Objectives

H3) **Native cover crops will survive and reproduce in a working orchard context**. We predict that robust native species that produce large amounts of seed will be able to establish and persist in a working orchard context. We have chosen locally harvested seeds from species that are adapted to environmental conditions where orchards are located. We have also chosen species that are adapted to the savanna-like structural overstory conditions present in orchards. By comparing the survival and reproduction of various native annual and perennial forbs and grasses with that of traditional cover crops (wheat, barley, clover), we will identify appropriate species for use as cover. Our results will be supported if we find comparable cover of natives to cover crops, and if natives reseed and continue to provide cover over time. To carry out this objective, plots established in hazelnut orchards will need to be observed for a minimum of two growing seasons (fall-summer).

H4) **Native cover crops will provide comparable benefits to traditional cover crops**. If natives establish and survive in orchards, we expect they will provide similar or greater levels of soil shading, soil moisture, erosion control, soil building and pollinator attraction as traditional cover crops. To asses these services, we will use percent bare ground as a proxy for shading and erosion control, spring soil moisture monitoring, peak standing biomass to represent potential carbon inputs to the soil, and pollinator surveys. Our results will be supported by comparable or improved levels of each metric.

Methods

Objective 3:

To test whether native grassland species can be used as a hazelnut row cover crop, we established native understory plantings at three orchards in the Willamette Valley. **Considering different orchard ages will help us answer the question whether** **trees of different ages can affect cover crop success through differing levels of competition, shading and leaf litter.** The first orchard, at My Brothers’ Farm, consists of five year old trees and is located in Creswell, OR (near Eugene). The second (Keizer, OR) and third (North Howell, OR) orchards are both owned by the Lane-Masse family. The orchard at Keizer is 60 years old, and the orchard at North Howell is mostly 40 years old, but has a section (two rows) on the edge of the orchard with 15 year old trees. The five year old trees have the most open canopy, followed by the 15 year old and the 60 year old, whose canopy has opened due to pruning and dropping of diseased limbs. In full leaf, the 40 year orchard has an almost completely closed canopy.

Within each age of orchard, we established six blocks (total 24 blocks) approximately 6 m x 18 m. Each block consists of three management-level plots: “no management”, “flailed”, and “flailed + scraped”. These plots are adjacent to each other between two rows of trees, and are bounded by trees at each corner (see attached figure). They represent different levels of orchard floor management intensity from the typical flailing (large-scale mowing/ branch chipping) and scraping (a tractor attachment that floats at a predetermined height and is pulled, leveling and mechanically disturbing the soil) to “no management” where only occasional tractor traffic and harvest sweeping disturb the plot. **With management plots, we will test the compatibility of native cover crops with typical orchard floor farming techniques, and identify which of these is most relevant to their success/failure in establishing and surviving.**

Within each plot, we have established four 2.5 m x 2.5 m sub-plots seeded with different groups of native and conventional cover crop species. **This is to evaluate the potential of different native species as a hazelnut orchard cover crop.** All species were purchased from Heritage Seedlings, the largest local purveyor of native, wild-collected seeds from within the Willamette Valley. Working with local prairie experts, we selected 19 native species: eight annuals forbs, eight perennial forbs and three graminoids (see Table 1). Within each of these functional groupings, we selected species that are common and persist in remnant natural grasslands, perform well in prairie restorations, and establish quickly and reproduce profusely. We selected species that perform well from full sun to partial shade. From these groups we developed four seed mixes: annuals, perennials, unmanaged natives, and industry control (see Table 1, and attached figure). Clockwise from the northwestern subplot, the seed mixes applied are annuals, perennials, true control (no seeds applied), and industry control. We did not seed an industry control in the no management plot, because we decided it would not be relevant in an unmanaged context. Instead, we seeded the “unmanaged natives” mix, which contains all of the annual and perennial forbs, as well as the three graminoids. This was primarily to limit the amount of grasses used (a concern of our farming partners) and to test for competitive/facilitative interactions between annuals and perennials. Each subplot was seeded at 8g/m2, regardless of the number of species in the seed mix. Each species in a mix was seeded at the same rate by weight (i.e. 1g/m2 in annual and perennial mixes) in November 2019.

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| --- | --- | --- | --- |
| Species | Native | Functional group | Seed Mixes |
| Collomia grandiflora | Yes | Annual forb | Annuals, unmanaged natives |
| *Amzinckia menziesii* | Yes | Annual forb | Annuals, unmanaged natives |
| *Clarkia purpurea* | Yes | Annual forb | Annuals, unmanaged natives |
| *Epilobium densiflorum* | Yes | Annual forb | Annuals, unmanaged natives |
| *Gilia capitata* | Yes | Annual forb | Annuals, unmanaged natives |
| *Lotus purshianus* | Yes | Annual forb (legume) | Annuals, unmanaged natives |
| *Plectritis congesta* | Yes | Annual forb | Annuals, unmanaged natives |
| *Sanguisorba annua* | Yes | Annual forb | Annuals, unmanaged natives |
| *Achillea millefolium* | Yes | Perennial forb | Perennials, unmanaged natives |
| *Agoseris grandiflora* | Yes | Perennial forb | Perennials, unmanaged natives |
| *Lomatium nudicaule* | Yes | Perennial forb | Perennials, unmanaged natives |
| *Potentilla gracilis* | Yes | Perennial forb | Perennials, unmanaged natives |
| *Prunella vulgaris* | Yes | Perennial forb | Perennials, unmanaged natives |
| *Viola praemorsa* | Yes | Perennial forb | Perennials, unmanaged natives |
| *Geum macrophyllum* | Yes | Perennial forb | Perennials, unmanaged natives |
| *Eriophyllum lanatum* | Yes | Perennial forb | Perennials, unmanaged natives |
| *Danthonia californica* | Yes | Perennial graminoid | Unmanaged natives |
| *Festuca roemeri* | Yes | Perennial graminoid | Unmanaged natives |
| *Carex tumulicola* | Yes | Perennial graminoid | Unmanaged natives |
| Winter barley | No | Annual graminoid | Industry control |
| Common oats | No | Annual graminoid | Industry control |
| Common vetch | No | Annual forb (legume) | Industry control |
| Climbing pea | No | Annual forb (legume) | Industry control |

Table 1: Selected species, characteristics and seed mixes.

To evaluate the success of each seed mix in establishing, percent cover will be estimated at the end of each month from January to June 2020. At peak biomass, each species success will be evaluated by sampling across each subplot with two line-point intercept transects of 50 hits each, crossing in the center of the plot. We will estimate percent cover of each species, representing its level of success in establishing and surviving the growing season. Without the addition of more seeds, this process will be repeated from January to June 2021 to evaluate the ability of each species to successfully reproduce, resist invasion by weeds, and maintain a viable population over time.

Objective 4:

For our project to be successful, we not only need the native seedlings to survive and reproduce, but also to **provide the intended benefits to the farm and the broader ecosystem**. These include soil stabilization and building, shading and moisture retention, and supporting populations of native pollinators.

Pollinators are a key piece of an interconnected farm-wildland landscape. Many farmed and native plants rely on pollinators to produce or reproduce. While crops can provide forage value for native pollinators, a diversity of native plants provides more diverse food resources, and extends the time when resources are available. We will monitor pollinator visits to subplots planted with different seed mixes in the spring of 2020. Observers will spend 5 minutes in each subplot, noting each visit to a flower by a pollinator and identifying the pollinator with the most precision possible.

Cover crop roots can help anchor the soil, minimizing losses to erosion. To test whether we are successfully **minimizing erosion risks**, we will estimate the amount of bare ground exposed throughout the wet/growing season (January to June 2020 and 2021). Each native seed mix will be analyzed against the industry control and true control (no seeds added).

Hazelnuts (especially young trees) rely on soil moisture being available as long as possible into the spring. In the Willamette Valley, nearly all precipitation falls between October and May, with the majority falling from December to March. By mid-summer, orchard soils can get very dry, prompting farmers to water trees weekly (often by hand). We will install soil moisture probes to test **whether native cover crops increase soil moisture** in the spring through shading the soil. We will measure soil moisture in four locations in each subplot every other week from March to July in 2020 and 2021.

In addition to short-term effects, cover cropping can have long term benefits for the soil, primarily through the incorporation of organic matter containing carbon and nitrogen to the soil. This organic matter increases soil fertility, water holding capacity, and can help resist compaction. We will use standing biomass as an indicator of the level of **soil building provided by our cover crops**. At peak standing biomass (in June 2020/2021), we will clip all aboveground biomass in a predetermined .25 m x .25m square portion of each subplot. Biomass will be dried in a 60 \*C oven for 48 hours and weighed.