**WORKING REPORT (YR 1)**

**FNE18-912**
**Effectiveness of Mixed Perennial Groundcovers in Establishing Hazelnut Hedgerow Systems in the Northeast**

**Submitted December 9, 2018**

SUMMARY
This is the first year of a three year study of perennial groundcovers in a hazelnut orchard. Overall we observed a wide spread of several species of groundcovers in the first year that exceeded our expectations. We collected baseline soil chemistry data in May and October and recorded representative growth measurements of the hazelnuts in each repetition of our polyculture treatments in August and October. We also made observations on beneficial insect presence in our trial area in August. Next year we will continue to collect soil, growth, and insect data for comparison.

REPORT FROM 2018
Our first task in early spring was to determine our final list of groundcover species for our research. In our original proposal we had selected eight perennial species with which to design four distinct polycultural treatments, in addition to a treatment using only Dutch white clover (*Trifolium repens*) and a control treatment of woodchips only, for a total of six different treatments. After working with our consultant Dave Jacke, we refined and simplified our experimental treatments to address one of three distinct objectives: 1) Soil/mineral building 2) Beneficial insect/pollinators and 3) Nitrogen-fixers, for a grand total of four treatments including a woodchip control. We briefly considered creating both a "conventional" and "alternative" nitrogen-fixing polyculture but ultimately were unable to identify enough woody perennial n-fixers that would qualify as groundcovers. We elected to direct seed a variety of herbaceous perennial clovers and lupines for our n-fixing groundcover treatment instead.

To design the two primary soil building and beneficial insect polycultures we narrowed down a much larger plant list using the following criteria:
1. Not a sterile cultivar or overly hybridized for use in landscaping
2. Relatively available and easy to acquire from a nursery at an affordable price
3. Must be hardy to zone 5 at least.
4. Anything planted from seed could not need more than 60 days of cold stratification (we only had 3 months before the warm growing season began)
5. Preference for edible plants over similar functioning plants that were not edible i.e. peppermint vs. ajuga mint

Each polyculture also needed a mix of types of groundcovers such as creeping, spreading, clumping, etc., as well as a mix of tolerance to sun and shade, wet and dry conditions.

Our final list was as follows:

**Soil Builders/Mineral Accumulators**

| | |
|---|---|
| Mentha arvensis | field mint |
| Mentha x piperita | peppermint |
| Nepeta mussinii | catmint |
| Symphytum officinale | comfrey |
| Allium schoenoprasum | chive |
| Allium tuberosum | garlic chives |
| Achillea millefolium | yarrow |

**Beneficial Insect & Nectaries**

| | |
|---|---|
| Origanum vulgare | oregano |
| Pycnanthemum spp. muticum | mountain mint |
| Symphyotrichum oblongifolium | aromatic aster |
| Coreopsis verticillata | tick seed |
| Ceratostigma plumbagenoides | plumbago |
| Geranium macrorrhizum | bigfoot geranium |
| Viola spp. | wild violets |

**N-Fixers**

| | |
|---|---|
| Lupinus perennis | perennial lupines |
| Trifolium repens | Dutch white clover |
| Trifolium pratense | Red clover |
| Lotus corniculatus | birdsfoot trefoil |
| Vicia sativa | common vetch |

We were ultimately successful in sourcing everything we selected. To save money we seeded the mints and aster in flats on our farm as they are fairly easy to grow, and we sourced oregano and wild violets from neighbors. We also sourced comfrey divisions from stock we already had growing. All the remaining plants were sourced from a small local nursery, with the exception of three less common species (C. verticillate, C. plumbagenoides, and G. macrorrhizum) which were obtained from a larger nursery.

After designing our polycultural treatments and sourcing our stock, we worked with our Technical Advisor Liz Garofalo on the experimental design of our field layout. Because our orchard is planted on contour, each row is somewhat curved and varies in length from 170' to 440'. This year's hazelnuts were planted in newly dug swale/berm rows #14 and #15 which measured 180' and 420' respectively (for a total of 600 row feet). Originally we had proposed six different treatments in 100' rows (each encompassing 33 hazelnuts planted 3' on center). Instead of planting 100' long rows of each treatment, we redesigned our experimental layout to incorporate treatment repetitions and thus minimize the effect of variables related to existing conditions in our field (i.e. differences in soils, sun exposure, moisture, etc.).

With only four different treatments in our experiment (Soil/mineral builder, Beneficial/pollinators, N-fixing, and control) we shorted each treatment to a 30' row (encompassing 10 hazelnuts planted 3' on center) and randomly repeated each treatment a total of five times over the total 600 available row feet.

Our final field layout is as follows:

North South

| | = 30' |
|---|---|

Row 14 (180')

| S | C | N | P | S | N |
|---|---|---|---|---|---|

Row 15 (420')

| C | P | N | S | P | S | C | N | N | P | S | C | C | P |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

S=Soil/mineral builder
P=Pollinator/beneficial insect
N=Nitrogen fixing
C=Control

The layout of the individual plants within the two primary polycultures ("S" and "P") came out of a few basic considerations: the availability of moisture across the berm, with more water near the base and drier conditions at the top; sun exposure, with more shade developing around and between the hazelnuts over time; and the habits of the groundcovers themselves, as we tried to minimize competition for horizontal and vertical space while still attaining good overall coverage for weed control. We elected to plant a "pattern within a pattern," as in our original proposal by repeating an identical 3' block of plants 10 times over the length of each of the five 30' treatments.

The layout of the primary polycultures is as follows (bird's eye view):

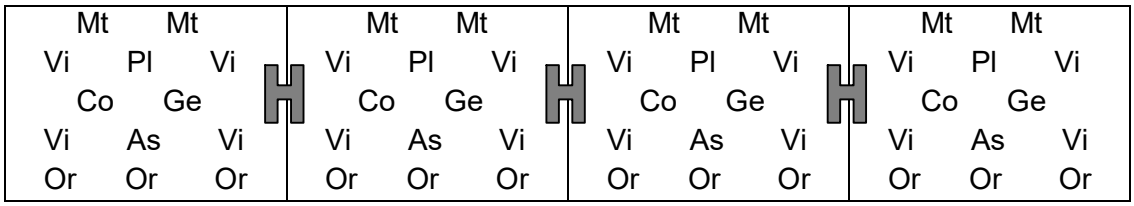
Soil/mineral builder ("S"):

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Pe | | Pe | | | | Pe | | Pe | | | | Pe | | Pe | | | | |
| Ga | | Ca | | Ch | H | Ga | | Ca | | Ch | H | Ga | | Ca | | Ch | H | G | |
| Ch | | Ya | | Ga | | Ch | | Ya | | Ga | | Ch | | Ya | | Ga | | C | |
| Cm | | Cm | | Cm | | Cm | | Cm | | Cm | | Cm | | Cm | | Cm | | C | |

Beneficial insect/pollinator ("P"):

KEY:

As = aster
Ca = catmint
Ch = chive
Cm = comfrey
Co = tickseed coreopsis
Ga = garlic chive
Ge = geranium
**H = hazelnut**
Mt = mountain mint
Or = oregano
Pe = peppermint
Pl = plumbago
Vi = violets




We planted 200 hazelnuts as bare root stock on May 15th-16th, 2018 into freshly dig berms. Prior to planting, we took a single representative soil sample of both rows, and then covered all bare soil with a 2" layer of fresh ramial woodchips. We also soaked overnight and broadcast seeded the nitrogen-fixing species into the N treatment plots and covered with a partially-decomposed layer of woodchip mulch. Later that week we started three flats of catmint, fieldmint and aster seed. Unfortunately the field mint germinated poorly and we were unable to include it in our Soil/mineral building polyculture as we did not have enough plants to distribute.

The following week we received and planted plugs of mountain mint, yarrow, chives, and oregano. At the end of May we received and planted the geranium and coreopsis. Unfortunately the plumbago was backordered and would be not be shipped until mid-July. In early June we obtained and planted wild violets and comfrey. In mid-July we planted out our flats of catmint and aster, along with the plumbago. We also decided to reseed our nitrogen-fixing treatments as germination had been spotty due to a dryer than normal June. Germination was much improved with good rainfall in July. The perennial lupines also did not germinate well when we planted them in May, but unfortunately we did not have any leftover seed to replant.

At the end of July we met again with Liz to determine our precise measurement methods and data collection techniques. We designed a field note template to record:

1) Diameter of primary hazelnut cane at 4" up from ground - to the nearest 1/32 (using calipers)
2) Primary and secondary shoot growth on hazelnuts
3) Number of suckers growing at the base of each hazelnut
4) Goundcover coverage on a scale of 0-5 (0 being unchanged; 5 being complete coverage) on either side of each hazelnut with the tree in the center (a 3' span, 18" on each side). For the control plots, N/A was recorded for coverage.

We collected this data on the middle four hazelnuts in each 30' treatment (#5, #6, #7, #8) to minimize crossover effects of adjacent treatment plots. We also noted other additional observations such as browse or dieback. We opted not at this time to collect hazelnut leaves for a tissue analysis; this will be included in next year's data collection.

Lastly with Liz's help we set out three large yellow sticky cards on stakes in our trial area to collect a sampling of insect specimen. We left them up for a period of five days and then collected and replaced with new cards for another period of five days. Unfortunately during both periods of insect collection we had an abundance of stormy weather and rain which soaked the cards and made it more difficult to precisely ID the insects. We hope to still have enough baseline information to assess changes in insect populations in future years.

At certain intervals throughout the growing season we hand weeded the entire trial area, a task which did become less onerous as the groundcovers grew. The primary weeds we were managing were: wild lettuce, brambles (blackberry, raspberry, dewberry), pokeweed, goldenrod, meadowsweet, buckthorn, bindweed, stump sprouts (birch, maple, oak, cherry), and ferns. In total we weeded five times on June 25, July 9, July 16, Aug 6, and Sept 30 for a total of 20 person-hours.

In early October we again collected measurement data on the hazelnuts using the same methods. A fall soil sample was also collected on Oct. 21st, this time taking two samples at a depth of 6" from the middle of each plot and mixing together the soils from the same type of treatment, for a total of four soil samples (S, P, N, C).

In our study, there are two main variables outside of our control which may have a significant impact on our results. The first is weather; this season started off very dry averaging 5" below normal at the end of June. By the end of August we were seeing water and flooding in our fields far above what we had seen in prior years, including more than 6" of rain in one three-day period, with heavy and frequent rainfall continuing well into the fall. For the most part it appears that the groundcovers were not affected as they were situated high on "raised bed" berms in well drained soil, and may have even benefitted from the ample water supply. Certainly we noted prolific spread and growth of the groundcovers in many of the treatment plots this year.

The second major variable in our study is the enormous genetic variation within the seedling stock of hazelnuts we are growing. Unlike cultivars, these hazelnuts were selected through a multi-year breeding program for high productivity and other desirable traits; however, as seedlings, their exact parentage, growth rate, and developmental characteristics are unknown. Regardless, even if we are not able to correlate hazelnut growth with specific groundcover treatments, we can still assess changes in the soil and make detailed observations about weed suppression and the management of the individual ground covers and the polyculture as a whole.