RESEARCH PROTOCOL: SOIL HEALTH & WEED CONTROL 2018
Comfrey as a Companion Plant for Saskatoon and Black currant

Farmer-researchers

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This document outlines the steps that Pat, Ivan and Arthur will follow to execute their multi-farm research project, *Comfrey as a Companion Plant for Saskatoon and Black currant*, including design, execution, data collection and data sharing. It also serves as a Memorandum of Understanding between the farmers and EFAO. This project is a continuation of Pat's 2017 research project.

Background and motivation

More research is needed to determine the practicality and effectiveness of perennial cover crops in Ontario. Cover crops and soil health are critical components of ecological and profitable farming. Cover crop practices and research continue to generate considerable innovation and research. This is usually in the context of row cropping systems (see, for example, the Ontario Cover Crop strategy). Internationally, some research is becoming available on long-term cover crops for perennial cropping systems as well (e.g. orchards, vineyards, and other fruit and nut production). However, there has been little research to date on the effectiveness, practicality and ecological benefits of perennial cover crops in the Ontario context.

Horticultural advice for vegetative cover between rows of perennial crops tends to focus on planting grasses (e.g. fescue), and using herbicides to prevent competition and maintain the highest possible yields (sources of such advice include OMAFRA and University of Guelph fact sheets, and growing guides from nurseries). In an organic context, continuous cultivation (i.e. bare soil) has been shown to result in the most vigorous vegetative growth in vineyards (Olmstead, 2012) and highest fruit yields (PEI Horticulture Association 2010).

For many ecological farmers, continuous cultivation and bare soil are unacceptable risks for soil erosion and loss of soil organic matter. The remaining options are to use cover crops or mulch for weed suppression. Mulches are expensive, labour intensive and the sustainability of plastic mulches is debatable.

Perennial cover crops are selected for this research project because of the ecological benefits they may provide, as outlined by previous research (e.g. Larsson 1997):

- They retain mobile nutrients and bring immobile nutrients to the active soil surface
- They accumulate biomass and help to feed soil microbial activity while moderating soil temperature and moisture

- Cover crops compete with and suppress weeds without the need for herbicides or tillage, while providing a source of additional nutrients in the case of some legumes and companion plants.

There are challenges in the use of cover crops in perennial crop production. For example, there is ongoing uncertainty about the effectiveness of organic mulches in fruit production in the following areas:
- Some cover crops compete for nutrients. Grass cover is known to decrease fruit yields by 25% on average (PEI Horticulture Association 2010).
- Many soil and nutrient benefits would only accrue over many years (e.g. increased soil organic matter)
- Depending on the farmer`s context, other forms of nutrient delivery and weed suppression may be more effective or economical in terms of typical farm material available (e.g. manure) or the farmer's time (e.g. tillage may be faster or take less planning in the short term than establishing cover crops).

To avoid the challenges above, perennial cover crops for fruit crop production must therefore perform well as long-lived `companion plants` that feed fruit-bearing plant nutrients, avoid shading or competition, enhance soil health and suppress weeds. In other research, additional co-benefits may also be observed such as pollinator attraction, pest deterrence, soil biotic diversity, fruit taste and nutritional content, and economic by-products from the cover crop.

This research has now expanded to include three farms, and there are four other farms interested in possible participation in the research in future. Organic fruit production is a growing area of interest in Ontario as competition from lower priced conventional products from the US and beyond drives Ontario farmers to differentiate their product. Companion plants are likely to be an attractive ecological management choice if they can be proven to be effective.

Challenges may involve comfrey's reputation as being difficult to control or eliminate; it is a prolific seed producer and readily spreads when roots are disturbed. Practical experience through this research will help to address this concern. Bocking 14 is a seedless variety of comfrey that can be used to address this. Further, Pat observed that comfrey is not spreading uncontrollably on her farm (possibly due to competition with grass).

In year 1, Pat observed that it might be desirable to plant a low-growing variety if the comfrey is going to be planted directly next to the fruit-bearing plant (avoiding mildew issues from lack of air circulation, avoiding shading, etc.) Dwarf comfrey does exist but may not provide the same nutrient accumulation benefits and may not be possible to find in time for spring 2018.

Crop details
Amelanchier alnifolia (Saskatoon berry) and *Ribes nigrum* (black currant) are known to be reliable berry producing species in organic production in Southern Ontario's climate. These

species are selected as appropriate for this research because they are able to produce fruit in low-input, low-maintenance ecological farming systems. Saskatoon is a moderate-cropping plant with corresponding moderate nutrient needs. Blackcurrant is a heavier cropping plant with higher nutrient needs. Future research would also be useful on the highest nutrient demanding species such as stone fruit and nut trees.

Symphytum officinale (Comfrey) is a well-known nutrient accumulating plant grown as green mulch and a companion plant. It is frequently promoted as one of the best companion plants for 'chop and drop' fertilizing in permaculture and forest gardening literature (e.g. Crawford 2010). Rigorous research has long been available to demonstrate the potential of comfrey as a nutrient source comparable to many legumes and annuals (Hill 1975). Accordingly, comfrey is selected as the experimental treatment for this research.

Experimental Details

Predictions

Pat, Ivan and Arthur predict that by the third year of this research, fruit production and vegetative growth will be higher in plants provided with comfrey companion plants (root divisions) compared to the control treatment (no fertilizer).

Design

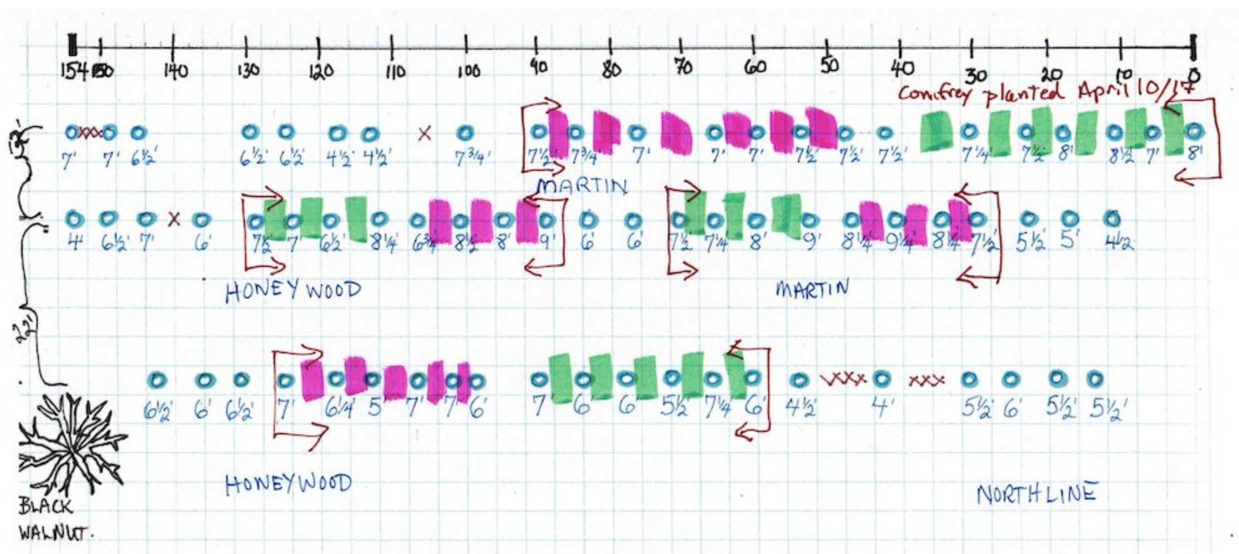
Based on their observations, the farmer-researchers decided on a sample size of four plants as representative of the variation among all plants of the variety. Plants that are small, diseased or uncharacteristic in some other way were excluded from the study.

	Pat	Arthur	Ivan
Design	3 replicates x 2 treatments with 4 plants per group = 24 Saskatoon total	3 replicates x 2 treatments with 4 plants per group = 24 Black currant total	3 replicates x 2 treatments with 4-6 plants per group = 30 Black currant total
Control	Low grass with no comfrey plants and no other fertilizer.	Low grass with no comfrey plants and no other fertilizer.	Tarp for weed control and no other fertilizer.
Treatment	Comfrey planted in between berry plants and allowed to die naturally. Allowed to spread naturally	Comfrey planted in between berry plants and allowed to die naturally. Allowed to spread naturally	Comfrey planted between plants, beside the tarp, allowed to die naturally. Allowed to spread naturally.
Notes		All black currant plants in this project are the 'Blackcomb' variety. Currant bushes are two	All rows are all silage tarped 4' each side with a running gap down the middle where Ivan

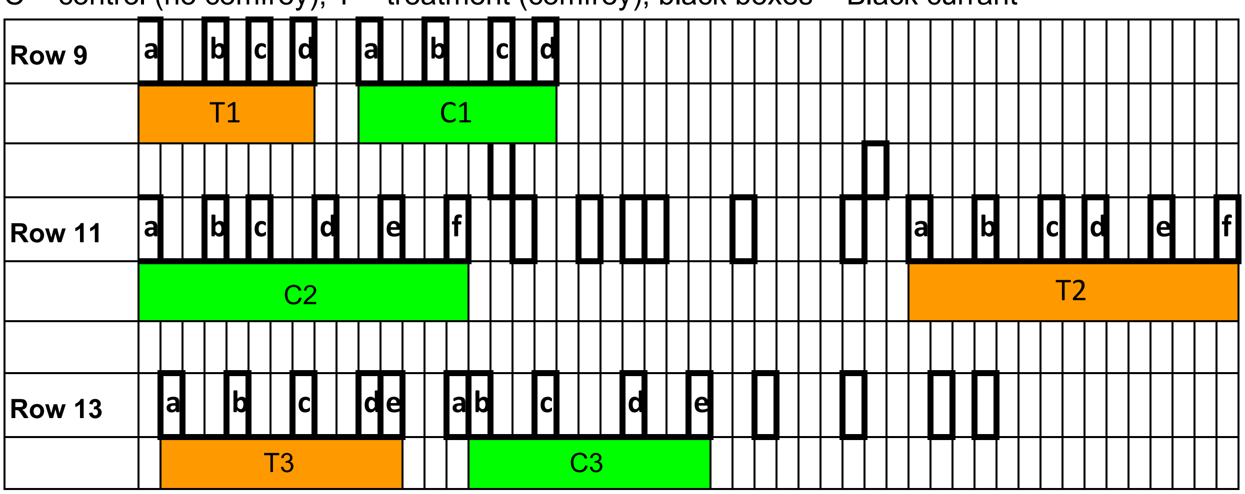
		years old, planted 16 inches apart in rows (aisles between rows are 14 feet). Most plants have two-four branches as of year 1.	usually cardboard and/or interplant with a herb.

The following images outline the experimental site design for the research at each farm. Note that the location of control/treatment pairs has been randomized.

Babalink Farm (Pat) Experimental Site Design
Pink = control (no comfrey); Green = treatment (comfrey)

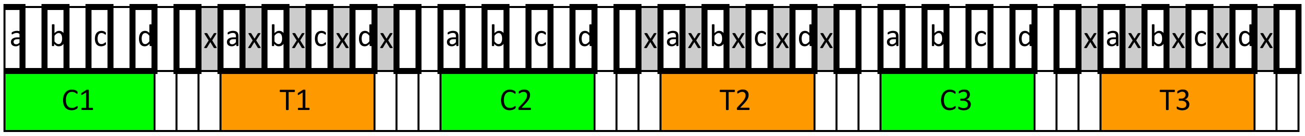


Eden in Season (Ivan) Experimental Site Design
C = control (no comfrey); T = treatment (comfrey); black boxes = Black currant



Eramosa Currants (Arthur) Experimental Site Design, Row 1

C = control (no comfrey); T = treatment (comfrey); c = location of comfrey; black boxes = Saskatoon or Black currant; grey boxes with x's = comfrey



Treatment details
Farmer-researchers will plant one comfrey plant on either side of each fruit-bearing plant. This number of comfrey plants is sufficient for nutrient needs of a black currant or Saskatoon bush, based on Crawford (2010). Note that Dale and Schooley (1999) recommend 175 to 225 g of 10-10-10 fertilizer per mature bush. The fertilizer equivalent of comfrey may be assessed based on weighing and leaf matter tests, or may be approximated if studies are found. Comfrey may be allowed to die naturally or chopped and dropped around the time of flowering once in year 1 and twice in years 2 and 3.

Propagation of comfrey for treatments: Dig up a pile of 20 root divisions and get them in the ground quickly. As the comfrey breaks the surface in the spring it is still mostly dormant (late March-early April). It adapts really well to replanting at this stage. Arthur will likely source from Pat and Ivan may try to get Bocking 14 from Brad Peterson as well. Roots will be planted halfway between plants in the row of treatment plots.

General management
The farmer-researchers intend to avoid pruning the Saskatoon and black currant plants during the three years of the study; and record pruning management if pruning is needed. Weeds around establishing comfrey and black currants may be an issue on Arthur's farm. Arthur will mow weeds with the grass in the same way in control and treatment plots. Some weeds will be handpicked around comfrey and black currant plants as necessary.

Emergency management
Comfrey is difficult to kill, as it can form roots six feet deep and is readily spread by cutting roots. In the event that comfrey spreads too rapidly and has unexpectedly negative effects on berry plant yields or growth, plastic mulch can be used to suppress further comfrey growth.

Measurements
Priority measurements include **soil tests**, **woody measurements in May and October**, critical **phenological dates** and are labeled in **green**.

April: **Soil tests** in first year only will provide basic SOM, P, K, and pH for comparison across study sites (S1B package from A&L, which includes Organic Matter, Phosphorus, (Sodium Bicarb and Bray 1), Potassium, Magnesium, Calcium, Sodium, (Ammonium acetate), soil pH, Aluminum, Saturation of Cation Elements including Sodium, calculated C.E.C. saturation %P, %K/Mg ratio). For each replicate plot (6 per farm):

- **Supplies needed**: Soil corer (standard, 2.2 cm diameter); 6 Ziplock-style bags, permanent marker
- Pre-label bags with the plot ID, your last name, EFAO and year
  - Example: T3, Churchyard, EFAO 2018
- Before you start in a plot, take a “dummy core” to clean the auger, which is simply a core from the plot that is discarded.
- After the dummy core, take 10 cores (2.2 cm x 15 cm or 6 inches) haphazardly throughout the plot, in a way that the cores are representative and do not include rocks or large roots.
- Combine the 10 cores in the pre-labeled bag; you should have 1.5-2 cups worth of soil in each bag.
- Package all bags (6) into an appropriately sized box
- Mail to:
- Email Sarah to notify her that you’ve sent them
- **Sarah will email you a submission form to print out and send in with your samples**

May: In each year, the farmer-researchers will take **woody measurements** :
- Height of each plant and number of shoots
  - Pat’s method for measurements: Using a long pole marked with feet with inches at the top, Pat measured the length of the tallest shoot, straightening out any drooping branches (as a measure of growth)
- Diameter at the base (i.e. cluster of stems) using caliper

July: In each year, the farmer-researchers will measure height of comfrey at time of blooming. Count number of stalks per cluster (a cluster is a group of comfrey between two saskatoons/currants). This measurement will approximate the amount of comfrey being added, to compare across sites.

June (Saskatoon); **July** (currant): In year 3 only, farmer-researchers will measure total amount of fruit picked in each of the replications; leaf analysis in first two weeks of July as per McGinnis 2012 testing recommendation, funding and plant size permitted.
- For leaf analysis: Collect a total of ~ 100 leaves from each treatment and control plot. Mature mid-shoot leaves should be selected for analysis. Leaf analysis will measure N, P, K, Mg, Ca for comparison.

October: **Woody measurements**: height and number of shoots.
- Height of each plant and number of shoots
- Diameter at the base (i.e. cluster of stems) using caliper

Monitoring Parameters, see **Data Collection Sheet**
- Temperature logging to compare observations across study locations
  - Farmer-researchers will either log daily temperatures on their farms or take daily temperatures from the nearest weather station.

- **Dates: budding, flowering, harvest date for each variety**
- Method, timing and development of comfrey at management, e.g. chop and drop or senescence. If the system is not chop and drop, then measure height and width at flowering.
- Soil moisture records bi-weekly (or monthly)
- Soil test results for calibrating results across sites
- Brix (Pat)
    - See reference below for info on challenges measuring Brix, and comparing across farms.
    - https://ohioline.osu.edu/factsheet/HYG-1436
- Beneficial companion plants and insects may be observed. Resilience to weather events, pest pressure, animal damage, flooding, drought, freezing, etc. may also be observed.

Statistical test
Analysis of variance (ANOVA) for each farm and a mixed-model factorial ANOVA to test differences between farms and across years.

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)
Digital Soil moisture meter	3	$60	$180	Y
Soil test: organic matter, pH. Initial test also establish in-ground P and K.	3 farms x 2 treatments x 3 replicates x 1 year = 18 tests	$40	$480	N
Shipping for soil samples	3	$30	$90	B
Caliper	3	$20	$60	Y
Total			$810	

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

References

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Olmstead, M., Miller, T.W., Bolton, C.S. and Miles, C.A. 2012. Weed Control in a Newly Established Organic Vineyard. Horticultural Technicology. December 2012, 22(6).

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Memorandum of Understanding

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

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