Engaging the Natural Cycles

Western SARE

Phil Rasmussen, Coordinator
Utah State University
Agricultural Science Building
Room 305
4865 Old Main Hill
Logan, Utah 84322-4865
phone: (435) 797-2257
fax: (435) 797-3344

Professional Development Program

Dennis Cash
Montana PDP Coordinator
Montana State University
235 Linfield Hall
Bozeman, MT 59717-2820
(406) 994-5688
dcash@montana.edu

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Biodesign Farm is developing a production system based on natural nutrient cycles. This includes farm-grown fertilizer and reduced-tillage soil management, conservation water management, biological insect and disease control and weed ecology.

We began farming this land in 1993 using a living mulch system. In this system, clover was planted between crop rows and maintained as an undisturbed cover crop during the growing season. The cover crop, or living mulch, was mowed several times each growing season to control annual weeds and to cycle residues back into the soil on a regular basis. The following spring the clover was tilled in and became the planting bed for the next growing season. We then planted another clover cover crop between the new crop rows. This system provided alternating strips with a clover cover crop every other growing season. Compost was added to the entire field and incorporated every spring. Over 12 years, we observed an increase in soil nutrient levels and soil organic matter as well as increased numbers of predator and parasite insects in the living mulch.

Farmer/Rancher Grant

Title: Agroecosystem Approach to Managing Imported Cabbage Worm

Project Number: FW06-025
Project Coordinator:
Helen Atthowe
Missoula County Extension Horticulturist
2825 Santa Fe Court
Missoula, MT 59808
(406) 258-4205
atthowe@missoulaeduplace.org

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In 2005, we moved to a new field. Our 50-year-old pasture was under cut and seeded to red clover and triticale. A 25- by 600-foot strip of untilled pasture was left as a control. We tested the soil in the tilled and untilled plots two weeks after tilling the 50-year-old pasture. Nitrogen levels doubled in the tilled plots, but phosphorus, potassium and organic matter levels dropped. In 2006, we began minimum and no-till experiments. The minimum-till and no-till plots (3- by 600-foot rows) received compost spread approximately ½ inch deep over the row. The minimum–till plots were then chisel plowed with a single shank chisel plow and rototilled with a 3-foot-wide tiller. The clover was approximately 3 inches tall when it was worked into the minimum -till plots. Untilled clover was left between the crop rows. No-till plots were mowed, flamed to 3- by 600-foot rows and planted. In 2007 we continued the minimum and no-till experiments and added more soil and vegetation management treatments to study weed management and crop competition effects.

NO SPRAYING. In 2006 we studied biological insect pest control in our system, designing an experiment to answer these questions: Can imported cabbage worm (ICW) be managed without the use of pesticides? Can ICW be managed by increasing habitat for predators and parasites?

The experiment evaluated three treatments: unsprayed (control), sprayed bi-monthly with a pyrethrum/rotenone mix (chosen to impact predators and parasites while not targeting ICW) and sprayed with Bt (Bacillus Thuringensis) when ICW larvae reached a threshold level (chosen to target ICW and have little effect on predators and parasites). We evaluated Brussels sprouts, cabbage and broccoli yields and ICW damage.

Our study indicated that acceptable ICW management is possible in a diverse, reduced-tillage production system, without spraying chemicals. Despite high ICW population pressure in July and August, marketable yields of unsprayed broccoli and cabbage were quite high (broccoli = 1,449 pounds/1,300 plants, cabbage = 931 pounds/256 plants). No broccoli or cabbage was deemed unmarketable from insect injury. Brussels sprouts in unsprayed plots produced an 88% marketable crop. Brussels sprouts in rotenone-pyrethrum sprayed plots produced fewer marketable

...continued on page 2

Engaging the Natural Cycles

sprouts (80%). Lower predator population numbers and fewer predator species were found in these rotenone-pyrethrum sprayed plots. These plots also showed a decrease in predator population numbers after each rotenone-pyrethrum spray. Thus, where predator populations were disturbed by spraying rotenone-pyrethrum, ICW damage to Brussels sprouts was highest. On the other hand, where predator populations were not disturbed, Brussels sprouts crop damage was lower. Plots sprayed 8 times with Bt had the least ICW injury – marketable yield was 97%. We found little parasitism of ICW, but instead recorded large numbers of generalist predators whose populations fluctuated over the season. We suspect that this complex of generalist predators contributed to the biological control observed in unsprayed plots. Yields were very good in unsprayed minimum-till plots (where undisturbed red clover grew between crop rows), but were reduced in no-till plots, probably because of the cooler soil temperatures and lower soil nitrogen levels we observed.

NO WEEDING. In 2007 we looked in more detail at nutrient cycling and weed competition in plots with different in-row soil/weed management treatments: no-till, minimum-till, tilled, sprayed with vinegar and mulched with paper (Ecocover). No treatment received fertilizer other than tilled-in clover in April. Untilled clover was maintained between crop rows. The no-till plots were flamed three times. Minimum-till plots received one initial light tillage. Tillage plots were tilled two times and hoed three times (every 5 to 6 weeks). Vinegar and paper mulch plots were tilled once and then sprayed three times with vinegar (every 5 to 6 weeks), or covered with paper mulch. The earliest and the highest yield was in the paper mulch plots, followed by tilled and vinegar plots. Paper mulch and tillage plots had the highest soil temperatures from April through the end of August. They also had the lowest vegetation cover (clover and weeds). Vinegar plots had cooler soil temperatures and more vegetation cover, 50% by August. Soil temperatures were lowest and vegetation cover highest in the no-till and minimum-till plots.

Nitrogen levels were highest early in the season in vinegar and tilled plots and lowest in the no-till plots. This follows what we observed in 2006 when we compared minimum tilled and no-tilled plots. However, minimum-till plots had nitrogen levels higher than in paper mulch plots, and nitrogen levels remained high through August. This was unexpected as we assumed nitrogen levels would be highest where soil temperatures were higher in the paper mulch plots. By July the highest nitrogen levels were in the paper mulch and minimum-till plots. These plots are the highest and next to lowest yielding plots in 2007. So, this year, unlike in 2006, the correlation between total nitrogen levels and yield is less clear.

NO FERTILIZING. When we compared soil tests in minimum-till plots with and without added compost, there was little difference in nitrogen levels. Incorporation of the clover in April provided enough nitrogen for a crop, as long as the competition from other vegetation (in this case clover mostly) was limited. However, the minimum-till plots with compost yielded well despite clover competition, while the minimum-till plots without compost did not yield well. In longer term soil fertility studies, the minimum-till plots and no-till plots have significantly increased in overall nutrient levels. Eggplant and pepper yields in 2007 were remarkably high. Eggplants were planted into rows that were no-till in 2006. Peppers were planted into minimum-till plots. Both were managed as minimum-till with compost addition and black plastic mulch in 2007.

SUMMARY. Our minimum-tillage/living mulch system allows us to avoid insect sprays, because the no-till living mulch row middles provide habitat for early and large numbers of beneficial insects. The system also significantly reduces, and with some crops eliminates, weeding and allows us to cut back or eliminate compost. The no-till living mulch can be managed to provide shade and cooling during hot, dry spells and mowed short to enhance drying and increase ambient air temperatures during cool, wet periods. It also provides a windbreak for seedlings and transplants. However, the permanent living mulch cools the soil more than would bare soil in the spring and can become competitive with the crop. It has also enhanced new pests such as voles. We are still working out the balance between soil fertility and long-term soil health, water needs, insect and disease pests, weeds, soil and air temperatures, labor inputs and crop yield.

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