# RESEARCH PROTOCOL: SOIL HEALTH & WEED CONTROL
# Updated 2018
# Garlic Mulch Experiment

### Farmer-Researchers
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This document outlines the steps that Ken, Eric and Heather will follow to execute the research trial, *Green Mulch Comparison for Garlic*, including design, execution, data collection and data sharing. It also serves as a Memorandum of Understanding between Ken/Eric/Heather and the EFAO.

### Eric's Experimental Design - Updated April 2018
Eric wants to know:
Does the cover crop make a difference to garlic yield and labour?
What is best way to manage the cover crop?

Eric will be looking at two key response variables: Survival and size breakdown.

In addition to a bare soil control, two different treatments will be tested with this plot size and number of varieties.

1) Oats and garlic planted together the first week of September.
2) Planting of oats (or oat/pea/barley cocktail) in treatment plots the first week of September, followed by mowing in late October prior to planting garlic.

Eric has 6 beds, with three rows each, of garlic, and he plants 6 varieties of garlic across the beds. Given the limited bed space given the scope of the trial (6 varieties, 2 treatments + control), the design is semi-randomized with each variety considered a replicate. Measurements will be based on a response ratio between treatment - control. To randomize the distribution of the largest seed, which are inherently planted first, Eric will follow the following pattern of planting:

Variety: Bed order

| |
|---|
| V1; 6, 1, 4 |
| V2: 3, 4, 1 |
| V3: 5, 6, 2 |
| V4: 4, 1, 3 |
| V5: 5, 2, 3 |

| V6: 2, 5, 6 |
|---|

garlic and cc planted together- T
garlic and cc staggered planting - S
bare soil control - C

**UPDATED OCTOBER 19**

| Bed 1 | | | | Bed 2 | | | | Bed 3 | | | | Bed 4 | | | | Bed 5 | | | | Bed 6 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1A | 1B | 1C | | 2A | 2B | 2C | | 3A | 3B | 3C | | 4A | 4B | 4C | | 5A | 5B | 5C | | 6A | 6B | 6C | |
| V4-T | | | | V6-S | | | | V5-C | | | | V1-S | | | | V1-T | | | | V3-B | | | |
| V2-T | | | | V5-S | | | | V4-C | | | | V4-S | | | | V3-T | | | | V1-B | | | |
| V6-T | | | | V3-S | | | | V2-C | | | | V2-S | | | | V5-T | | | | V6-B | | | |

Note: Eric will divide beds by seed availability for each variety. He will split the seed from each variety into 3 groups (2 treatments + 1 control). For the purposes of depicting the design, the beds are divided evenly into 3 sections. In reality, Eric will fill in with better yielding varieties for for varieties that take up less than ⅓ a bed,  marking where the varieties change in the bed.

**Measurements**

To be recorded on the Data Collection Sheet provided:

1. Eric will note the weed pressure developing in spring, and the date if/when he decides to jump into the patch to hoe. Specifically, Eric will record:
    - Date weeding was necessary
    - Weeding method (e.g. hand pulling, hoeing, etc)
    - Time taken
2. At harvest, Eric will measure garlic yield by counting number of mature heads in size classes, per plot, using his nail board technique. In each plot, Eric will
    - Count all garlic heads planted, record time to plant in each plot - DONE FALL 2017

- Count all garlic heads harvested (survival) as # sprouted
- Count all garlic heads in each size class by:
    1. Prepare labels with plot numbers (refer to map in protocol; e.g. V6-T)
    2. Harvest each plot in labeled bundled of 20-30
    3. Hang labeled bundes in the barn to cure
    4. Working in bundles, as to maintain the label assignment, cut off the stems post-curing (~ 2 weeks after harvest)
    5. Grade the garlic from each plot into the following categories by diameter: XS, Small, Medium, Large, XL, Jumbo. (Diameter below XS is culled); record the number in each category.

***Statistical analysis***
ANOVA comparing the treatments and control.

***Notes***
- The hope is that the oats will provide sufficient dead mulch to suppress weeds in season, however, if weed pressures rise Eric will (hoe?) the whole plot following his standard weed suppression methods.
- PFI project Oat cover crop vs. Straw mulch by Mark Quee suggests that September planted garlic with oats did no better nor worse than October planted.
- Ken used to use just oats. He switched mostly because cocktails are supposed to be better for the soil. He has noticed that oats and barley just grow better together. Peas have a relatively low nitrogen contribution. He suggests oats or a cocktail would have very similar spring/winter biomass and neither are sufficient for season-long weed control the following summer. So you get to choose, we'll suggest oats alone since that's what you're used to!
- Ken says oats are very sensitive to planting, and he never plants them after the first of September. If planted in mid-august, the oats risk going to seed. First week of September leaves 8-10" growth for garlic planting in the first week of October.

**Materials and Research Expense Budget**. Prices are approximate; NA or in-kind for any materials that you already own or have access to. Please indicate if you intend to give any of the supplies to EFAO's Tool Library for others to use after you are finished with them.

| **Material** | **Quantity** | **Unit** | **Total Cost** | **EFAO's Tool Library (Y/N)** |
|---|---|---|---|---|
| Cover crop seed (oats) | | | ~ $10 | N |
| Total | | | ~ $10 | |

## Deadline for data and photo submission:
October 31, 2018 or earlier if possible

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## Ken's Experimental Design - COMPLETED in 2017

Ken will compare standard spring management (cultivating between garlic rows) to a cover crop treatment (spelt, a fall cereal planted between rows) and a dry mulch treatment (straw mulch between rows). Ken planted the same variety of garlic throughout and he planted all garlic no-till into a cover crop of oats/peas/barley.

The field is set-up in 15 rows x 176'. The field will be split into 15 test plots, each 60' long and spanning 3 rows each for ease of applying the straw mulch, cover crop seed, and cultivating. This results in a *randomized complete block design* with 5 replicates.

### *Measurements*

Management time for each treatment including time mulching, planting cover crop seed, cultivating.

1) At harvest, a count of # of fresh heads in each test plot will be recorded along with the total weight of garlic (greens included, dirt knocked off as much as possible). This will give an average weight per plant in each test plot. Ken and crew usually tie up garlic in bunches of 10 for drying, which will facilitate counting of garlic in the field. They will keep garlic from each test plot separate for counting. Garlic will have to be hand harvested.
2) Alternately, at harvest, a count of # of heads of garlic in different size classes (seed, CSA, bad) could be recorded by test plot.

### *Predications*

Ken predicts that the yields will be highest on average in the straw mulch beds, followed by cultivated (control) beds, and that green mulch will have smallest heads. Production time, however, will be greatest in the straw mulch beds, second in the cultivated beds, and lowest in the cover cropped beds.

Straw mulch will give increased growth due to water conservation, and no cultivation time will be needed (however, mulching time will be recorded per test plot). Cultivated beds, which are free from competition, will be slightly smaller due to water stress. Green mulch plots will have to compete with the spelt for nutrients and water, but there will only be a small reduction in production with much less cultivation time and better soil quality.

Control (Bare Soil, Cultivated)
Dry Mulch (Straw)
Cover Crop (Spelt)

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

| | | | | | |
|---|---|---|---|---|---|
| 60' | | | | | |
| 60' | | | | | |
| 60' | | | | | |
| | Block 1 | Block 2 | Block 3 | Block 4 | Block 5 |

***Statistical analysis***
ANOVA (analysis of variance) with complete block design.

***Further details***

- This experiment assumes that the fresh weight of the garlic including greens is a good reflection of yield (dry saleable/plantable heads).
- In an extraordinary circumstance, Ken would irrigate his garlic with overhead sprinklers that wet a 60' circle, and are 6 or 7 in a line with lines placed at 30'. Because of the small size of the patch, watering would not be even across the beds. Since harvest is in mid-July, Ken hasn't had the need for irrigation in the past (not even 2016) so he doesn't foresee needing it.
- Mulches (dry or green) may affect scape timing by encouraging the plant to continue vegetative growth for longer due to increased soil moisture. Something to observe as scapes start to emerge, and check to see if scape production per test plot should be recorded (if it appears there's a substantial effect on timing).

## Research Expense Budget

- Hay: 44 bales @ $4 = $176
- Winter Wheat Seed: 10lb @.25/lb = $2.50
- Flags: $22

Total Approved Budget: $200.50

- Additional research expenses pending approval

## Heather's Experimental Design - COMPLETED IN 2017

***Research Question***
Does a white clover cover crop planted in our garlic beds (May-July) lead to better garlic yields than our standard bare soil beds?

White Clover will be used as a cover crop, seeded in spring after two passes with hoes to limit weed seed bank pressure. Pathways (very narrow) will be cultivated on all beds. Control will be full hoeing of beds.

The experimental area consists of six 250 foot beds of two rows each, all planted with Fish Lake garlic. For the experiment, beds will be considered blocks; treatment or control will be assigned randomly to either the northern or southern end of the bed for a *randomized complete block design with 6 replicates*.

Cover Crop
Control

| Bed/Block | 6 | 5 | 4 | 3 | 2 | 1 |
|---|---|---|---|---|---|---|
| Plot | F | E | D | C | B | A |
| 125' | | | | | | |
| Plot | L | K | J | I | H | G |
| 125' | | | | | | |

***Prediction***
Heather and Steve predict that a white clover cover crop in season will improve the garlic yield when compared to bare soil around the crop.

***Predicted Mechanisms***
They anticipate that cover cropping will lead to increased soil moisture and retention, allowing garlic to be actively growing better throughout the growing season. There may also be a nutritional benefit of nitrogen from the clover within the season. They are also hoping that the cover crop presence will not increase nematode damage, which would reduce yield.

***Measurements***
Heather and Steve will measure garlic yield by counting number of mature heads in each of three size classes per plot on harvest, using holes cut in a plastic lid for simple sizing. If size classes aren't ascertained due to timing during harvest, they will keep yields from each plot SEPARATELY and ENTIRELY until such recording is possible.

- Record weight of clover seed used per patch as a seeding rate proxy.
- Observations in season will be noted down, with dates.

***Other notes***

- Green garlic will be harvested from a seventh bed, not included in the experiment.
- Beds will be irrigated, with one line of drip down each row of Garlic. All beds will be irrigated simultaneously, as needed.
- If weed pressure in cover cropped beds (not the clover, but other weeds) threatens to shade out the garlic, a line-trimmer will be used to knock back the majority of the weeds a few inches off the ground which should leave the clover intact. Timing will be recorded if this technique is used.

## Research Expense Budget

$ 0 Field stones to mark plot boundaries
$ 10 White clover seed (from a bag we have)
$ 20 Hand held broadcaster from canadian tire
$ sorting or weighing equipment, none foreseen as needed

- Additional research expenses pending approval

## Acknowledgements

We thank members of the Advisory Panel, Jason Hayes, Rebecca Ivanoff, Ken Laing, Annie Richard, Darrell Roes and Dr. Ralph Martin, for their thoughtful input that helped guide the design of this trial.

## Memorandum of Understanding

Please refer to **efao.ca/research-mou** for Memorandum of Understanding.

## Contact

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