus ilicifolia (holly l. cherry)	hover fly (syrphid)	NA	aphid predators	Bugg 93
scabra (Florida pusley) big-eyed bug S8 predators soybean, NA generalist predator fistulosa (goldenrod) big-eyed bug, S8 predators soybean, NA generalist predator bicolor predaceous earwig, predatory mites cassava, grape control fall armyworm bicolor predaceous earwig mover fly weed species sugar cane borer, Diatraea saccharalis sugarcane weedy habitats sugar cane borer, Diatraea saccharalis sugarcane weedy habitats below-ground predators, predators predators predators predators below-ground predators, predators predators below-ground predators	Quillaja saponaria (soapbark tree)	hover fly	NA	aphid predators	Bugg 93
fistulosa (goldenrod)big-eyed bug, 58 predatorssoybean, NAgeneralist predatorhalapensepredaceous earwig, predatory mitescassava, grapecontrol fall armywormbicolorpredaceous earwigcassava, Nicaraguacontrol fall armywormbicolorpredaceous earwigNAgeneralist predatorssugar cane borer flyhover flyNAaphid predators41 weed speciessugar cane borer, Diatraea saccharalissugarcaneweedy habitats52 species, 15 familiesladybird beetles, lacewingNAextra floral nectar52 species, 15 familiesbelow-ground predators, predatorsNAcorn rootworm, others53 species, 15 familiesbelow-ground predators, predatorspeanut, variouscorn rootworm, others54 weetspredatorspredatorssugarcaneweety habitat55 species, 15 familieshadybird beetles, lacewingNAcorn rootworm, others51 species, 15 familiesbelow-ground predators, predatorspeanut, variouscorn rootworm, others52 species, 15 familiesbelow-ground predators, predatorspeanut, variouscorn rootworm, others	Richardia scabra (Florida pusley)	big-eyed bug	soybean	generalist predator	Naranjo, Stimac 87
halapense predaceous earwig, predatory mites cassava, grape control fall armyworm bicolor predaceous earwig redatory mites cassava, Nicaragua control fall armyworm arvensis (corn spurry) hover fly armyworm NA aphid predators sugar cane borer, Diatraea saccharalis sugarcane weedy habitats flowed species, 15 families <sup>2</sup> ladybird beetles, lacewing NA evaluations below-ground predators, predators predators predators peanut, various corn rootworm, others paraitoids proble or control fall armyworm aphid beetles, lacewing below-ground predators, predators predators predators predators predators predators predators below-ground predators predators predators and predators predators below-ground predators predators below for protector peanut, various corn rootworm, others apple orchard best of the predators below for below for the predators below for below for the predators below for the pre	Solidago fistulosa (goldenrod)		soybean, NA	generalist predator	Naranjo 87; Altieri & Let 86
bicolor predaceous earwig cassava, Nicaragua control fall armyworm arvensis (corn spurty) hover fly arga cane borer, Diatraea saccharalis sugarcane weedy habitats betweed species sugar cane borer, Diatraea saccharalis sugarcane weedy habitats losed canopy <sup>1</sup> Predators and parasitoids soybean, collards weedy habitat, aphids c2) species, 15 families <sup>2</sup> ladybird beetles, lacewing NA extra floral nectar below-ground predators, predators predators and perdators and predators and	Sorghum halapense	Ų.	cassava, grape	control fall armyworm	Jones et al 87; Flaherty 69
arvensis (corn spurty) hover fly aphid predators 54) weed species sugar cane borer, Diatraea saccharalis sugarcane weedy habitats losed canopy <sup>1</sup> Predators and parasitoids soybean, collards weedy habitat, aphids 52) species, 15 families <sup>2</sup> ladybird beetles, lacewing NA extra floral nectar below-ground predators, predators predators apple orchard cater idflowers parasitoids apple orchard cater idflowers parasitoids apple orchard cater in the set of	Sorghum bicolor	predaceous earwig	cassava, Nicaragua	control fall armyworm	Jones et al 87
54) weed species     sugar cane borer, Diatraea saccharalis     sugarcane     weedy habitats       closed canopy <sup>1</sup> Predators and parasitoids     soybean, collards     weedy habitat, aphids       closed canopy <sup>1</sup> Predators and parasitoids     NA     weedy habitat, aphids       c2) species, 15 families <sup>2</sup> ladybird beetles, lacewing     NA     extra floral nectar       below-ground predators, predators     peanut, various     corn rootworm, others       parasitoids     parasitoids     apple orchard     caterpillar pests	Spergula arvensis (corn spurry)	hover fly	NA	aphid predators	Bugg 93
<ul> <li>dosed canopy<sup>1</sup> Predators and parasitoids solbean, collards weedy habitat, aphids</li> <li>species, 15 families<sup>2</sup> ladybird beetles, lacewing NA extra floral nectar</li> <li>below-ground predators, predators peanut, various corn rootworm, others</li> <li>idflowers parasitoids apple orchard cater</li> </ul>	Various (54) weed species	sugar cane borer, Diatraea saccharalis	sugarcane	weedy habitats	see: Ali, Reagan 85; Showler 91
(2) species, 15 families <sup>2</sup> ladybird beetles, lacewing NA extra floral nectar below-ground predators, predators peanut, various corn rootworm, others idflowers parasitoids apple orchard caterpillar pests	Various, closed canopy <sup>1</sup>	Predators and parasitoids	soybean, collards	weedy habitat, aphids	Alston et al 91; Horn 81
below-ground predators, predators peanut, various corn rootworm, others idflowers parasitoids apple orchard caterpillar pests	Various (32) species, 15 families <sup>2</sup>	ladybird beetles, lacewing	NA	extra floral nectar	see: Pemberton 93
parasitoids apple orchard caterpillar pests	Various	below-ground predators, predators	peanut, various	corn rootworm, others	Brust 90, Altieri et al 77
	Various wildflowers	parasitoids	apple orchard	caterpillar pests	Leius 67

<sup>1</sup> Weed species in the soybean study included large crabgrass (Digitaria sanguinalis, broadleaf signal grass (Brachiaria platyphylla), fall panicum dichotomiflorum), common lambsquarter (Chenopodium album), redroot pigweed (Amaranthus retroflexus), and morninglory (Ipomoea spp); Beneficials included: the predators Orius insidiosus, Geocoris punctipes, Coleomegila maculata, <sup>2</sup> Also see: Lanza 1993; Agnew et al., 1982; Yokoyama, 1978; Stone et al., 1984; Treacy et al., 1987, for a review see: Koptur, 1992. For an overview of the attraction of several insect groups to and Hippodamia convergens, and the parasitoids from the groups Tachinids (Diptera) and ichneumonids (Hymenoptera). Major weeds in the collard study were pigweed (Amaranthus retroflexus, goosefoot (Chenopodium album), cocklebur (Xanthium strraminium), smartweed (Polygonum spp), purslane (Portulaca oleracea), thistles (Cirsium spp), ragweed (Ambrosia artemisiifolia), and several grass spp.. Beneficials in the collard study included lacewings, beetles, and syrphids (Horn 81).

<sup>3</sup> Weeds and reported beneficials increases as reported by Altieri et al (1977) were: increased predators in cotton with Rumex crispus for control of Heliothis sp.; Increased predators and parasites in floral volatiles see: Dobson, 1994.

cabbage for aphid control in a weed complex consisting of Barbacea vulgaris, Armoracia rusticans, Cardamine pennsylvanica, Lepidium campestre, and Brassica nigra; and increased predators and parasites in brussel sprouts for caterpillar control in a weed complex consisting of Avena fatua, Polygonum persicaria, P. aviculare, Chenopodium album, Sinapsis arvensis, and S. nigrum.

# Table 4. List of insectary mixes sold in California Seed Co. Common Name Scientific Name

#### 'Border Patrol' Mix

Clyde Robin Seed Co. Hayward, CA Baby blue eyes Bishop's flower Black-eyed Susan California buckwheat Candytuft Evening primrose Nasturtiums Strawflowers Yarrow

#### 'Fall-sown' Insectary Mix

Lohse Mill Inc. Artois, CA

Alfalfa Baby blue eyes Brown mustard Carrot Celery Common vetch Coriander Crimson clover Rye Subterranean clover (3-4 varieties) Sweet alyssum Sweet fennel Tidy tips White mustard White sweetclover Yarrow Yellow sweetclover

#### 'Spring-sown' Insectary Mix

Lohse Mill Inc.,

Artois, CA

Buckwheat Cowpea Sesbania Sorghum

#### 'Germain's' Insectary Mix

Germain's Inc. Fresno, CA

Baby blue eyes Birdsfoot trefoil Buckwheat Crimson clover Little burnet Poppy Sweet alyssum Yarrow

#### 'Pacific Coast' Insectary Mix

Pacific Coast Seed Pleasanton, CA

Annu. white sw. clover Annual baby's breath Caraway Coriander Cosmos, white Dwarf white sweet alyssum Fennel Parsley Tall white sw. alyssum Tidy tips White yarrow Yellow sweet clover (Table adapted from Bugg and Waddington 1994) Nemophila menziesii Ammi majus Rudbeckia hirta Eriogonum fasciculatum Iberis imbelatum Oenothera argillicola Nasturtium sp. Helichrysum sp. Achillea millefolium

Angelica sp.

Medicago sativa Nemophila menziesii Brassica juncea Daucus carota L. Apium graveolens Vicia sativa L. Coriandrum sativum Trifolium subterraneum Secale cereale Trifolium subterraneum

Lobularia maritima Foenicum vulgare var dulce Layia platyglossa Sinapsis alba Meliotus alba cv. 'Hubam' Nemophila menziessi Meliotus officinalis

Fagopyrum esculentum Vigna unguiculata Sesbania exaltata Sorghum bicolor

Nemophila menziesii Lotus corniculatus Fagopyrum esculentum Trifolium incarnatum Sanguisorba minor Eschscholzia californica Lobularia maritima Achillea millefolium

Meliothus alba cv. Hubam Gypsophila muralis Carum carvi Coriandrum sativum Cosmos bipinnatus

Lobularia maritima Foeniculum vulgare var. dulce Petroselinum crispum Lobularia maritima Layia platyglossa Achillea millefolium Meliothus officinalis

# Resources

Insectary propagation materials (Plants and Seed)

W. Atlee Burpee & Co. 300 Park Ave. Warminster, PA 18974

Gardens Alive! Highway 48 POB 149 Sunman, IN 47041

Thompson & Morgan Inc. POB 1308 Jackson, NJ 08527

Well Sweet Herb Farm 317 Mt. Bethel Rd. Port Murray, NJ 07865

Whayes End Nursery POB 310 Burgess, VA 22432

Seed Sources of Insectary Plants

Peaceful Valley Farm POB 2209 Grass Valley, CA 95945 916-272-4796

Goog bug blend of clovers, flowers, and herbs

Harmony Farm Supply POB 460 Graton, CA 95444 707-823-9125

Insectary blend of sweetclovers, herbs, and flowers

# Super

# Weeds!!

Studies conducted by Norman Ellstrand indicate that genetically engineered crops that cross-pollinate with wild relatives may result in "super weeds" with herbicide resistance or other superior traits not available in "natural" weed populations. In California weedy species exist as relatives to such crops as asparagus, carrot, and celery.

# **INSECTARY REFERENCES**

- 1. Agnew, C.W. et al. 1982. Influence of cotton nectar on red imported fire ants and other predators. Environ. Entomol. 11:629-634.
- 2. Ali, A.D. and T.E. Reagan. 1985. Vegetation manipulation impact on predator and prey populations in Louisiana sugarcane ecosystems. J. Econ. Entomol. 78:1409-1414.
- Alston, D.G. et al. 1991. Relationship of Heliothis zea predators, parasitoids and entomopathogens to canopy development in soy- 24. bean as affected by Heterodera glycines and weeds. Entomol. exp. appl. 58:279-288.
- Altieri, M.A. 1988. The dynamics of insect populations in crop 25. systems subject to weed interference. pp. 432-451. In: E.A. Heinrichs (ed.) Plant stress-insect interactions. John Wiley. New York.
- Altieri, M.A. and W.H. Whitcomb. 1979a. The potential use of 26. weeds in the manipulation of beneficial insects. HortScience. 14:12-18.
   27.
- Altieri, M.A. and W.H. Whitcomb. 1979b. Predaceous arhtropods associated with Mexican tea in North Florida. Florida Entomol. 62:175-182.
- Altieri, M.A. and W.H. Whitcomb. 1980. Predaceous and herbivorous arthropods associated with camphorweed in North Florida. J. Georgia Entomol. Soc. 15:290-299.
- 8. Altieri, M.A. and D.K. Letourneau. 1986. Vegetation diversity 29. and insect pest outbreaks. CRC Crit. Rev. Plant Sci. 2:131-169.
- Brust, G.E. 1990. Effects of below-ground predator- weed inter- 30. actions on damage to peanut by southern corn rootworm. Environ. Entomol. 19:1837-1844.
- Bugg, R.L. 1993. Habitat manipulation to enhance the effective- 31. ness of aphidophagous hover flies.. Sust. Agr. (Univ. Calif). 5(2),12-15.
- Bugg, R.L. et al. 1991. Cool-season cover crops relay intercropped 32. with cantaloupe: influence of a generalist predator, Geocoris punctipes. J. Econ. Entomol. 84:408-416.
- Bugg, R.L. and C. Waddington. 1994. Using cover crops to manage arthropod pests of orchards: a review. Agric. Ecosys. Environ. 50:11-28.
- Chiverton, P.A. 1989. The creation of within-field overwintering 34. sites for natural enemies of cereal aphids. Brighton Crop Prot. Conf..-Weeds.3:1093-1096.
   35.
- Cicero, Karen. 1993. Making a home for beneficial insects. The New Farm Mag. Vol. 15 No. 2 pp. 28-33.
- Cook, J. 1991. Beneficial insects. Organic Gardening. June. pg. 36. 36-40.
- Cromartie, W.J. 1981. The environmental control of insects using crop diversity. pp. 223-251. In: D. Pimentel (ed.) CRC Handbook of pest management in agriculture Vol.I. CRC, Boca Raton, FL. 37.
- Dobson, H.E.M. 1994. Floral volatiles in insect biology. pp. 47-81. In: E. Bernays (ed.) Insect-plant interactions, Vol. V. CRC. Boca Raton, FL.
- Flaherty, D. 1969. Ecosystem trophic complexity and the Willamette mite densities. Ecology. 50:911-916.
- Gilkerson, Linda and J. Grossman. 1991. The organic gardening 39. guide to important beneficial insects and mites of North America. Organic Gardening Magazine. May/June pg. 46-56.
   40.
- 20. Hoffman, P. and A.C. Frodsham. 1993. Natural enemies of vegetable insect pests. Cornell Univ. Coop. Ext. Serv., 7

Resource Ctr, 7 Business/Tech. Park., Cornell Univ., Ithaca, NY 14850, Tel. 607-255-2080.

- 21. Horn, D.J. 1981. Effect of weedy backgrounds on colonization of collards by green peach aphid, and its major predators. Environ. Entomol. 10:285-289.
- 22. Jones, R.W. et al. 1987. Activities and plant associations of the earwig, Doru taeiatum, in a crop-weed habitat. So. Western Entomol. 12:107-118.
- Klassen, P. 1994a. Vineyards in the Clover. Fruit Grower. May. pg. 7-9.
  - Klassen, P. 1994. BIOS-Beyond IPM: A new pest management strategy called BIOS shows great potential in almond orchards. Fruit Grower. May, pg. 12-13.
  - Koptur, S. 1992. Extrafloral nectary-mediated interactions between insects and plants. pp. 81-129. In: E.. Bernays (ed.) Insect-plant interactions.Vol IV. CRC. Boca Raton, FL.
  - Kouric, R. 1992. Flower power. Garbage. May/June pg. 26-31.
  - . Koric, R. 1986. Designing and maintaining your edible landscape-naturally. Metamorphic press, POB 1841, Santa Rosa, CA 95402, 707-874-2606.
- Lanza, J. et al. 1993. Preferences of the fire ants Solenopsis invicta and S. geminata for amino acid and sugar components of extrafloral nectars. Environ. Entomol. 22:411-417.
  - Leius, K. 1967. Influence of wildflower on parasitism of tent caterpillar and codling moth. Can. Entomol. 99:444.
     Naranjo, S.E. and J.L. Stimac. 1987. Plant influences on predation and oviposition by Geocoris punctipes in soy-
  - beans. Environ. Entomol... 16:182-189.
  - Oraze, M.J. and A.A. Grigarick. 1989. Biological control of aster leafhopper and midges by Pardosa ramulosa in California rice fields. J. Econ. Entomol. 82,745-749.
  - Pemberton, R.W. 1993. Observations of extrafloral nectar feeding by predaceous and fungivorous mites. Proc. Entomol. Soc. Wash. 95:642-643.
  - Pemberton, R.W. and N.J. Vandenberg. 1993. Extrafloral nectar feeding by ladybird beetles. Proc. Entomol. Soc. Wash. 95:139-151.
  - Poncavage, Joanna. 1991. Beneficial borders. Organic Gardening Mag. May/June. pg. 42-45.
  - Showler, A.T. and T.E. Reagan. 1991. Effects of sugarcane borer, weed, and nematode control strategies in Louisiana sugarcane Environ. Entomol. 20:358-370.
  - Stone, T.B. et al. 1984. Relationships of cotton phenology, leaf soluble protein, extrafloral nectar carbohydrate and fatty acid concentrations with populations of five predator species. J. Georgia Entomol. Soc. 19:204-212.
  - Thomas, M.B. 1989. The creation of island habitats to enhance populations of beneficial insects. Brighton Crop Prot. Conf..-Weeds.3:1097-1102.
- Treacy, M.F. et al., 1987. Parasitism of bollworm eggs on nectaried and nectariless cotton. Environ. Entomol. 16:420-423.
  - Yancy, C. 1994. Covers challenge cotton chemicals. New Farm. Feb. pg.. 20-23.
- 40. Yokoyama, V.Y. 1978. Relation of seasonal changes in extrafloral nectar and foliar protein and arthropod populations in cotton. Environ. Entomol. 7:799-802.

# Local Extension Activities Second Annual TeleConference for Commercial Vegetable Growers

Over 55 people attended the first two sessions of the 2nd TeleConference for Commercial Vegetable Growers, which has been conducted through the HITS interactive television system in the state. Participants have attended the several sites in the state to learn about 1) Virus cross-protection and a Primer on Nematode Management, on the first session, and 2) Alternative Pest Control Practices for the second session. Time for the presentations, only 1 hour long each, leaves little room for discussions, but the interaction from different sites in the state is really invaluable. Don't miss the next two sessions:

```
Nov. 16, 1994, 9-10 AM:
Weed Control in Vegetable Crops by Dr. Joe DeFrank
Nov. 23, 9-10 AM
Fertilizer Recommendations for Vegetable Crops
by Dr. Joe Tamimi
```

Sites are in Hilo CC, Kona-Ch. 7, Molokai, Maui CC, Oahu Leeward CC, Kauai CC.

**Waimanalo Field Day.** Over 40 people attended the Vegetable Composting Field day in Waimanalo in late June. Short lectures were given on composting, nitrogen fixation, the new soybean rust disease, an update on weed control, and an ono taste panel of basil dishes. The attendants visited the nature farming (organic) demonstration plots, and the ongoing basil composting experiment.

**Poamoho Field Day.** About 30 people showed up for the vegetable field day held at Poamoho in early September. Growers received an update on mosaic virus control, and crossprotection from Dr. Steve Ferreira, and visited the zucchini and daikon variety trials. Daikon growers were especially impressed with 'High Snow' from Know-you seed and have asked about sources of seed (contact Kaigo Inc. at 396-1028 Attn. Ms. Joyce Luh). Know-you seed is sending me a large seed sample of 'High Snow' so let me or Steve Fukuda know if you would like to conduct some on-farm collaborative trials with us. The zucchini varieties showed a range of damage from low to high, from feeding by leafminers and the silver leaf whitefly. Hope

to see you at our next field day!

# ACTION GROUP UPDATE

The Vegetable Action Group met on Oct. 18 in Oahu for the third time this year. The committee received an update from several research projects and updates from DOA on the soybean rust, and other issues. In addition to the normal business items, the several vegetable extension agents that attended presented an overview of what are their views are in terms of future extension needs. Dr. P.Y. Lai and K. Rohrbach, CTAHR Assistant Directors also attended the meetings. Kert Hamamoto, Wendell Koga, and the representatives from the different production areas did an excellent job by providing an opportunity for this dialogue.

# **UPCOMING EVENTS**

Liquid Manure Application Systems Design, Management and Environmental Assessment, 1-2 Dec. 1994, Rochester Marriott Thruway Hotel, Rochester, New York, For information contact Cooperative Extension, 152 Riley-Robb Hall, Ithaca, NY 14853-5701, Tel. 607-255-7654.

California Farm Conference, 26-28 Feb., 1995, Radisson Hotel, Sacramento. Family farming, direct marketing, and ag sustainability. For information contact the Small Farm Center, UC, Davis, CA 95616.

Western Nutrient Management Conf., Salt Lake City, Utah. 9-10 March 1995. Contact: Terry Tindall, Univ. Idaho, Twin Falls, ID 83341, tel. 208-736-3600.

4th National Symposium on Stand Establishment of Hort. Crops, 23-26 Apr.. 1995, Doubletree Hotel, Monterey, CA. Tim Hartz, Dept. Veg. Crops, UC, Davis, CA 95616-8746, tel.. 916-752-7049.

Workshop: Mineral Nutrition of Root Crops in The Pacific. Nuku'alofa, Tonga, April 17-20, 1995. For information contact: Prof. Colin Asher, The Univ. Queensland, Brisbane, O'ld, 4072, Queensland, Australia. Tel. 617-365-2067; FAX 617-365-1188.

An International Training Program in New Crops: Aromatic and Medicinal Plants. 19-30 June 1995, Purdue Univ. Cost is \$1,800. Mr. Tom Robertson, Continuing Educ., Purdue Univ. 1586 Stewart Ctr., West Lafayette, IN 47907-1586. Tel. 317-494-7220, Fax. 317-494-0567.

92nd ASHS Annual Meeting. Montreal Convention Center, 30 July-3 Aug. 1995. R.L. Granger, Res. Station AC, CP-457, 430 Blvd. Gouin St. Jean-sur Richelieu, P..Q., Canada, J3B 6Z8; tel. 514-346-4494.

## STATEMENT OF PURPOSE

The purpose of this newsletter is to update the Vegetable County Extension Agents and Industry Leaders with recent developments in the area of Vegetable Crops Production. Contributions, news bits, and comments are welcomed. Anyone is free to use the information in this newsletter. Whenever possible, please give credit to the authors. The purpose of trade names in this publication is solely for the purpose of providing information and does not necessarily consitute a recommendation of the product.

Hector Valenzuela, Ph.D. Vegetable Crops Extension Specialist Tel. 808-956-7903, Fax 808-956-3894