Using Ecological (ECO Farming) Systems to Suppress Agricultural Pests

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Weeds, insects, and diseases annually cost farmers 30% of their crop and this percentage of crop destruction has held fairly constant ~~stayed the same~~ since the 1940's (Altieri et al., 2005). Monocultures (one crop production systems) are common in agriculture and create conditions under which ~~where~~ pests can rapidly increase in numbers. The soils upon which these monocultures are produced tend to be highly disturbed (i.e. tilled, compacted, eroded, etc.) and are part of the conditions that lead to potential pest problems. Native, undisturbed soils possess a diverse soil flora and fauna (including predators and prey, parasites and hosts, scaveangers, decomposers, and producers and consumers) that interact with one another producing a balance of species. ~~Each soil has a natural ecosystem of diverse microbial species, predators and soil fauna that keep each species in balance.~~ By promoting a healthy soil ecosystem that more closely resembles the natural soil ecosystem, many pests are kept in balance and the economic impacts of these pests are greatly reduced.

Altieri et al. 2005 statesays, "Numerous researchers have shown that increasing plant diversity and thereby habitat diversity favor the abundance and effectiveness of natural enemies. In the old approach, 100% control of pests was the goal but with new ecological methods, the goal is to keep pests at acceptable levels to minimize damage using multiple and natural ecological strategies that is more profitable, safe, and durable." ~~(Altieri et al, 2005).~~

Weeds are considered scavengers of soil nutrients and tend to thrive under disturbed conditions. Farmers promote weed production when they till the soil because they stir the soil and at the same time, bury or replant the weed seed. Tillage also disrupts habitats needed by predator and parasitoid arthropods (e.g. insects, spiders, mites and centipedes) and beneficial plant and animal diseases. ~~When insect and disease predators are diminished, crop insect and disease damage increases in agricultural fields.~~ Most arthropod predators and parasitoids~~insect~~ and beneficial disease~~s predators~~ need a stable soil environment (no-till) with actively growing plants and a food source year round to survive. ~~-~~ When these beneficial organisms ~~insect and disease predators~~ are diminished, crop insect and disease pest damage increases in agricultural fields. To deal with these added insect and disease pest pressures, farmers have become more dependent on pesticides (herbicides, insecticides, and fungicides). As mankind continues ~~starts~~ to rely more and more~~solely~~ on manmade solutions like pesticides ~~(herbicides, insecticides, fungicides);~~, resistant weeds, damaging insects, and harmful disease organisms tend to prosper and ~~-~~ adapt to these products rendering many of them~~se products~~ less effective or useless.

Potential Solutions to Suppressing Agricultural Pests

Adding cover crops to a field may improve weed, insect, and disease management. Cover crops compete directly with weeds for sunlight, energy, and soluble nutrients. Planting an early cover crop in the fall reduces the growth of weeds and may limit seed production. Some cover crops have allopathic effects (e.g. ~~S~~sorghum-~~-~~Sudan-grass, buckwheat, and cereal rye)~~;~~ (Managing Cover Crops Profitably, 2007) on germinating weeds seeds. Brassicas (daikon radish) have a natural herbicide (glucosinolates) that suppresses weed germination, while other cover crops simply grow faster than the weeds and limit weed growth through shading and competition like most cereal grain plants (e.g. cereal rye, oats, wheat, and sorghum-~~-~~Sudan-grass)~~;~~ (Drinkwater and Snapp, Altieri et al., 2005). Some cover~~-~~ crops with long-term no-till provide a mulching effect (e.g. cereal rye, crimson clover, and hairy vetch)~~;~~ (Midwest Cover Crops Field Guide, 2014, Managing Cover Crops Profitably, 2007).

Weed suppression of certain weed species is feasible with cover crops, but it also requires greater attention to additional details for it to be successful. One has to be aware of potential herbicide carry over to cover crop species. Attention to cover crop burndown is important to avoid the cover crop from becoming a "weed" itself. And understanding the limitations of which weeds can be managed by which cover crops.

Farmers should avoid over-~~-~~applying nitrogen (N) to crops because weeds ~~love~~can benefit from the ~~-~~excess N~~nitrogen~~. ~~and~~Excess N is ~~are~~ one major reason why many conventional farmers have more weeds. Excess N~~nitrogen~~ has also been found to reduce a plant's natural resistance to insect pests, since excess nitrogen tends to reduce hormone production, a natural dense used by plants to ward off pests. Also, plant breeders have not always emphasized the selection of natural plant resistance to ~~modern genetic selection has lowered most natural plant defenses to~~ weeds and insects~~,~~ due to a mankind's greater reliance on herbicides and insecticides. Compost, manure, and soil organic matter release nitrogen slowly and may make grain crops less attractive to pests (Altieri et al., 2005).

Many beneficial insects do not thrive under tilled conditions. Cover crops add a number of additional resources to an agricultural system that aid beneficial insects in their survival and success. These additional resources include but are not limited to alternative prey, pollen, nectar, honeydew (sugar-rich insect excrement from piercing-sucking insects such as aphids), greater moisture availability, and physical niches in which beneficial organisms can hide. Beneficial insects need a constant source of food and large stable pieces of residue to survive the winters. Ground beetles (Family Carabidae ~~beetles~~) and lightning-bugs or fireflies (Family Lampyridae) many soft bodied insects (e.g. aphids, slugs, and caterpillars) which may reduce crop yields. A ground beetle may eat its weight in weed seed or insect larvae per day (Altieri et al., 2005).

Many beneficial insects have a four stage life cycle and need flowering plants or nectar as a food source in the summer to complete their cycle. Beneficial insects need alternative food sources,

often from flowering weeds or other nearby plants (Altieri et al., 2005). Planting a flowering cover crop like buckwheat, sunflower, or a flowering legume crops (e.g. sweet clover, crimson clover, and hairy vetch) around the edges of fields or grass waterways improves the population of beneficial insects and may reduce the need for some insecticides. Beneficial insects need nectar throughout the growing season including early spring, mid-summer, and late autumn. Dandelions and/or yellow rocket often bloom early and supply nectar in early spring while ~~G~~goldenrod and wild carrot or Que~~e~~n Ann's ~~L~~lace offer beneficals nectar in late autumn (Altieri et al., 2005).

Biological control is often more effective next to native or wild vegetation rather than in the middle of crop rows due to alternative food sources and refuge in the winter (Altieri et al., 2005). Predacious ground beetles do not disperse or travel far from their food, so large chucks of residue (no-till or permanent cover) are needed for many beneficals to survive (Altieri et al., 2005).

Altieri et al. 2005 offers several management strategies for suppressing insect pests and boosting predators. "Buckwheat and sunflower greatly increase beneficial insects as well as natural pollinators. When summer-blooming cover crops flower early, they allow populations of beneficial predators to surge ahead of pests. When they keep flowering throughout the growing season, they provide constant supplies of pollen, nectar, and alternative prey for beneficial predators. The best flowering plants for beneficial insects are small flowers with relatively open flowers. Mowing every other row of cover crops is a management practice that forces those beneficial predators out of resource rich cover crops into other crops. Reducing the frequency of mowing or the mowing height are two practices that increase beneficial insects. Increasing beneficial insect populations may take up to three or four years" (Altieri et al., 2005). Many of these strategies work well in orchards and vegetable production; however, many organic farmers and ecologically minded farmers are using these practices with success on their corn-soybean-wheat and hay farms.

Most diseases are opportunistic organisms that thrive under monocultures. Multi-species cover crops increase microbial diversity in the soil and may keep disease causing organism populations at a lower level. Most soybean disease such as *Phythopthora, Rhizocotnia*, *Pythium,* and *Fusarium* thrive under wet conditions or compacted soils. If cover crops improve water infiltration and promote better soil drainage, some of the effects of these diseases may be kept in check (Drinkwater and Snapp, 2006). Cover crops promote mycorrhizal fungus and beneficial microorganism which inhibit *Phytopthora, Rhizoctonia, Phythium,* and *Fusarium* disease causing organisms (Amaranthus and Simpson, 2011). Cereal rye and annual rye have been found to have a negative impact on soybean cyst nematodes, reducing their populations severely (Midwest Cover Crops Field Guide, 2014; Managing Cover Crops Profitably, 2007).

Alteri et al., 2005 offers these five suggestions for attracting beneficial predators to fight both insects and diseases. "1) Fields should be small and surrounded by natural vegetation. 2) Cropping systems should be diverse and perennial and flowers plant populations should be in and around the fields. 3) Crops should be managed with a minimal use of pesticides especially insecticides and fungicides. 4) Soils should be high in organic matter and biological activity and during the off season should be covered with mulch or live vegetation. Simple mulches provide habitat for over wintering beneficial predators. 5) Using multiple tactics, rather than one major tactic like a single pesticide, lessens pest damage by reducing the odds a pest will adapt to ecological control measures. The goal of biological control is to hold or suppress a pest, not total elimination since totally removing a pest removes potential food sources for beneficals" (Altieri et al., 2005).

Cover crops along with no-till offer many benefits to growing crops because this system closely mimics Mother Nature and the natural soil ecology. An added benefit of cover crops is that they supply added habitat for wildlife and are pleasing esthetically, because most people prefer looking at green plants over bare soils. Altieri et al. 2005 statesays, "Ecosystems with more diversity tend to be more stable and exhibit greater *resistance* and have the ability to avoid or withstand disturbances or greater *resilience*, or the ability to withstand stress" (Altieri et al., 2005). Healthy soils with vigorously growing plants enable many crops to avoid or ward off many weeds, insects, and diseases because they can outgrow them and they can utilize their natural defenses while poor unhealthy soils tend to do the opposite.

Ecological or ECO farming is a sustainable and economical way to naturally fight pests (weeds, insects, and diseases) while improving the environment. ECO Farming uses continuous no-till or zero-till with continuously living crops on the soil year round (Hoorman, 2013; Hoorman et al., 2012). ECO Farming improves soil health by increasing crop diversity leading to increased predators relative to pests in a crop field and ultimately leads to more profitable, higher and sustainable crop yields.

References

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Understanding Soil Microbes and Nutrient Recycling SAG-16-10

Using Cover Crops to Improve Soil and Water Quality