BIODESIGN FARM REDUCED TILLAGE/LIVING MUCLH VEGETABLE PRODUCTION & WEED MANAGEMENT SYSTEM.

Explanation of Biodesign Farm’s agroecosystem approach.

In 1993, Biodesign farm began developing a high plant diversity, reduced tillage vegetable production system to enhance beneficial insect habitat and mimic natural system nutrient flow. The farm used legume living mulches planted between vegetable rows each spring for 12 years, until 2005. In 1995 and 1996 Biodesign received a WSARE grant to study methods of managing living mulches to enhance weed, insect, and disease management without sacrificing yield. We found more natural enemies, earthworms, and soil microorganisms in plots where living mulches were mowed compared to bare soil (zero-tolerance weed cultivation) plots or lightly tilled plots. In 1997 we began to experiment with minimum tillage, tilling lightly only in the spring and leaving “Biological islands” of undisturbed living mulch from which soil-dwelling natural enemies and soil micro-organisms could “re-colonize” the cropping area. Crop yields and quality remained high. In 2000 we stopped spraying for the last two pests for which we had been treating, Colorado Potato Beetle (CPB) and Imported Cabbage Worm (ICW). In 2004 we decided to experiment with greater in-field vegetation diversity and further reducing tillage. Our goal was to see how much we could reduce tillage and “make-perennial” our annual system. We moved to a new 6 acre field and set up long and short term organic minimum and no-till experiment plots. The new field had been in pasture for 50 years until fall 2004 when we pastured 600 sheep for one month, employing “sheep tillage”. In April 2005 we undercut and turned over the pasture 4”- 6” deep, then disked twice and let it dry out. In May we disked two more times and seeded a cover crop of triticale and red clover. The cover crop was mowed to 3” tall in September 2005. A 600’ by 30’ strip of untilled permanent pasture was left as a control in the center separating two 2.5 acre cover-cropped sections. In the spring of 2006, we mowed and flamed the red clover in our no-till plots and planted Brussels sprouts transplants in double rows into a 600’ by 3’ strip of flamed clover. The row middles were 4-5’ wide and remained as permanent, undisturbed red clover. Broccoli and cabbage were planted in our minimum tillage plots. In these rows, second year red clover was chisel-plowed with a one-shank chisel plow to make 3’ by 600’ rows. The 3’ rows were tilled using a 3’ cultivator before planting. Double rows of transplants were planted in the 3’ beds. Row middles were left in permanent red clover and mowed periodically with a tractor mounted 4’ rotary mower. We compared no-till and levels of minimum-tillage in 2006 and 2007.

ECOLOGICAL WEED MANAGEMENT EXPERIMENTS:

Our studies in 2006 and 2007 indicate that reduced tillage and permanent clover row middles resulted in a trend towards better soil health, decreased labor, decreased annual weeds, reasonable nutrient cycling, and enhanced biological control of pests. However, the least tillage (no-till and one-pass minimum-till options) increased clover cover within the crop row and resulted in lower yields. Lower yields appear to be related to cooler soil temperatures and spatial/nutirent competition. In 2006 the lower yields were also related to lower early season nitrate-nitrogen, but we did not observe this relationship in 2007 when we compared an increased gradation of reduced tillage options. In 2006, we applied compost to our treatments, but not in 2007. In 2007, the only nutrient addition was tilled-in 3 year-old red clover within the crop row. In 2007, lower soil temperatures and lower phosphorus levels were found in treatments with lower yields. There appears to be a relationship between timing and availability of main plant nutrients such as nitrogen and phosphorus, soil temperature, and vegetation cover competition with the crop for nutrients, space, and possibly water. Water was not measured in these studies, but was provided in adequate levels for both the crop and the clover. Our conclusion is that the minimum-till crop row management option with 2 tillage passes in the spring is our most economical option to manage early season vegetation competition and soil cooling in order to increase yields to an acceptable level. Permanent red clover row middles remained weed-
free for 3-4 years. Thus, our “permanent” clover row middle system is probably only effective for 4-5 years in our climate. Still this system saved us labor and clover seed cost over our living mulch system in which we tilled and re-seeded clover each spring. It also resulted in far fewer annual and biennial weeds over time.

ECOLOGICAL WEED MANAGEMENT STRATEGIES AT Biodesign Farm:

1. Weed seed bank management. Without new input to the weed seed bank, it will decrease over time, due to losses from germination, predation, microbial decay, and age-related embryo degeneration (Gallandt, 2006). Permanent living mulches At Biodesign Farm decreased new input to the weed seed bank and resulted in a decrease in annual weeds, but an increase, over time, of perennial, grassy weeds.

2. Living mulch residue addition to soil. In one study, sweet corn yield loss due to wild mustard competition was negatively correlated with the amount of red clover biomass incorporated into the soil prior to planting. The more red clover biomass incorporated, the more early-season suppression of wild mustard occurred (Liebman and Davis 2001). In another study, Ohno et al. (2000) report that inhibition of wild mustard seedling growth by red clover–amended soil was due to phytotoxic effects of the red clover residues. Phytotoxic potential has been well documented for several cover crops, including: cereal rye, hairy vetch and red clover (Haramoto and Gallandt 2004). Dyck et al. (1995) found that crimson clover green manure used as a nitrogen source decreased lambsquarters biomass by 65% and increased sweet corn biomass by 131%. Thick cover crop canopies can also extinguish light cues needed for weed seed germination as well as exuding chemicals that inhibit germination and growth of weeds (Creamer et al., 1996). Properly timed mowing or incorporation of living mulches can disrupt weed growth and weed seed production, reducing weed populations in subsequent crops.

3. Soil health. Biodesign has built healthy soils with increased organic matter. Soil organic matter levels and most nutrients have increased over time. Healthy, high organic matter soils host a greater diversity of soil microorganisms and invertebrates, which can enhance both weed seed decay and predation (Gallandt et al., 1998; Fennimore and Jackson, 2003). In fact, carabid beetles known to be effective weed seed predators were measured in high numbers at Biodesign in a 2006 beneficial insect study.

4. Reduced Nitrogen. Biodesign has managed soils for less nitrogen input over time. There is some evidence that weeds may be more competitive with crops in higher soil nutrient level fields, especially high nitrogen levels (Di Tomaso, 1995). Some studies suggest that low early-season nitrogen levels could result in selective weed suppression (Liebman and Davis 2000).

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Citations


