

Organic Agronomy Training

Dr. Martin Entz – University of Manitoba

Lesson 5

Questions & Answers



Organic Agronomy Training

This training was developed and delivered by Martin Entz, PhD, Department of Plant Science, University of Manitoba. It is intended for private and public sector agronomists who want to respond to the growing demand from producers for more information about organic grain production. Grain farmers considering a transition to organic or current organic practitioners who want to learn the theory and latest science will also find the course valuable. The course was designed with the Prairies in mind, however agronomists in other ecoregions will learn universal principles of organic production.

The training consisted of five 75 minute live online sessions over two weeks in January 2023:

- January 5: Designing Cropping Systems with a Focus on Nutrient Management
- January 6: Crop Establishment and Seeding Systems, Tillage and Weed Control
- January 10: Pest Management with a Focus on Disease, Insects (and Weeds)
- January 12: Soil Management for Organic Production: Putting Theory into Practice
- January 13: Question & Answers

All course content (lesson recordings, presentations and notes) can be accessed on pivotandgrow.com.

The Organic Agronomy Training was developed as part of the Prairie Organic Development Fund's Canadian Organic Ingredient Strategy.

The Canadian Organic Ingredient Strategy was funded by:



Lesson 5 - Questions & Answers

Participants in the live online sessions for Lessons One to Lesson Four were encouraged to ask questions in the chat function and/or email questions to the training organizers with the understanding that they would be answered by Dr. Entz in Lesson Five. This document contains Dr. Entz's written responses to all of the questions received throughout the training and the conversation between participants and training organizers.

Designing Cropping Systems with a Focus on Nutrient Management January 5, 2023

1. How can one avoid disease in pulse crops, with pulses in rotation on sort intervals: How long should the interval be between pulse crops or green manures?

A. Let's focus on *Aphanomyces* in peas (also called root rot)

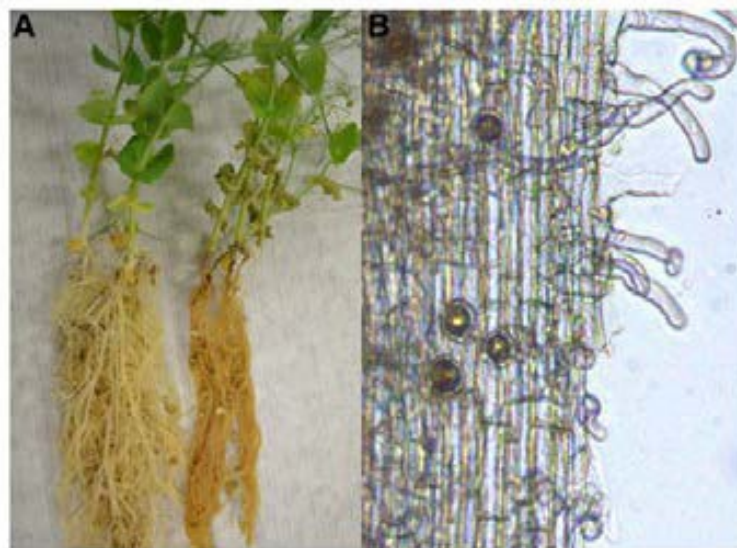


Fig. 5. Root rot symptoms (healthy plant on left) of field pea caused by *Aphanomyces euteiches* (A) and oospores (B) in infested roots.

Plant Disease / October 2016

Banniza, S., Phelps, S., Chatterton, S., Hubbard, M. and Ziesman, B., 2020, March.
Rethinking pulse crop production in the era of *Aphanomyces* root rot. In *Soils and Crops Workshop*.



Syama Chatterton

Agriculture and Agri-Food Canada

Verified email at agr.gc.ca

plant pathology root diseases oomycete



Old European textbooks indicate *Aphanomyces* susceptible crops (peas mainly) should only be grown every 6 years. In Canada, recommendation is every 4 years. “Fields diagnosed with *Aphanomyces* should be cropped to peas only once every 7-8 years to reduce inoculum levels in soil and avoid yield loss from this disease”. Manitoba Pulse and Soybean Growers <https://manitobapulse.ca/production/field-pea-production/seeding/>

B. Rotate susceptible (peas, lentils) with non-host legume species (or varieties)

| Species | Grau et al. Plant Disease 1991, 75 (11), 1153-1156 | Chatterton 2020 (AAFC Lethbridge) |
|---|--|-----------------------------------|
| Arrowleaf clover (<i>Trifolium vesiculosum</i>) | R | |
| Aslike clover (<i>T. hybridum</i>) | R | |
| Berseem clover (<i>T. alexandrinum</i>) | S | R |
| Bird's-foot trefoil (<i>Lotus corniculatus</i>) | R | |
| Chickling vetch (<i>Lathyrus sativus</i>) | | S |
| Cowpea (<i>Vigna unguiculata</i>) | R | |
| Crimson clover (<i>T. incarnatum</i>) | S | S |
| Crown vetch (<i>Securigera varia</i>) | R | |
| Ebena vetch (<i>Vicia sativa</i>) | | S |
| Faba bean | S | |
| Field pea | S | |
| Garden pea | S | |
| Hungvillosa vetch (<i>Vicia villosa</i>) | | S |
| White Dutch/Ladino clover (<i>T. repens</i>) | R | R |
| Lima bean (<i>Phaseolus lunatus</i>) | S | |
| Lucerne/alfalfa (<i>Medicago sativa</i>) | S | |
| Lupine (<i>Lupinus</i> spp.) | R | R |
| Persian clover (<i>T. resupinatum</i>) | | Maybe S |
| Red clover/Sweet red clover (<i>T. pretense</i>) | S | R |
| Snap bean (<i>Phaseolus vulgaris</i>) | S | |
| Soybean | R | |
| Subterranean clover (<i>T. subterraneum</i>) | | R |
| White sweet clover (<i>Melilotus albus</i>) | S | |
| Yellow blossom/sweet clover (<i>M. officinalis</i>) | | Maybe S |

Crop Choices: Hosts for Aphanomyces

| Crop | Disease reaction | Oospores |
|-----------------|------------------|----------|
| Pea | Susceptible | Yes |
| Lentil | Susceptible | Yes |
| Cicer milkvetch | Susceptible | Yes |
| Dry bean | Variable | Few |
| Alfalfa | Variable | Yes |
| Chickpea | Resistant | Few |
| Sainfoin | Resistant | Few |
| Faba bean | Resistant | No |
| Soybean | Non-host | No |
| Fenugreek | Non-host | No |

Source: Dr. S. Chatterton, AAFC & Dr. S. Banniza U of S

Gossen, B.D., Conner, R.L., Chang, K.F., Pasche, J.S., McLaren, D.L., Henriquez, M.A., Chatterton, S. and Hwang, S.F., 2016. Identifying and managing root rot of pulses on the northern great plains. *Plant Disease*, 100(10), pp.1965-1978.

From France...

Aphanomyces root rot affects pea, lentil and susceptible varieties of vetch and fababean. Lupin, clover, alfalfa and resistant varieties of vetch and fababean are not nearly as susceptible. Thus, according to the present results, pea, lentil and susceptible cultivars of common vetch and faba bean should be avoided in infested fields whatever the level of IP. Conversely, lupin, clover and resistant cultivars of vetch or faba bean can be grown in these infested fields.



c. Inclusion of Brassica's in rotation (or in intercrops) can reduce pea root rot.

Precropping with oat or Brassica green manures (reviewed by Hossain et al. 2012) have shown potential for reducing severity (Fritz et al. 1995; Hossain et al. 2014; Smolinska et al. 1997; Williams-Woodward et al. 1997).

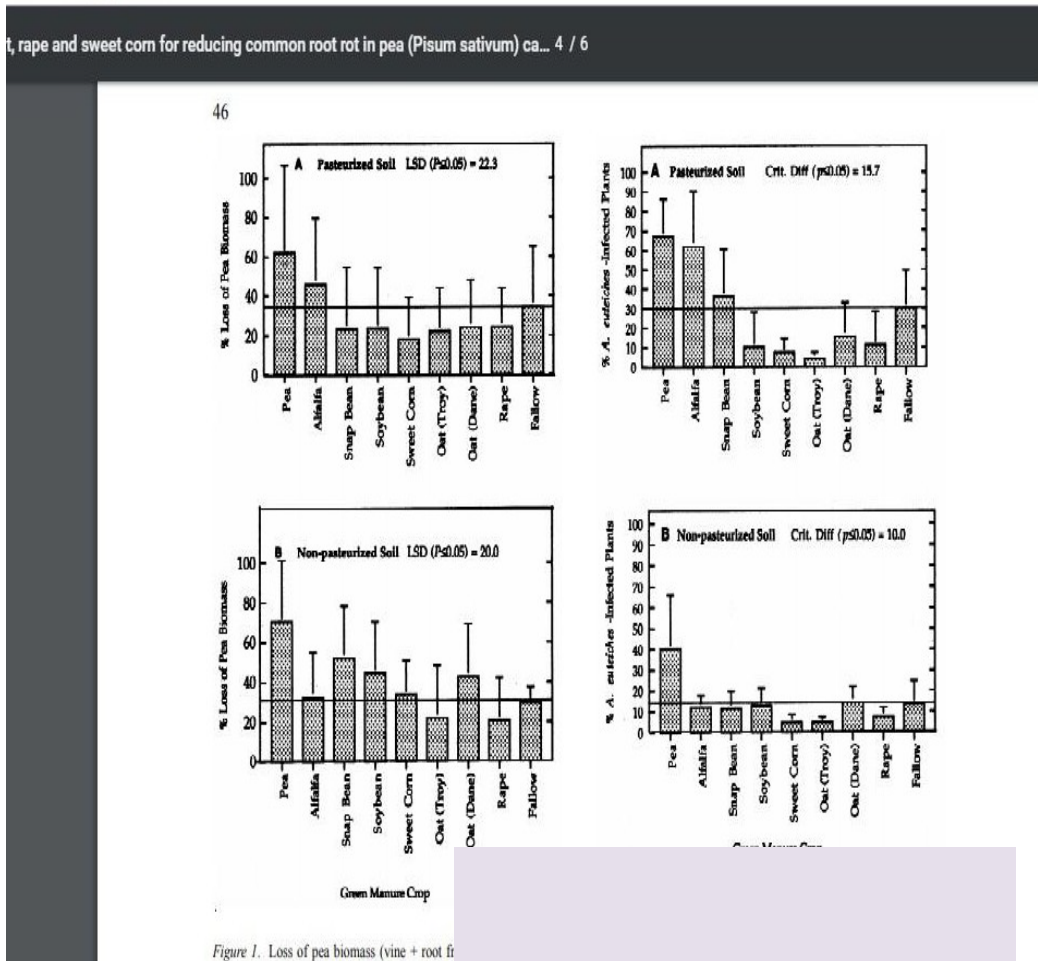
Resistance. Soybean, chickpea, and some faba bean lines carry resistance (Malvick et al. 2009; Moussart et al. 2008, 2013; Vandemark and Porter 2010). Lines of field pea with partial resistance have been developed and released (McGee et al. 2012), and a line with tolerance has been identified (Conner et al. 2013). Partial resistance and tolerance were found to be controlled by multiple genes with complex inheritance (Hamon et al. 2013; McGee et al. 2012; Moussart et al. 2007) and QTLs contributing to partial resistance have been described (Hamon et al. 2013; Pilet-Nayel et al. 2005, 2009). Two races have been described based on an alfalfa differential set (Malvick and Grau 2001; Malvick et al. 2009), but screening isolates from pea against a set of pea differentials failed to characterize distinct groupings (Wicker and Rouxel 2001; Wicker et al. 2003).

Rotation project with Brassicas and other potentially beneficial crops
Syama Chatterton & Christopher Morrison, AAFC Lethbridge

- Includes oats, rye, mustard, *Brassica carinata*, faba bean (control) as green manure or seed crop
- Legume (clover or vetch) - Brassica cover crop (biofumigation and/or Aphanomyces increases?)
- Assorted combinations of *Brassica* species, based on species with high glucosinolate levels and availability of seed from Canadian seed suppliers



The slide below shows *Aphanomyces* infestation after different rotation crops. Results show that peas were the crop that most increased the disease. Alfalfa to a lesser extent. Note that breeding for *Aphanomyces* resistant alfalfa ongoing. However, alfalfa varieties are populations, so there may always be some susceptibility in the variety.



The slide below is from my crop production notes. It emphasizes that soil health (mainly avoid waterlogging) very important for disease reduction. It also points out that mycorrhiza can reduce the disease as can intercropping peas with brassicas.

The question of diseases in peabased intercrops

Aphanomyces – a fungus that affects peas (and alfalfa) that can last in soil 10 years

No effective seed treatment control

Factors that increase Aphanomyces include:

Wet soils

Soil compaction

Factors that reduce Aphanomyces damage include:

AMF protection of root surface

Certain green manure plants

Oats

Cruciferous plants (mustards, etc.)

So the question becomes

Can adding an intercrop reduce Aphanomyces infection to peas?



D. A final note: Peas in green manures different than peas for grain



Does alfalfa dry out in the soil?

- Yes. Here is the water profile of an alfalfa crop over several years. 1995 was a very dry year, and you can see that the water content in the deepest soil layer really dropped. On the other hand, 1993 and 1994 were very wet years, and in these years the subsoil water was recharged even in the subsoil. To avoid a drought in the grain crop following a perennial alfalfa stand, terminate the alfalfa during a wet summer.

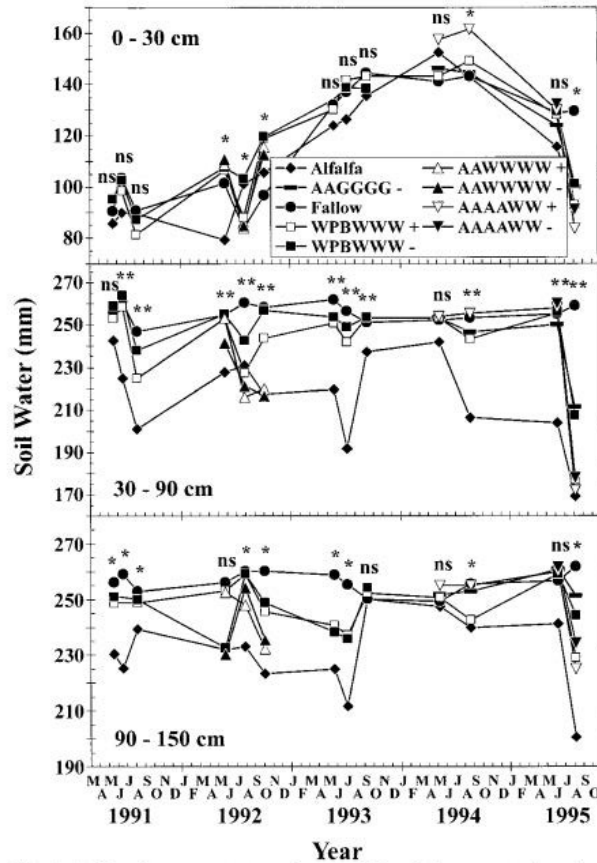


Fig. 3. Soil moisture content at three soil depth increments for nine different cropping and land use systems from 1991 to 1995. A, alfalfa; B, spring barley; G, native grasses; P, field pea; W, spring wheat. + indicates N fertilizer added according to soil test while - indicates no fertilizer N added.

There is also data on water use of green manure legumes for the dryland areas of southern Saskatchewan. Here is a summary of work conducted at Swift Current, Ag Canada in the 1980 and 1990s. The work shows that even though green manure crops use more water than tilled fallow, in most cases this water was recharged over winter.

Abstract

Data on plant water use and soil water depletion by green manure legumes are needed to develop sustainable cropping systems in a semiarid environment. The objectives of this study were to determine:

(i) seasonal water use by legumes, (ii) their water use efficiency (WUE), and (iii) residual soil water contents after legume growth compared with summerfallow and continuous spring wheat (*Triticum aestivum* L.). Black lentil (*Lens culinaris* Medikus), Tangier flatpea (*Lathyrus tingitanus* L.), chickling vetch (*Lathyrus sativus* L.), and feed pea (*Pisum sativum* L.), were seeded into wheat stubble with snow trap strips on an Orthic Brown Chernozem soil (Aridic Haploborolls) at Swift Current, SK, from 1984 to 1990. Legume water use exceeded that of fallow at 4 to 6 wk after seeding. When legumes were tilled into the soil at full bloom, differences in water content between cropped treatments and fallow were largest and most consistent in the top 0.6 m, suggesting that the legumes extracted water primarily from this depth. In an extreme drought year, substantial water depletion occurred below 0.6 m. Water use efficiency of legumes was 11 to 29 kg ha⁻¹ mm⁻¹, similar to that of spring wheat. Feed pea and chickling vetch used water more efficiently than the other legumes or N-fertilized wheat. Significant differences in WUE across years were related to differences in DM production. Soil water contents above the 0.6-m depth in late fall following green manuring were 62 to 82% that of fallow and increased over winter to 79 to 103% of fallow. Subsoil water was, on average, recharged after wheat to only 68% but following green manure to 81% of fallow. Partial fallow replacement with legumes would reduce the risk of erosion and nutrient leaching and minimize the hazard of salinization and eutrophication of downstream ecosystems.

How can one avoid disease in pulse crops, with pulses in rotation on sort intervals: How long should the interval be between pulse crops or green manures?

- Martin shared the answer to this one on Jan. 6

What crop or crops are used in the green manure in SK?

- The Pivot and Grow website has great resources on which species of green manure are adapted to different regions. I suggest using a mixture of at least two species. For example, consider adding some red clover to sweetclover. <https://www.pivotandgrow.com/resources/production/green-manures/green-manure-tool-kit/>
- Saskatchewan has Brown (dry), Dark Brown (bit wetter), Black (wetter) and Gray (along northern Ag fringe) soil zones. The specific green manure species, or

- species combination should be tailored to moisture available.
- Also, see abstract above regarding water use of different legume green manures.

What has been the most beneficial termination process of the green manure for maximum nutrient availability? (i.e. moldboard plow, roller crimping...)

- Anything that cuts up the green manure into small pieces and then incorporates that material into the soil will result in the most rapid release of plant nutrients.
- The trick is then to aggressively terminate the green manure without sacrificing a lot of soil water through aggressive tillage. So, flail mowing followed by tillage just before seeding is one option.

What should nodules on alfalfa root look like in organics?

- The same as in any other production system where legumes are grown. The nodules should appear red in colour when you cut them open.

How leachable in green manure N?

- Response from Crabtree “only a problem when it rains”
- Response from Shandrea Stallworth, Rodale “the southeast, LOL”
- Martin: The data that I showed in Lesson 1 gives a good picture that leaching can occur. But I agree with Doug Crabtree – leaching occurs only when it rains, and it has to rain a fair bit (3”). We have sampled deep N on several organic farms over the years, including in areas that one would consider quite dry. But, if a lot of rain falls (4” plus) after green manure termination, leaching will result. In our cases, we found high N between 2 and 4 feet.
- The big risk of N leaching comes from prolonged periods of tilled fallow (with no crop growing) and then getting some big rains.

Where is a good source for cover crop seeds? Such as clover for example. Are there sources for small scale producers using small volumes?

- North Star Seeds, MB: Grazing and soil health mixes [Northstar Seed Ltd. | Cover Crops](#)
- Interlake Forage Seeds, MB: Grasses, legumes, native species, alfalfa, organic seed available [Home - Interlake Forage Seeds](#)
- Imperial Seed, MB: Cover crops, forage seeds, mixes [Western Canada Seed & Inputs – Imperial Seed](#)
- Thomson Forage & Grass Seeds, MB: alfalfa, clover, grasses, forage blends [Products - Thomson Forage & Grass Seeds](#)
- Birch Rose Acres, SK: forage seed, organic seed available [FORAGE SEED FOR](#)

SALE from BIRCH ROSE ACRES LTD

- Pickseed Canada, locations across Canada, cover crops, alfalfa, forage grasses, forage mixes [Forage \(dlfpickseed.ca\)](http://dlfpickseed.ca)
- Covers & Co. Seed retailers from AB to ON [Cover Crop Blends — Covers & Co. - A Plant Diversity Company \(coversandco.ca\)](http://coversandco.ca)
- Albert Lea Seed, MN: alfalfa, forages, cover crops, organic seed available [Albert Lea Seed: Farm Seeds for Sale - Non-GMO & Organic \(alseed.com\)](http://alseed.com)
- BrettYoung, MB: forages, alfalfa, grasses [BrettYoung - Home](http://BrettYoung.com)
- Union Forage, AB: forage seeds, grazing blends [Annuals | Union Forage](http://UnionForage.com)
- Small quantities: West Coast Seeds, organic seed available [Cover Crops Seeds – West Coast Seeds](http://WestCoastSeeds.com)

How would grazing or swathing (for later grazing) compare in terms of nitrogen contribution from green manures?

- Grazing speeds up the release of N from green manures and in our research grazing green manure resulted in about 10% more N available for the following wheat crop compared to tillage termination of the green manure.

Is this for all crops? Or only wheat?

- Wheat is an example of a cereal in organic production.

If a Yellow Blossom clover is harvested for hay or silage will any N be produced? I always thought 50% of the N was in the below ground portion.

- No. Most of the N is in the topgrowth, so if sweet clover is harvested for forage, most of the N will be removed.
- Below is data produced by former Ag Canada scientist, Ken Bowren. (Two Saskatchewan locations).

Table 4. Yield of nitrogen from tops and roots of sweetclover, alfalfa, and red clover at five growth stages

| | | Kg N/ha | | | | | |
|-----------------------------------|-------------|-------------------------|--------|---------|-------------------------|--------|---------|
| | | Melfort | | | White Fox | | |
| Growth stage and date of sampling | Legume | Av. 2 tests 1956 & 1960 | | | Av. 5 tests 1956 – 1960 | | |
| | | Tops | Roots | Total | Tops | Roots | Total |
| Seedling year (September 15) | Sweetclover | 22.8 a | 9.4 a | 32.2 a | 40.4 a | 16.6 a | 57.0 a |
| | Alfalfa | 15.7 a | 7.2 a | 22.9 a | 37.3 a | 15.2 a | 52.5 a |
| | Red clover | 20.8 a | 4.6 a | 25.4 a | 29.1 a | 8.4 b | 37.5 b |
| Spring second year (April 15) | Sweetclover | — | 29.2 a | 29.2 a | — | 35.8 a | 35.8 a |
| | Alfalfa | — | 8.2 b | 8.2 b | — | 24.5 b | 24.5 b |
| | Red clover | — | 9.8 b | 9.8 b | — | 19.8 b | 19.8 b |
| Early bud (June 15) | Sweetclover | 54.8 a | 12.8 a | 67.6 a | 65.5 a | 10.3 b | 75.8 a |
| | Alfalfa | 30.9 b | 10.1 a | 41.0 b | 65.8 a | 16.3 a | 82.1 a |
| | Red clover | 24.8 b | 10.3 a | 35.1 b | 48.9 b | 12.6 a | 61.5 b |
| Full bloom (July 15) | Sweetclover | 73.1 a | 9.7 c | 82.8 a | 83.1 a | 10.8 c | 93.9 a |
| | Alfalfa | 60.2 a | 28.2 a | 88.4 a | 70.9 a | 29.8 a | 100.7 a |
| | Red clover | 49.8 a | 19.7 b | 69.5 a | 62.1 a | 19.0 b | 81.1 a |
| Mature seed (September 15) | Sweetclover | 53.6 a | 10.7 b | 64.3 b | 53.8 a | 9.4 c | 63.2 b |
| | Alfalfa | 49.4 a | 54.8 a | 104.2 a | 53.8 a | 38.5 a | 92.3 a |
| | Red clover | 68.5 a | 24.8 b | 93.3 a | 66.9 a | 24.8 b | 91.7 a |

*Means followed by the same letter are not significantly different ($P = 0.05$).

Participant shared link to: [A survey of green manure productivity on dryland organic grain farms in the eastern prairie region of Canada \(cdnsiencepub.com\)](https://doi.org/10.1007/s11300-019-0950-0)

Is the C:N ratio the same for conventional farms where chemical nitrogen is added: Or are those fields carbon deficient?

- All soils have a C:N ratio about 10:1, regardless of farming method.

What varieties of beans don't produce nitrogen?

- Here is response from Kristen McMillan: Nodulation and response to N management strategies has been consistent across bean types and presumably varieties, which is an important finding! I've tested Windbreaker and Vibrant pinto beans, T9905 navy beans and as Eclipse black beans. Those are also the most grown varieties for each market class.

How often should we test our soil in a year to confirm there is enough N in the soil?

- One soil test in late fall is sufficient; multiple times per year is excessive.

- In a 3-year rotation (e.g., Green manure-wheat-flax) it might be useful to test the soil after the wheat crop to see how much N left for the flax. If lots of N is left, could substitute a higher N use crop such as mustard, corn, etc.
- Sampling soil for N the year (or spring after) a legume green manure is often a waste of effort since most of the N is still in the organic phase. The biomass of the green manure is likely a better indicator of how much N will be made available the year after the green manure.

If you don't see a lot of nodules on the alfalfa root, how much N might you still be fixing or providing for the following year's crop through plowing alfalfa biomass under?

- No nodules means no N fixation.
- Sample alfalfa nodules before alfalfa flowers and use a shovel so that the nodules are not ripped off while extracting the root.

Check out the work of Dr. Stephanie Yarwood at U of Maryland. When measuring N type in soil, nitrate- N is less than 1% of the total N. And we tend to focus on it. For example, average total soil N in Manitoba and Saskatchewan cropland is approximately 9,000 lbs./acre! This is measured to 1 foot depth. So lots of N just not available. Why? Lack of cycling by soil biology.

- See slide from Rothamsted in lesson 4, which confirms that a lot of N in the organic matter.
- Martin showed increased N supplying power in organic systems at Glenlea and also more enzymatic activity. This suggests that in these instances there was no lack of soil activity to supply nutrients.

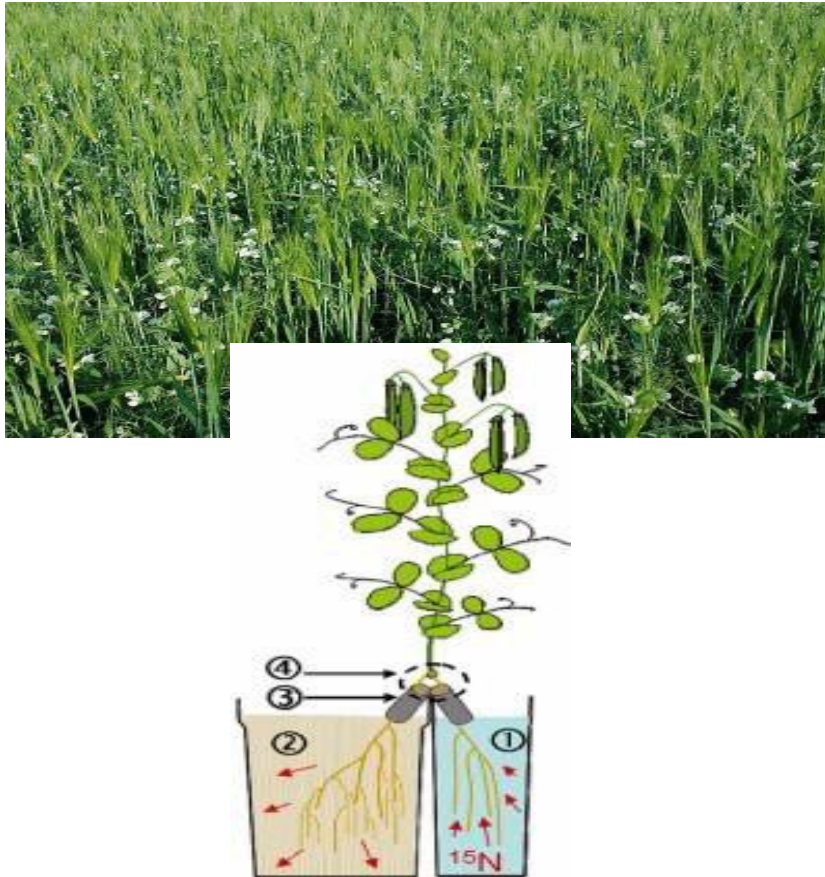
Michael T: And any discussion of N needs to include C. They are deeply interconnected. Carbon is the more fundamental nutrient than N or P. Carbon to build soil aggregation will create a home for the free-living nitrogen fixers (Diazotrophs) that do not require legume. Also poorly aggregated soils do not allow gas exchange and therefore poor N fixation from legumes and poor performance from legume inoculants (rhizobium).

What are some of the challenges with underseeding companion legumes with the 'extractive' crops; i.e. underseeding red clover in wheat (not as an intercrop for seed production, but instead just including it for N contribution). I'm wondering why there isn't more of that happening?

- The underseeded crop adds very little N to the wheat (or other similar crop) in

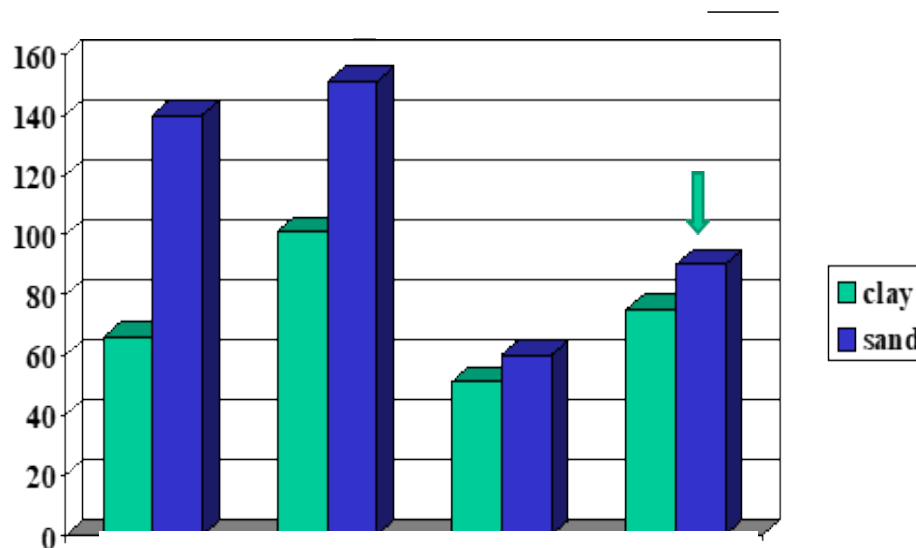
the year of clover establishment. This is because clover biomass remains small under the wheat. But after wheat harvest, the clover can grow and fix N.

- In a perennial crop (e.g., alfalfa-grass), the alfalfa would supply significant amounts of N to the grass (e.g. brome grass, orchardgrass, etc.). But in an annual system, the time is simply too short for a lot of N transfer.
- Finally, if the intercrop with wheat was a grain legume such as peas, we would expect about 15 lb/acre of N transfer from pea to wheat in good growing conditions.



Comments on timing of a green manure termination vs. timing of N mineralization/N availability for subsequent crop? If green manure terminated late might not get N mineralization in green manure year, but will get N mineralization in subsequent crop year be available in time for grain crop needs (and not reduce yield)?

- Yes, as long as there is sufficient moisture in spring – which in most years there is simply due to snowmelt.
- If the spring is very cold, the release of that N will be slower.
- Below is some work we did on alfalfa termination timing and availability of N the next spring. Waiting until after second cut to terminate meant less N next year. BUT, still lots of N to grow a crop. This work done in Black soil zone.



What about dissolved and diluted then spread as a liquid (phos in acid). I guess that would be phosphoric acid.

- Sounds right.

What manure is higher than pigs?

- **Another participant** responded to the question above – poultry. Correct!

Can you source pelleted poultry manure easily? If so, where?

- Not sure. I would ask around in the organic farm community.

What are the consequences of using manure from non-organic operations to organic fields?

- Possible according to Canadian organic standards but a few restrictions such as manure must be stored (or composted) for a certain time before use (to reduce pathogens). See below from <https://www.tpsgc-pwgsc.gc.ca/ongc-cgsb/programme-program/normes-standards/internet/032-310/032-310-eng.html#s5.5>

5.5 Manure management

5.5.1 Manure sources

5.5.1.1 Animal manure produced on the operation shall be used first. When all available manure is used up, organic manure from other sources may be used. If organic manure is not commercially available, non-organic manure is permitted provided that:

- a. the non-organic source is not a fully caged system in which livestock cannot turn 360°; and
- b. livestock is not permanently kept in the dark; and
- c. the source and quantity of manure, type of livestock, and evaluation of the criteria in [5.5.1.1 a](#) and [5.5.1.1 b](#) shall be recorded

How many chickens would be required to ensure higher concentration of P in an acre?

Response from participant: If you can afford to buy it.

- We compiled a “price list” of different real world manure experiences from farmers in Manitoba. Here is what we found. It gives a rough price per lb of P205 for different sources. Results show that farmers paid from 0.29 to almost \$2/lb of P205.

- 1000 lb worth of broilers produces 11.7 tonne raw manure per year
- Assuming each bird is 4 lbs at slaughter, that is 250 broiler chickens



- There are 8.35 kg of P_2O_5 in each tonne of broiler manure
 - But that is P_2O_5 , not P
 - $P_2O_5 \times 0.43 = P$
 - Therefore, $8.35 \text{ kg } P_2O_5 \times 0.43 = 3.59 \text{ kg P/tonne of manure}$



- $11.7 \text{ tonne/year} \times 3.59 \text{ P/tonne} = 42.3 \text{ kg P per 1000 lb broilers per year}$
- If you have a P deficiency of 31.5 kg (see above), how much broiler manure needed?
 - $31.5 \text{ kg per ha} / 3.59 \text{ kg per tonne} = 8.77 \text{ tonne manure/ha}$
- How many broilers per ha to provide 8.77 tonne manure?
 - $8.77 \text{ tonne needed} / 11.7 \text{ tonne} = 0.74 \times 250 \text{ birds/year} = 187 \text{ birds/ha}$
 - That's 75 birds per acre

Price Comparison for Selected Sources of Phosphorus

Prepared by Joanne Thiessen Martens
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UNIVERSITY
OF MANITOBA

| Product | Product Information | | | Retail Cost | Standardized cost | | | Notes: |
|--------------------------------------|---------------------|----------------------|--------------------|---------------|-------------------|--------------------------|-------------------------|--|
| | Formulation | % P_2O_5 Available | % P_2O_5 * Total | \$ unit | \$/T of product | \$/lb of avail. P_2O_5 | \$/lb of total P_2O_5 | |
| Calphos | 0-3-0 | 3 | 20 | 625.00 ton | 687.50 | 10.42 | 1.56 | FOB Ontario; volume discount available |
| TekMac - Eco Green 5-6-1 powder | 5-6-1 | 6 | 6 | 435.00 tonne | 435.00 | 3.30 | 3.30 | Minimum bulk order: 43 tonnes |
| TekMac - Eco Green 5-6-1 crumble | 5-6-1 | 6 | 6 | 565.00 tonne | 565.00 | 4.28 | 4.28 | Minimum bulk order: 43 tonnes |
| TekMac - GoodnGreen 7-4-1 powder | 7-4-1 | 4 | 5 | 480.00 tonne | 480.00 | 5.45 | 4.36 | Minimum bulk order: 43 tonnes |
| TekMac - GoodnGreen 7-4-1 crumble | 7-4-1 | 4 | 5 | 610.00 tonne | 610.00 | 6.93 | 5.55 | Minimum bulk order: 43 tonnes |
| TekMac - high P crumble | 3-10-3 | 10 | 10 | 765.00 tonne | 765.00 | 3.48 | 3.48 | Minimum bulk order: 43 tonnes |
| TekMac - 1-29-0 pork bone | 1-29-0 | 29 | 29 | 1500.00 tonne | 1500.00 | 2.35 | 2.35 | Minimum bulk order: 43 tonnes |
| Dirt'n'Grow - Evolve 10-3-3 | 10-3-3 | 3 | 3 | 1400.00 ton | 1540.00 | 23.33 | 23.33 | 10% discount on 27 2000lb totes |
| Manure - composted feedlot - applied | | 0.75 | 1.5 | 25.00 tonne | 25.00 | 1.52 | 0.76 | Applied (10 T/ac) |
| Manure - feedlot - applied | | 0.1 | 0.23 | 10.00 tonne | 10.00 | 4.55 | 1.98 | Applied (from 15 miles away) |
| Manure - solid poultry - manure only | | 2 | 5 | 16.00 tonne | 16.00 | 0.36 | 0.15 | Not hauled or applied |
| Manure - solid poultry - applied | | 2 | 5 | 32.00 tonne | 32.00 | 0.73 | 0.29 | Applied (from 18 miles away) |
| Fertilizer MAP dry granular | 11-52-0 | 52 | 52 | 600.00 tonne | 600.00 | 0.52 | 0.52 | Shur-Gro |
| Fertilizer liquid phosphate | 10-34-0 | 34 | 34 | 630.00 tonne | 630.00 | 0.84 | 0.84 | Shur-Gro |
| Fertilizer suspension liquid | 10-30-0 | 30 | 30 | 425.00 tonne | 425.00 | 0.64 | 0.64 | Shur-Gro |

*Total P_2O_5 is assumed to be the same as Available, unless information on total P is available.

Additional notes:

Prices and nutrient formulations of commercial products were quoted by manufacturers or distributors in December 2016.
 Prices and nutrient concentrations of manure were obtained from farmers who sourced manure for their own farms.

Participant comment: I think the difference between manure and fert P is biology.

- Manure P also adds Carbon, which provides food source for soil bacteria. This is one reason why manure better than mineral fertilizer alone.

Does composting non-organic manure leave it organic?

- See manure regulations above. Short answer – it can.

Can you get sulphur besides from manure?

- Yes, there are sulfur sources other than manure allowed. One example is elemental (unprocessed) sulfur.

Participant comment: All tillage is not equally destructive.

- Correct. This was demonstrated in lesson 4.
- Tillage can be least destructive when it does not shatter the soil aggregates. So, traveling slower sometimes helpful.
- But if aggressive tillage done (e.g., high speed disc), planting a crop (or cover crop) immediately after tillage allows rapid re-establishment of health biological function.
- Comment from another participant: For sure there is a huge range of consequences from different tillage operations and timing. Key is understanding

Comment: Note that Chilean nitrate is not approved for organic use in Canada.

- Thank you for point this out!

If I'm just starting to get into regenerative agriculture any sources that can be recommend would be appreciated

- Focus on what your soil needs. That is a great place to start.

What if I try and attract the ducks and geese to my land every spring and late fall in their migration instead of using chicken or rumen manure? Would I get a significant benefit of N and Ph?

- This is exactly what Lundberg rice farmers did in California. Learn more here_ <https://calag.ucanr.edu/Archive/?article=ca.v049n06p58>
<https://www.farmprogress.com/rice-farmers-winter-flood-ducks>



Tundra swans visit a rice field reflooded after harvest. Flooding fields from October to February creates suitable winter wetland habitat for resident and migratory waterfowl.

- Here is a short study from Japan
<file:///C:/Users/mentz/Downloads/AA12005506-2010-7-113.pdf>
- If flooding your field is not an option – which I assume it is not, see comment below on chaff collection.

Comment: When appropriate tillage facilitates diverse crops and green manure, the net impact is positive.

- Correct

It seems to me that sustainable agriculture cannot be done without livestock?

- Livestock do add many options. They should be used strategically to enhance the functionality of the whole farm.
- Great point!

Try using a chaff saver, the accumulation of seeds would lure flocks

- Interesting. Relates to above question about flooding fields to attract waterfowl.

How much N is in the legume green manure roots?

- In annual plants it is a small proportion – less than 15% of total.
- The root N is accounted for in the “2.5% of biomass is fixed N” equation.

I’ve had the rotation in the past of a nitrogen fixing clover crop followed by three crops nitrogen using crops with the third under seeded back to a clover. How would I use a catch crop in a rotation? Would I underseed that crop?

- In such a rotation, I think the concern is not leaching but lack of N. So, it may be a good idea to underseed a cereal, for example, to clover as a late season cover crop to add a bit of N.
- There is an advantage to underseeding during the spring seeding operation instead of trying to seed a late-season cover crop in late summer – when the soil may be bone dry.

How is the flax straw managed in the rotation

- In our rotation it is baled off.
- In a later comment (below), a farmer underseeds flax with clover then tills the whole remaining straw (after grain harvest) into the soil.

Where do you source black medic seed?

- Laura note: couldn’t find any sources for this.

Can you please discuss or comment on using alfalfa/hay mixtures for green manures so as to allow for grazing?

- Popp and McCaughey did a lot of grazing work at Brandon in 1990s showing that grass/alfalfa pastures (with large proportion of alfalfa) resulted in amazing gains and productivity.

How could you use human waste as an organic fertilizer not being able to regulate the source. Wouldn't it be similar to municipal grass clippings off lawns pelleted to be used as a fertilizer

- Struvite is a pure form of P that is being considered for registration in organic in Europe and so it may be allowed in Canada in the future as well.

Crop Establishment and Seeding Systems, Tillage and Weed Control January 6, 2023

In the notes for the first session it says, "Each hay bale weighing 1000 lb (400 kg) contains approximately 15 lb of P205 ; this is true for both alfalfa and pure grass bales." However, in the presentation slides the consistent figure is 15lbs of P/ton. That seems like a significant difference. Can you clarify?

- Sorry for the confusion. They should both be 15 lb P205.

Were same-variety comparisons made between conventional production and organic systems in the same/nearby location/same year?

- The yield data that I showed on the seeds (seeding rate, depth, etc.) were all done under organic production.

Is there any guidance to the nutrients removed by weeds? Can it be based on the weighed dockage?

- Here is some data on the feeding value of some weed seeds

TABLE 3. RESPONSE OF RATS TO GREEN FOXTAIL, YELLOW FOXTAIL AND WILD OAT DIETS IN EXP. 1 (19 DAYS)

| Item | Diet ^a | | | Reference |
|--|--------------------|--------------------|--------------------|--------------------|
| | GF | YF | WO | |
| No. of rats | 8 | 8 | 8 | 8 |
| Avg initial wt, g | 79.9 | 80.8 | 81.4 | 80.6 |
| ----- Period (7 days) (No added lysine) ----- | | | | |
| Avg daily gain, g | -.34 | -.71 | -2.79 | 3.45 |
| Avg daily feed, g | 6.86 | 6.14 | 2.02 | 8.21 |
| Avg feed to gain ratio | b | b | b | 2.38 |
| ----- Period 2 (12 days) (.7 lysine added) ----- | | | | |
| No. of rats | 8 | 8 | 5 ^e | 8 |
| Avg initial wt, g | 77.5 | 75.8 | 69.8 | 104.8 |
| Avg daily gain, g | 7.01 ^c | 6.14 ^c | .43 ^d | 6.45 |
| Avg daily feed, g | 16.57 ^c | 15.73 ^c | 6.98 ^d | 14.58 ^c |
| Avg feed to gain ratio | 2.36 ^c | 2.56 ^c | 12.70 ^d | 2.26 ^c |
| ----- Digestibility values (period 2) ----- | | | | |
| DM, % | 74.82 | 63.78 | 55.69 | 92.59 |
| Energy, % | 77.79 | 67.31 | 58.31 | 93.96 |
| DE, kcal/g DM | 3.478 | 3.068 | 2.696 | 4.396 |
| CP, % | 77.13 | 68.60 | 54.22 | 89.81 |
| A-D Fiber | 70.20 | 3.60 | 10.91 | ... |

^aDiet descriptions are given in footnote "a" of table 1.

^bFeed per unit gain value cannot be calculated for treatments resulting in weight loss.

^{c,d}Values bearing different superscripts are different ($P < .01$).

^eOne rat died within 24 hr after receiving the lysine-supplement diet. Two animals were in weakened condition and were removed from the experiment. Average weight loss of these rats was 35% of initial weight.

- My grad student, Myra Van Die, did grass-fed work in organic and measured the TDN of the weeds. See below.

Table 3. Plant stand, crop dry matter (DM), weed DM, total DM and utilization for sheep of six annual forages over 3 site-years.

| Plant species | Plant stand (plants·m ⁻²) | DM (kg·ha ⁻¹) | | | Utilization ^a (%) |
|---------------|--|---------------------------|-------|----------|------------------------------|
| | | Crop | Weeds | Combined | |

Table 4. Total digestible nutrients (TDN) and crude protein (CP) of crop, weed, and total dry matter (DM) and crop nitrogen (N) uptake of six annual forages over 3 site-years.

| | TDN (% DM) | | | N Uptake (kg N·ha ⁻¹) ^a | CP (% DM) | | |
|--------------------|------------|---------|----------|---|-----------|---------|----------|
| | Crop | Weeds | Combined | | Crop | Weeds | Combined |
| Site-year 1 | | | | | | | |
| Annual ryegrass | 65.8ABC | 60.8A | 61.4B | 9 | 11.3A | 8.4BC | 8.6AB |
| Winter triticale | 68.7AB | 59.7AB | 64.9AB | 29 | 10.1AB | 6.4C | 8.6AB |
| Oat | 64.4C | 60.2A | 62.7AB | 59 | 9.8AB | 10.2AB | 9.9A |
| Millet | 64.8BC | 59.8A | 63.6AB | 61 | 8.0BC | 10.4A | 8.6AB |
| Corn | 69.2A | 60.1A | 65.9A | 30 | 6.7CD | 10.9A | 8.2B |
| Sorghum-sudangrass | 64.3C | 55.4B | 61.7B | 37 | 4.8D | 6.5C | 5.3C |
| P>F | 0.0026 | 0.0117 | 0.0072 | — | <0.0001 | <0.0001 | <0.0001 |
| Site-year 2 | | | | | | | |
| Annual ryegrass | 61.2B | 63.3AB | 63.5ABC | 3 | 15.5A | 9.5B | 10.8AB |
| Winter triticale | 66.9A | 63.9AB | 65.2AB | 31 | 13.6A | 5.5C | 9.2AB |
| Oat | 62.3B | 67.3A | 64.4ABC | 37 | 10.9B | 12.0A | 11.4A |
| Millet | 67.3A | 67.3A | 67.3A | 36 | 10.0B | 12.0A | 10.9A |
| Corn | 65.1AB | 60.8BC | 62.9BC | 27 | 6.0C | 9.0B | 7.4BC |
| Sorghum-sudangrass | 63.3B | 57.5C | 60.9C | 29 | 4.7C | 7.4BC | 5.9C |
| P>F | 0.0003 | <0.0001 | 0.0027 | — | <0.0001 | <0.0001 | <0.0001 |

Note: Means within a column followed by the same letter are not significantly different at $P \leq 0.05$ with the Tukey test
^aCrop N uptake.

Note: Means within a column followed by the same letter are not significantly different at $P \leq 0.05$ with the Tukey test.

^a% of pre-grazing DM.

Organic and natural fertilizer suppliers tell us that, although rock phosphate is inert, they have found that if combined with sulphur and with sufficient moisture and organic matter as a determining factor in microbial activity, the sulphur along with microbes can have a similar effect to sulfuric acid (which is how conventional phosphorus is solubilized) and greatly increase the solubility of rock phosphate. Are you aware of third-party tests verifying this?

- The work at U of Guelph a few years ago looked at all kinds of ways of making Rock P more available. There are many different options as you likely know. Here is a review paper that is worth looking at. Arcand, M.M. and Schneider, K.D., 2006. Plant-and microbial-based mechanisms to improve the agronomic effectiveness of phosphate rock:

a review. *Anais da Academia Brasileira de Ciências*, 78, pp.791-807. This paper is available on line. Google Scholar.

- But no, I do not know of any third-party work that has verified the claims being made.

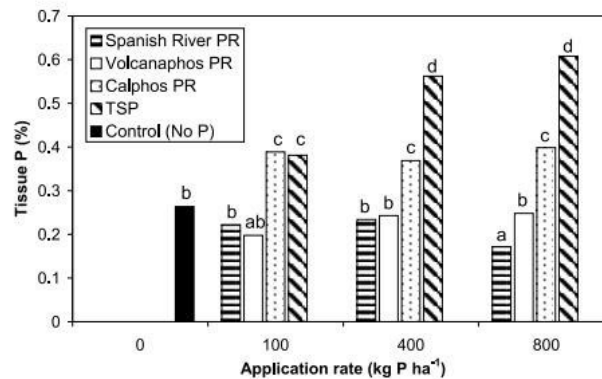
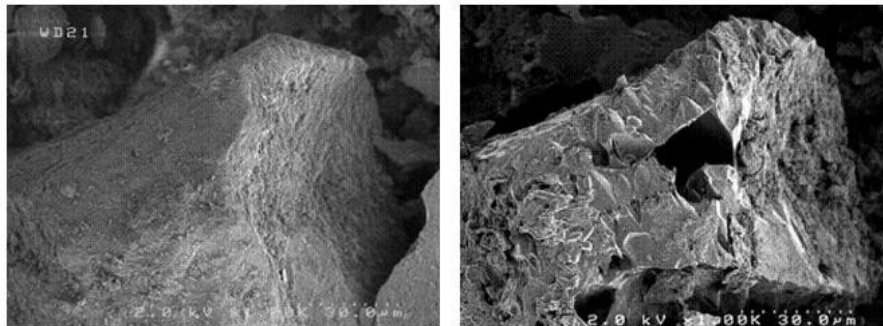


Fig. 1



In our soils which are high in potassium and magnesium, using cattle can result in a growing excess of these nutrients. Some scientists claim that this will create a nutrient imbalance that can have various negative effects such as electrical bonding of more soil colloids to smaller potassium cations causing lack of soil aeration, etc. Is there a noticeable difference in plant based and animal manure-based compost in this regard? What can be done to manage for excess nutrients?

- My first concern is the health of your animals. Are they doing OK on these pastures?
- If it is the “base saturation” that you are concerned about, there are many studies that show our base saturation is just fine in Prairie soils and so no efforts to try and balance different base elements is necessary.

- If it is base saturation that you are referring to, here is an article written by two Prairie soil scientists. Available at: www.agvise.com/wp-content/uploads/2015/02/PPI-Cation-Ratios.pdf

Should we consider different (lower) seed rate when intercropping? Such as oat with pea, etc.

- Yes.
- One rule of thumb is reduce each crop in a 2-way intercrop by 50%.
- But in some cases you want to be more selective. For example, go with a full rate of grain legume and only add in about 20% of oat seed rate in order to provide physical support to the legume plants. Here is a paper that we did with variable cereal and mustard seeding rates for pea intercrops. Bailey-Elkin, W., Carkner, M. and Entz, M.H., 2021. Intercropping organic field peas with barley, oats, and mustard improves weed control but has variable effects on grain yield and net returns. *Canadian Journal of Plant Science*, pp.1-14.

Good day, all! I am interested to improve marginal land in northern Ontario. Please advise if switchgrass, as with great biomass and environment friendly, may also be a good choice for cover crop or livestock feed applications? Kindly provide some avail data or study result. Enhancement of biodiversity and soil improvement are some of our goals for newly cleared land. Thanks.

- I would add a legume into any perennial grass that you are intending to improve your marginal soil with.

Surprised that the 2009 soybean seeding rate study from Carman, MB wasn't referred to. It matches on-farm trials and experiences from ON organic growers showing significant yield and profit advantages to increased seeding rates.

- Correct. UM research at Carman showed that going up to 200,000 soybean seeds per acre provided yield and weed control benefits in organic soybean. But we did not do the economics. I think this is why the Minnesota study showed 120,000 being OK. Plus the Minnesota study could have had better mechanical weed control that we did. We seeded ours solid seeded. But you are correct, higher seeding rates often important.

Do you consider semi deep furrow with a hoe drill vs the use of a single disc drill with no option to make a furrow?

- In what application? Deep furrow with hoe drill has been used a lot (including by us). One concern is big rains sometimes wash soil into furrow making seeding depth functionally deeper.

Do packers encourage weed re-establishment

- Yes, we notice this with small seeded broadleaved weeds and foxtail.

Are there any comparisons of organic wheat vs organic spring wheat? Or comparisons of yield/dockage of organic vs conventional winter wheat?

- Our work is all spring wheat.
-

What is research on early seeding vs. delayed to allow termination of the first flush of weeds with a single tillage pass prior to seeding? We have found that the advantage of improved weed control outweighs that of earlier seeding... to a point.

- Thanks for advice from an experienced organic farmer. You are correct that direct seeding with no spring tillage increases risk of weed problems.

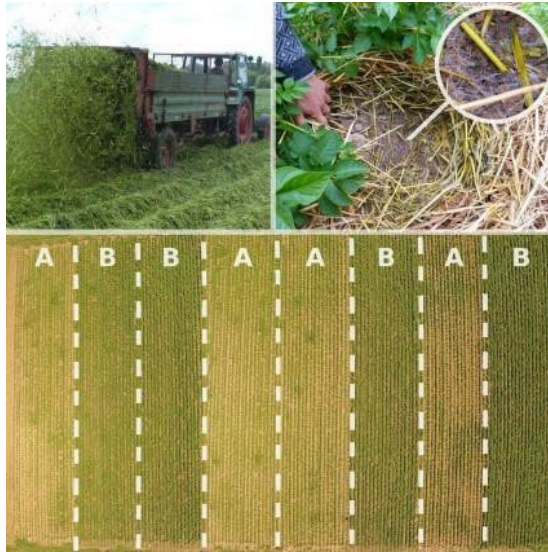
If feeding hay is such a good source of phosphorus, what are best practices for achieving uniform distribution? I have experimented with bale grazing, and find it results in very patchy results that take many years to even out. Is there a better way?

- Agreed, that bale grazing leaves the P in patches.
- Bale shredding may help.
- In Europe, they do some spreading of baled or chopped material on top of vegetables.



Transfer mulch for soil cover and nutrient addition

- The images below are from a strip farming system where perennial legumes are grown in strips with potato. We have modelled such a system. Having 1/3 of field in alfalfa (in strips) would supply a lot of N, and more than enough P, to crops if the alfalfa plant material was moved onto the grain or horticultural crops. Wiens, M.J., Entz, M.H., Martin, R.C. and Hammermeister, A.M., 2006. Agronomic benefits of alfalfa mulch applied to organically managed spring wheat. *Canadian journal of plant science*, 86(1), pp.121-131.



M. R. Finckh, S. M. Junge, J. H. Schmidt and O. D. Weedon, 2018. Disease and pest management in organic farming: a case for applied agroecology. In *Improving organic crop cultivars* (pp. 23-212). Burleigh Dodds Science Publishing.

Top, left: Application of freshly cut mulch material in mid ay with a manure 3 spreader to a depth of 10 cm on the potato plots.

Top, right: The potatoes spread their 4 roots into the mulch in order to access water and nutrients.

Bottom: During a dry period 5 in 2015, canopy closure is achieved in the mulched potatoes (B). In the unmulched potatoes (A), the plants remain stagnant in their development and are unable to compete with weeds, contributing to a reduced yield.

Is there a maximum to seeding rates, where increased rate leads to yield decreases?

- Yes, but we rarely reach this point even in the “high” seeding rates that organic farmers use.

Does seeding the forage at same time as oat seed, rob moisture first thing in spring.

- No. This is actually the best time to seed the small-seeded forage since you likely have soil water to get the seeds germinated.

Have you ever left a plot go to weeds then monitored the results in soil tests relative soil nutrients and organics? Have you ever left a plot to weeds over a long term (5+ years)?

- Here is some data from a former long-term study at U of Manitoba. They had a “weed” plot as a green manure. The study ran for over 30 years. The weeds added little to soil fertility and as a result did not help yields as much as legume green manures. Poyser, E.A., Hedlin, R.A. and Ridley, A.O., 1957. The effect of farm and green manures on the fertility of blackearth-meadow clay soils. *Canadian Journal of Soil Science*, 37(1), pp.48- 56.

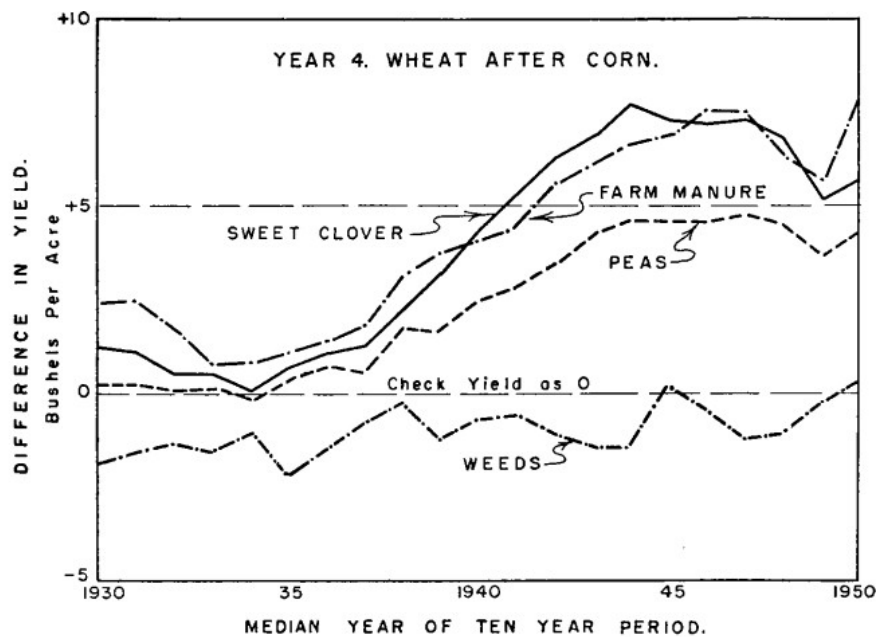


FIGURE 4. Diagram showing the moving 10-year average yield response of second crop corn to representative green crop treatments and farm manure.

How much of the soil biology is killed by tillage?

- If land is seeded immediately after tillage, very little. See lesson 4.
- Tillage is “disturbance,” but so is applying chemicals like fertilizers, herbicides, fungicides, and insecticides.

Cultivator to terminate red clover would never work in our area :(Too many very large rocks

- Yes, rocks would create a limitation for the Quebec built machine.

Are you suggesting that I don't terminate a 2-foot alfalfa green manure with a vertical tiller but maybe leave all that top growth all season long. Terminate with the farmer made cultivator/disc and try and direct seed into that alfalfa biomass next spring?

- The cultivator was purpose built for terminating young red clover stands. It is important to note that red clover plants that were only established the previous year (and under a wheat crop) are actually smaller plants. So, they are easier to kill than perennials which might be growing for multiple years before tillage. I am not sure such a one-pass system would work on a tall multi-year alfalfa crop.
- The point is that equipment is designed for specific purposes. And because the industry does always recognize the little nuances of organic production, in this case, the farmers built it themselves.

Comment from experienced organic farmer: We use a light tillage pass, as early as possible in spring to stimulate uniform emergence of small-seeded annual weeds. Then, our seeders have sweeps that terminate (most of) the weeds at “white-root” stage -10 days later. We have observed significant yield penalty if we eliminate the pre-tillage, or seed too early or late after pre-tilling- from greater weed competition.

- This is the kind of farmer experience wisdom that is invaluable. It also demonstrates the importance of farmer-to-farmer knowledge exchange.

How aggressive of a setting do you have on the tines?

- If it is the soybean example, I think they were quite aggressive.
- From our experience, peas and lentils are more resistant to harrowing aggressively. What always concerns me about harrowing cereals is burying the leaves and then get a rain that crusts the soil – killing the plant.
- Harrowing later – when the plants are better established – can be easier on crop. But this assumes the harrow can still kill the weeds. See Hemp image below.



Re: the Scandinavian data on tillage - was there any measurement of soil temperatures? Sometimes in early spring, our soils are still very cold and germination of seeds may be delayed.

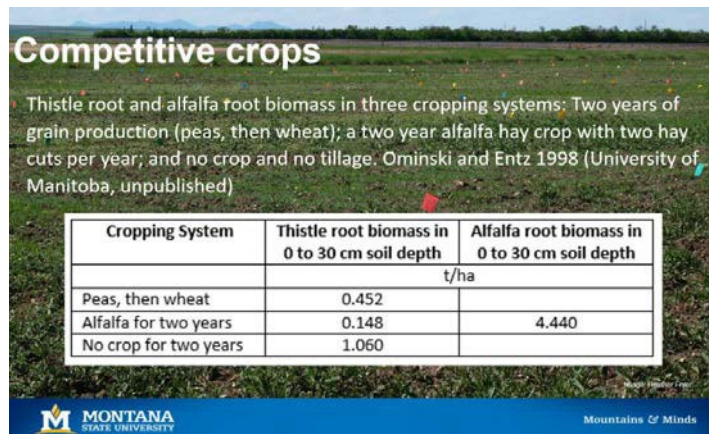
- Yes, but on dark coloured soil, it is amazing how early certain weeds grow. We have used plexiglass plates laid on the field after planting. They give us an early indication of what weeds might be coming.

Is the use of a chaff saver another way to control wild oats?

- Not slide in lesson 2. Chaff collectors are indeed very effective.

How long do you have to leave alfalfa down to deplete wild oat banks and thistles.

- For wild oats, sometimes just a one-year silage crop makes difference. But a 3-year minimum alfalfa hay crop is quite effective.
- For Canada thistle, 2 to 3 years is quite effective. Cutting regime important too. Cutting twice better than only cutting once. Sometimes a fall cut helps control thistle as well.
- Below is some work we did on root reserves in Thistle (Pat Carr of MSU used the data in a presentation).



- Here is the data from the one-year silage study. Schoofs, A. and Entz, M.H., 2000. Influence of annual forages on weed dynamics in a cropping system. *Canadian Journal of Plant Science*, 80(1), pp.187-198.

SCHOOFS AND ENTZ — WEED SUPPRESSION WITH ANNUAL FORAGES 195

Table 5. Density of weeds emerged (seedlings m⁻²) in a pea test crop as influenced by forage system at Carman, MB in 1995 and 1996

| Treatment | Wild Oat | Green foxtail | Redroot pigweed | Lambs-quarters | Wild buckwheat |
|---------------------------------------|----------|---------------|-----------------|----------------|----------------|
| <i>Trial 1 (1995)</i> | | | | | |
| Wheat+grass and broadleaf herbicide | 29b | 42cde | 50c | 12bc | 11a |
| Wheat+broadleaf herbicide | 283a | 290ab | 3d | 8bc | 10ab |
| Wheat-herbicide | 283a | 333abc | 88c | 318a | 9ab |
| Winter triticale | 4e | 91bcd | 4d | 2c | 2c |
| Spring and winter triticale intercrop | 10de | 18de | 327b | 15bc | 5abc |
| Spring triticale | 31b | 60bcd | 611ab | 9bc | 9ab |
| Sorghum-sudangrass | 12cd | 30cde | 8d | 25b | 2c |
| Alfalfa | 30b | 460a | 406b | 11bc | 2c |
| Weed fallow | 20bc | 8e | 1096a | 7bc | 5abc |
| CV (%) | 18.4 | 41.6 | 22.1 | 46.7 | 54.3 |
| <i>Trial 2 (1996)</i> | | | | | |
| Wheat+grass and broadleaf herbicide | 1461b | 962abc | 20ab | 1bc | 1c |
| Wheat+broadleaf herbicide | 2426a | 316d | 2bcd | 0c | 1c |
| Wheat-herbicide | 2144a | 461cd | 1cd | 3bc | 1c |
| Winter triticale | 369f | 669bcd | 13abc | 6bc | 16abc |
| Spring and winter triticale intercrop | 421f | 490cd | 24abcd | 7bc | 4bc |
| Spring triticale | 773de | 1338ab | 79a | 51a | 41ab |
| Sorghum-sudangrass | 1001cd | 103e | 12abcd | 4abc | 5abc |
| Alfalfa | 662e | 1205ab | 19ab | 7abc | 17abc |
| Sweet clover/triticale doublecrop | 1077bc | 404d | 2bcd | 9abc | 51a |
| Fall rye | 744de | 16f | 0d | 0c | 18abc |
| Weed fallow | 667e | 1712a | 35a | 16ab | 55a |
| CV (%) | 3.4 | 10.5 | 78.5 | 126.8 | 83.1 |

a-f Means within individual weed species followed by different letters are significantly different ($P < 0.05$). Statistical analysis was performed on log transformed data in both years. Values in the table are actual weed densities.

With the rye/soybean combinations of till/no till, what was the actual yields of rye and soybeans from each system and dollar values per acre achieved?

- Sorry but we didn't do economics.
- However, given that 3-gen organics gave up trying to no-till into rye and now harvest the rye for hay, till and seed beans, indicates that they must feel it is a better economic option.

Could you please elaborate on the benefits of perennial grass strips (mentioned in the context of soil conservation in drylands)? Thanks!

- A host of benefits including snow trap, capture any soil that might be drifting, home for beneficial insects, reduction in windspeed which helps improve water use efficiency.

The “Noble blade” works beautifully to terminate shallow-seeded green manures... under proper soil moisture. They do not work well if either too wet or too dry. SO, you need back-up plans

- Agreed. Flexibility is just so important.

Anyone using a Kelly Harrow for weed control,

post emergent? Chickling vetch? Is it a

resistant species?

- The Lethbridge folks say it is susceptible.

| Species | Grau et al. Plant Disease 1991, 75 (11), 1153-1156 | Chatterton 2020 (AAFC Lethbridge) |
|---|--|-----------------------------------|
| Arrowleaf clover (<i>Trifolium vesiculosum</i>) | R | |
| Aslike clover (<i>T. hybridum</i>) | R | |
| Berseem clover (<i>T. alexandrinum</i>) | S | R |
| Bird's-foot trefoil (<i>Lotus corniculatus</i>) | R | |
| Chickling vetch (<i>Lathyrus sativus</i>) | | S |
| Cowpea (<i>Vigna unguiculata</i>) | R | |
| Crimson clover (<i>T. incarnatum</i>) | S | S |
| Crown vetch (<i>Securigera varia</i>) | R | |
| Ebena vetch (<i>Vicia sativa</i>) | | S |
| Faba bean | S | |
| Field pea | S | |
| Garden pea | S | |
| Hungvillosa vetch (<i>Vicia villosa</i>) | | S |
| White Dutch/Ladino clover (<i>T. repens</i>) | R | R |

How does intercropping affect the number of years between a crop in a rotation?

- A great question for which there is no easy answer. However, I would say intercropped peas, for example, are a lot less susceptible to root rots.
- One other consideration is how the intercrop allows the susceptible crop to stand up. Sometimes pulses get diseased when the plant lays flat on the soil – which is avoided with many intercrops.
- Sorry I do not have a better answer for you.

The rotation to avoid disease applies to monocrop growing. What is the impact of mulit spp cover crop or intercropping to rotations for disease management?

- See answer right above this one.

Have there been any studies in relation to tillage and reduction in root rot susceptibility?

- Bailey, K.L., Mortensen, K. and Lafond, G.P., 1992. Effects of tillage systems and crop rotations on root and foliar diseases of wheat, flax, and peas in

Bailey, K. L., Mortensen K. and Lafond, G. P. 1992. **Effects of tillage systems and crop rotations on root and foliar diseases of wheat, flax, and field peas in Saskatchewan.** Can. J. Plant Sci. 72: 583–591. The dynamics of root and foliar diseases were studied in spring and winter wheat, peas, and flax and under zero, minimum, and conventional tillage at Indian Head, Saskatchewan, from 1987 to 1990. No disease was observed on flax during the 4 yr. Year-to-year variation was more important than tillage systems in explaining the incidence of bacterial leaf spot and foot rot of peas. Tan spot and septoria leaf blotch were the most important foliar diseases of wheat. Disease ratings (0–9) of the leaf spots were greater on winter wheat (average 2.2) than on spring wheat (average 1.9) and also greater on spring wheat following a cereal (average 2.0) than following peas or summer fallow (average 1.7). Hot and dry weather did not enhance development of foliar diseases, and no consistent effects of tillage on leaf disease ratings were observed. However, take-all and common root rot were affected by crop management. Incidence of take-all was greater on winter wheat (8%) than on spring wheat (1%) and also greater on winter wheat under conventional (11%) than minimum (8%) or zero tillage (6%). Severity of common root rot of spring wheat was greater following either spring (24%) or winter wheat (25%) than peas (22%) and summer fallow (15%). The severity of common root rot varied from year to year. In 3 of the 4 years, minimum-till and zero-till reduced the severity of the disease.

Saskatchewan. *Canadian Journal of Plant Science*, 72(2), pp.583-591.

Is there any difference for disease management or avoidance between pulses taken to harvest, terminated as green manure or inter-seeded in other crops?

- My feeling is yes, but I have little hard evidence.

Dumb question, green, yellow and maple peas would all have equivalent problems with root rot? about winter peas/winter lentils, do they have the same equivalent problem

- Don't now.
- But the winter vs spring pea types experience very different conditions
- No such thing as a dumb question

why are my oat stems sometimes very narrow

- Is it because your seeding rate is extremely high and plants are competing with each other a bit too much?

I see piles of screenings (mostly weed seeds) lying around a lot and farmers are happy

to get rid of them. Can these be composted to ensure weed seeds are denatured and used as a source of nutrients? What is the nutrient content of composted seeds as opposed to animal manure?

- We know that composting reduces viability of weed seeds. See this work from Lethbridge. Larney, F.J. and Blackshaw, R.E., 2003. Weed seed viability in composted beef cattle feedlot manure. *Journal of Environmental Quality*, 32(3), pp.1105-1113.

1110

J. ENVIRON. QUAL., VOL. 32, MAY-JUNE 2003

Table 3. Effect of time of removal from compost windrow on weed seed viability in 1999.

| Weed | Time of removal | | | | | |
|---------------------|-----------------|-------|--------|--------|--------|--------|
| | Control | Day 7 | Day 14 | Day 21 | Day 42 | Day 91 |
| | % | | | | | |
| Downy brome | 95.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| False cleavers | 54.0 | 2.5† | 6.5‡ | 0.0 | 0.0 | 0.0 |
| Foxtail barley | 79.0 | 0.5‡ | 0.0 | 0.0 | 0.0 | 0.0 |
| Green foxtail | 91.0 | 2.8‡ | 1.0‡ | 1.2‡ | 0.0 | 0.0 |
| Green smartweed | 62.5 | 21.0† | 12.0‡ | 9.0‡ | 3.3‡ | 0.0 |
| Redroot pigweed | 77.5 | 15.7† | 7.2‡ | 2.0‡ | 0.0 | 0.0 |
| Round-leaved mallow | 21.0 | 13.5† | 14.0† | 6.5† | 0.0 | 0.0 |
| Scentless chamomile | 94.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Stinkweed | 13.5 | 5.5‡ | 8.5‡ | 3.3‡ | 0.0 | 0.0 |
| Stork's-bill | 94.5 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Wild buckwheat | 52.0 | 14.7† | 30.7‡ | 15.2‡ | 3.0‡ | 0.0 |
| Wild mustard | 50.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| Wild oat | 66.0 | 0.7‡ | 0.8‡ | 0.0 | 0.0 | 0.0 |

† Germinable seed and respiring seed contributing to viability.

‡ Zero germinable seed, respiring seed only contributing to viability.

- As far as nutrient value – this depends on weed species. I would guess composted weed seed nutrient concentration similar to beef cattle manure but lower than poultry or swine.

I have heard that cattle grazing can result in a buildup of salts. Is this just anecdotal or are there studies about this connection?

- If the perennials (which may have been seeded in areas to reduce salinity) are overgrazed and perennial plants start to be replaced with shallower rooted weeds, then perhaps grazing can increase salts.

Pest Management with a Focus on Disease, Insects (and Weeds) January 10, 2023

It's my observation as well. Also that pests do not like red leafed plants vs green leafed.

- This is new to me. I would love to learn more.

Rather, my experience in organic vs conventional in market gardening also supports a pest advantage in organic systems.

- This is great to hear.

Has there been an effort to extract spray type chemicals from the deterrent plants?

- I am not aware. In tropics, farmers will make their own insecticides from plants – for example the Neem tree.

WE have been growing organic hemp. The grain is absolutely loaded with lady bugs. It makes us wonder what levels would be there if the lady bugs were not there.

- Interesting – thanks for sharing!

That is what levels of aphids would be there without the ladybugs.

- I think the levels shown in the “non-strip cropped” field in Quebec would give some idea. Ladybugs are good at finding aphids in most fields – it just takes them longer in a large field.

What are your thoughts on insects being repelled by plants with a high brix?

- I asked my entomology colleague. Here is the answer. Skeptical? I haven't seen much literature in support of it. A healthy plant might be able to defend itself well, but a nutritious plant would presumably be attractive to pests. Some pests are well adapted to deal with excess sugars in sap, so I don't see why it would deter them. I assume brix levels would be highly variable and context dependent, but I haven't put much thought into the idea.

Years ago when I worked as a summer research assistant I witnessed Colorado potato beetles swarming all over wild tomato plants. I could see the benefit of keeping these weeds to lure pests away. I also saw tachinid flies emerging from potato beetle larva.

Very interesting to watch parasitoids at work

- Interesting – thanks for sharing!

Doug C: That was a picture of our farm. We strip crop 12,509 acres- 240-3 0' crop strips with 20-30' perennial strips between each crop strip. Crop strips feature alternate portions of the seven-year crop rotation. We observe many advantages, but do not have capacity to quantify.

- Interesting – thanks for sharing!

Interesting articles for biological control of soybean aphids in Manitoba (including

increasing landscape complexity, having extra field habitats).

<https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0218522>

<https://www.sciencedirect.com/science/article/abs/pii/S0167880918301245>

- These are great papers from Manitoba. Not organic, but really great work showing biological control of soybean aphids in Manitoba.

Is there an advantage of having a pea/oat intercrop instead of a monocrop of peas for grasshoppers? Peas seem to be a deterrent and they love oats.

- Yes. See Allison Squires comments in lesson 3. She said the same thing you did.

Can polycrops be a substitute for rotation? Could you grow the same polycrop/intercrop every year, if they are diverse enough?

- Similar to questions above. Limited data. I would say to an extent intercrops could substitute some for rotation. Perennial pastures that mix grasses and legumes are an example.
- But, rotation does some unique things to some rotation would be desirable.

Is there a specific mycorrhizal seed treatment for potatoes? I tried it one year and I got extremely scabby spuds

- On healthy soils, adding mycorrhizal fungi is really not necessary. The spores are already in the soils. We just need to create the soil environment to make these beneficial fungi happy.
- Try adding sulfur with your potatoes (advice from a fellow farmer or agronomist)

Is there edge benefit for both crops? Or mostly for the taller specie?

- The edge effects can be enjoyed by all species. For example, a N fixing crop growing next to a cereal might be able to reach roots into the cereal zone and fix some N (this is because nodules tend to work harder when available N levels in soil are low – which they would be in cereals).

Is it the leaves and stems of the mustard that contains the biofumigate??? is there some benefit from the roots and chaff?

- For biofumigation, it is the young plant tissue that provide the fumigant. Need to kill mustard just as starts to flower.

Do these oat fungicides take care of basal rot in onions?

- Not sure – no experience.

Are you aware of any research that supports benefits of biodynamic preparations, in terms of disease management?

- This first study showed more disease from the preparations.



Effect of spray of biopreparates on diseases and yielding of spring wheat [2007]

Stepien, A.; Adamiak, J., Uniwersytet Warmińsko-Mazurski, Olsztyn (Poland). Katedra Systemów Rolniczych;

The aim of the study was evaluation of influence of fertilization recommended by organic agriculture i.e. using composts and biopreparates on plants health and yielding of spring wheat. Investigated spring wheat grew in crop rotation: sugar beet - spring wheat - winter barley. In growing plants organic fertilizer was applied only, sugar beet - with dose 30 t/ha - compost, winter barley with 10 t/ha as well. Spraying with biodynamic biopreparates: (P500 - made out of cow dung, P501 silica) was done according to the pattern. Applied doses of biopreparates affected increase of wheat disease intensity. More stimulative on disease development was P501 - silica than P500. On average, 12 years of experiment did not proved statistically biopreparates positive influence on wheat yield

- This next study showed that the preparations stimulated natural defense in grapes. Botelho, R.V., Roberti, R., Tessarin, P., Garcia-Mina, J.M. and Rombolà, A.D., 2016. Physiological responses of grapevines to biodynamic management. *Renewable agriculture and food systems*, 31(5), pp.402-413.

Abstract

A 3-year (2011–2013) field trial was carried out in a mature vineyard (*Vitis vinifera* L., cv. Sangiovese), planted in 2003, to assess physiological responses of grapevines to biodynamic management. Starting in 2007, the vineyard was managed with organic production protocols in accordance with EC Regulations (834/2007). In 2008, the vineyard (2 ha) was divided in two large plots, with each plot having similar soil physico-chemical properties. One of the plots was managed with organic protocols per EC Regulations and the other with biodynamic practices, consisting of spray application of preparations 500, 500 K, fladen and 501. During the 2011–2013 season, the biodynamic preparations were used at least twice per year, with the exception of 501 that was applied only once in 2013. Concentration of hormones and mineral elements in biodynamic preparations were determined. Biodynamically managed vines showed lower stomatal conductance in all years and lower leaf water potential in 2012. Leaf photosynthetic activity was not influenced by cultivation method. Biodynamic management led to an increase in leaf enzymatic activities of endochitinase (EC 3.2.1.14), exochitinase (β -N-acetylhexosaminidase, EC 3.2.1.52 and chitin 1,4- β -chitobiosidase) and β -1,3-glucanase (EC 3.2.1.39), which are typically correlated with plant biotic and abiotic stresses and associated with induced plant resistance. Year effects were observed with 1,3- β -glucanase, whose activity in 2012 was 4.1-fold higher than in 2013. Disease incidence and grape yields were not different between organic and biodynamic treatments. This study provided a strong indication of a stimulation of natural defense compounds in grapes grown under biodynamic cultivation, but subsequent effects on plant protection and productivity require further evaluation.

insects and thistle control. please talk about that.

- Cannot provide useful comment here. Sorry.

What would the “ECOTE” PRODUCTS be classified as?

- They would be a form of compost tea. I know some of their teas use vermicompost too.

Other Comments received outside of the live recording:

In horticultural conditions, it's been my observation that insect pressure on plants is most often the result struggling plant growth as a result of fertility imbalance, temperature/growth imbalance, and seasonal progression. It seems to me that these problems can be mitigated by varietal selection. What kind of work has been done on varietal selection and identification for pest resistance?

Soil Management for Organic Production: Putting Theory into Practice

January 12, 2023

Soil tests from my better land are always closer to balance by William Albrecht's principles. Why are his principles not followed within organics? Any thoughts on his principles of balance?

- While I appreciate what Albrecht was thinking and doing, I am not a fan. Prairie soils have bases well-saturated.
- See this article for Prairie Soil Scientists perspective on what is essentially Albrecht's methods. www.agvise.com/wp-content/uploads/2015/02/PPI-Cation-Ratios.pdf
- I also think there are larger challenges (e.g., getting enough legumes for N; getting some manure to replace P) than trying to adjust ratio to achieve some unproven (my words) balance.

How does one measure soil carbon in the biology of the soil?

- Microbial biomass C (chloroform extraction).

The microbial biomass accounts for only 1–3% of soil organic C but it is the eye of the needle through which all organic material that enters the soil must pass (Jenkinson 1977). During this process these materials are converted

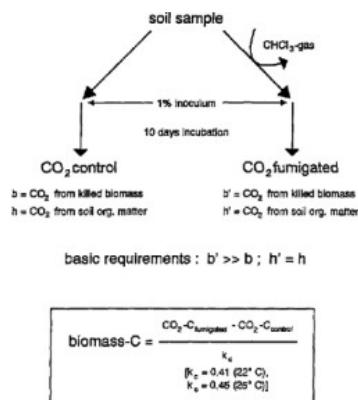


Fig. 1 Experimental procedure and calculation for the estimation of microbial biomass C by the CHCl₃ fumigation-incubation method (org. organic)

- Agvise labs in North Dakota will measure this for farmers.



604 Highway 15 West
 P.O. Box 510
 Northwood, ND 58267
 (701) 587-6010
 FAX (701) 587-6013
 email: agvise@polarcomm.com
 Homepage: www.agvise.com

AGVISE Soil Health Report

| | | | |
|--------------------------|---------|----------------------|--------|
| Submitted For: | | Submitted By: | LE0002 |
| MR FARMER | | JOHN LEE | |
| Box 316 | | 698 EVERGREEN DR. | |
| 123 | | | |
| Northwood, nd | 58267 | GRAND FORKS, ND | 58201 |
| Field ID = 12 | Sherbys | Sample ID = East 1/2 | |
| County = Ward | | Township = Lund | |
| Section = 17 | | Quarter = SW | |
| Date Received = 10/ 2/15 | | AGVISE Lab No = | 1 |
| Date Reported = 12/27/16 | | AGVISE Ref No = | 1 |
| Date Sampled = 10/12/15 | | | |

| | |
|---|------------|
| 1:1 Soil pH | 6.6 |
| 24 Hour CO2 Burst | 87.6 ppm C |
| Water Extractable Total Nitrogen | 42.2 ppm |
| Water Extractable Ammonical Nitrogen | 2.0 ppm |
| Water Extractable Nitrate Nitrogen | 13.5 ppm |
| Water Extractable Organic Nitrogen (WEON) | 26.7 ppm |
| Water Extractable Organic Carbon (WEOC) | 222 ppm |
| H3A Extractable Total Phosphorus | 16.5 ppm |
| H3A Extractable Inorganic Phosphorus | 10.6 ppm |
| H3A Water Extractable Organic Phosphorus | 5.9 ppm |
| H3A Extractable Potassium | 122 ppm |
| H3A Extractable Calcium | 690 ppm |
| H3A Extractable Magnesium | 192 ppm |
| H3A Extractable Sodium | 29.8 ppm |
| H3A Extractable Iron | 59.6 ppm |
| H3A Extractable Zinc | 0.6 ppm |
| H3A Extractable Aluminum | 112 ppm |

Calculated Values **

| | |
|---------------------------------------|----------|
| Soil Health Score | 13.7 |
| Organic Carbon:Organic Nitrogen Ratio | 8.3 |
| Mineralizable Nitrogen | 0.0 ppm |
| Microbial Active Carbon (MAC) | 39.5 % |
| Organic Nitrogen Release | 26.7 ppm |
| Organic Nitrogen Reserve | 0.0 ppm |
| Organic Phosphorus Release | 5.9 ppm |
| Organic Phosphorus Reserve | 0.0 ppm |

I think I wrote the link down incorrectly. Can you put the link in the chat? Laura Telford:
https://www.researchgate.net/publication/336285888_Conceptualizing_soil_organic_matter_into_particulate_and_mineral-associated_forms_to_address_global_change_in_the_21st_century
<https://www.pivotandgrow.com/organic-agronomist-training/>

Could Dr. Entz provide the reference for the study that looked at forage-grain rotation increase in DOM at Glenlea?

- Xu, N., Wilson, H.F., Saiers, J.E. and Entz, M., 2013. Effects of Crop Rotation and Management System on Water-Extractable Organic Matter Concentration, Structure, and Bioavailability in a Chernozemic Agricultural Soil. *Journal of*

environmental quality, 42(1), pp.179-190. (Available on line).

- **Laura Telford:** not sure if this is the right study: <https://www.researchgate.net/publication/363231334> Aggregate stability after 25 years of organic conventional and grassland management. This is a different study. But also from our lab with data from Glenlea.

I thought the dissolved carbon could be 10 to 70% of total photosynthate.

- Literature indicates it is less than 10% for the types of crops were grow in Canada, typically 5 to 7%.

Are the implications of tillage soil type dependent regardless of Nitrogen level?

- The studies that I referred to indicate that tillage particularly damaging when the available (or potentially available) N in the soil is very low.
- At Glenlea, the Potentially mineralizable N was high in some organic systems, and these would be more “tillage resilient.” The higher wet aggregate stability in these rotations supports that they indeed did have better aggregation despite that tillage was used. You can compare in the table below.

| Cropping System | Total C % (Microbial biomass C) | ² Potentially mineralizable nitrogen mg N/kg | Inorganic P Mg/kg | ³ Water stable aggregates |
|----------------------------------|------------------------------------|--|----------------------|--------------------------------------|
| Prairie | 4.4 ¹ (1750a) | 114 b | 18.2 a | 87.3 a |
| Grain only conventional | 4.5 (1179c) | 141 b | 15.1 a | 79 bc |
| Grain only organic | 3.7 (1080d) | 124 b | 19.5 a | 76 c |
| Forage-grain conventional | 3.9 (1476 b) | 140 b | 10.7 b | 75.3 c |
| Forage-grain organic | 4.2 (1648a) | 135 b | 5.3 c | 80 bc |
| Forage-grain organic plus manure | 4.5 (1718a) | 189 a | 16.5 a | 82.6 a |
| P value | 0.092 (0.0001) | 0.0013 | 0.0001 | 0.0001 |

When is it best to soil sample - spring, fall or both. What are your recommendations as to soil labs? And what about plant tissue testing?

- Plant tissue testing – see “Green manure bioassay” in lesson 1.

- For soil testing, early spring or late fall.

Wouldn't carbon capture correlate with the ability of the land to grow certain types of vegetation? i.e., wouldn't the ecosystem change to fit the climate?

- You are correct in saying that the total C coming into a soil would be dictated by the environment – i.e., the rainfall, temperature regime, etc.
- BUT – the efficiency with which that C “sticks” in soil can vary. The examples that I showed were of soil systems (some organic) where the C use efficiency was higher. This resulted in more C “sticking” in soils even though less total C was produced by the crops.

What is the impact of fallow- either tilled or chemical imposed on SOM?

- “lac ” tilled summerfallow is known to reduce SO since during one whole cropping season, soil respire C but no new C is added through plant growth. It is for this reason that the organic standards want farmers to grow a cover crop during the fallow phase.

so soil shading (cover crops) with added carbon (low tillage incorporating cover crops back into soil organic matter) especially with nitrogen (legume mixture) incorporation would be the best option?

- Yes, but also let me add adequate soil P. Very low levels of P will keep the soil at a low carbon use efficiency.

What is it about bio-dynamic farming makes a greater impact than organics?

- The biodynamic preparations are known to alter the soil microbiome.
- But not all studies have observed this. For example Carpenter-Boggs, L., Kennedy, A.C. and Reganold, J.P., 2000. Organic and biodynamic management effects on soil biology. *Soil Science Society of America Journal*, 64(5), pp.1651-1659.
- But the biodynamic system has recorded many improved soil functional properties, which over time have allowed it to have a higher carbon use efficiency.
- BUT – the straight up organic system (at DOK trial, for example), also performed very well.

Why would AMF colonization be so low in forage-grain organic plus manure?

- My explanation would be there is more P available, so plants do not need to invest as much C to support AMF for P supply.

Are conventional soils becoming more acidic because of synthetic fertilizers?

- Yes. <https://www.producer.com/news/zero-till-linked-to-acidic-soil/>
- "The entire soil profile won't be acidic and it may only be a problem on parts of a field, but no-tillers could have a band of soil, or a stratified layer, with a pH of 5.5 or lower."

What is the mechanism for the pH drop in conventional?

- See above

Any the slippage Carbon in the conventional system? Lost to the air?

- Yes. The "slippage" really refers to respiration – which is carbon dioxide being released to the atmosphere.

Would the metabolic quotient (krause slide) be related to the C:N ratio of the plant residue?

- A favourable (low) metabolic quotient is related to a very healthy population of soil micro-organisms. This healthy populations results in a "tighter" C cycle owing to more rapid growth – see slide from Lesson 4. It is the higher growth rate of the microbes that drives the higher CUE and metabolic quotient.

Can a Biodynamic System be defined?

Marla Carlson: <https://www.demeter-usa.org/>

An abundance of resources on biodynamic farming <https://www.demeter-usa.org/learn-more/>

More info on demeter biodynamic certification

<https://www.demeter-usa.org/certification/>

Kong and Six is that due to nitrogen fert boosting microbial 'processing' of soil carbon?

- Kong and Six basically just found that in organically managed soils, the proportion of plant C that ended up in the soil C pool was greater than conventional. There would be many processes involved, and they did not check them all.

Could you duplicate the grazing study by mowing and leaving mulch on surface. which stimulates the root to send up new shoots.....like mowing your lawn???

- I do not think so.

Cow drool as a natural biostimulant? Has there been studies?

- Sadly none that directly studied this effect. But lots of research on rumen fluid and how it helps break down cellulose. Perhaps the cow drool is helping break down old plant material on the floor of the pasture?
- Here is what my grassland/animal science colleague said. "Hmmm off hand I would guess not much. Saliva does have enzymes, minerals, buffers but although it is secreted into the mouth, really very little (to none) comes in contact with the plants/soil. Gallons of saliva is produced and contributes to the "vat" of rumen fermentation but much reabsorption of nutrients (of things like urea, sulphates etc.) eventually into the bloodstream results in an internal recycling so to speak." Martin here: I would add that the tongue would contain some saliva which would be transferred to plants.

Oxygen levels at 2m?

- Yes, if there was no oxygen roots would not grow.
- Roots cannot grow in saturated subsoils (soils with high water tables) due in part to lack of oxygen.

To follow up on my earlier comment.... or using light tillage (discing), for example on alfalfa that stimulates more growth

- Not same mechanism

History: In regards to sweet clover having a poor catch vs great catch within a mile of each other.

- This comment focusses on the variability in establishing small seeded legumes like sweet clover. Thank you for sharing your experience. I wonder if a different legume species, e.g., alfalfa, would react the same way.

Same year, same seed, same inoculant, different prior land management. 20-year wheat/fallow repeat rotation vs. wheat/fallow/oats/fallow/sweet clover/fallow repeat rotation.

Poor sweet clover growth on wheat/fallow/oats/fallow/sweet clover/fallow vs very good stand of clover introduced on wheat/fallow rotation.

The wheat/fallow/oats/fallow/sweet clover/fallow rotation initial years started out with very good stands of sweet clover.

What is the conversion of nitrogen to carbon?

- N is required to capture C. The mechanism is that N is required for plants to grow leaves (solar collectors) that can fix the C through photosynthesis.

Question: Is long term use of sweet clover removing a trace mineral required by biology for adequate nodulation? Molybdenum, manganese, cobalt &/or other? I have read aforementioned are important in nitrogen processes.

- My suggestion is that soil be tested for micronutrients once every 5 or 6 years to check on their status.

Other Comments received outside of the live recording:

Dr. Entz mentioned doing a feed test on green manures to determine phosphorus level and said they should be .2% or higher. Is there a recommended amount we should see in the test for other nutrients like K, S or Ca for example?

- Great question. The best data comes from animal nutrition. We have struggled to find good values for plants. I suggest two options. First, a standard soil test will help. Second, a “plant root simulator” approach can be very useful. Western Ag labs provides this service.

Are there any data or trials you may have for using elemental sulfur to acidify soil and make soil phosphorus or added rock phosphorus more plant available?

- The whole idea of trying to acidify your soil is a bad one. Be happy if your soil has a neutral pH. Once pH below 6 or even 6.5, bacteria slow down. Not what you want.

When do you typically do soil testing, spring or fall? Have you noticed much difference between the two?

- Late fall or early spring similar.
1. I believe that low pH soils are capable of converting rock phosphate (that is in abundance at least in my soil) into a plant useable form. To what extent should we try to lower the pH by including buckwheat in our rotation for example?
 - a. This has been tried many times. Unless your soil is already below 6 pH, I would not recommend it.
 2. I prefer sweet clover as a green manure crop. When I started a long time ago establishing and producing a good crop was easy now it seems to be getting more difficult. I believe the sweet clover weevil is a major part of the problem.

What other reasons may there be?

- If soil P levels are low, legumes do not grow as well. What is your soil P level?
 - This is one good reason to add some red clover or alsike clover with sweet clover –
diversity of species for insect control.
3. I often seed the clover along with flax. Incorporating the sweet clover green manure along with the flax stubble and straw with a discer the next year results in the flax trash decomposing rapidly and completely. Does this mean that the flax straw contributes to mineralized carbon rather than particulate carbon?
- Yes – correct. The roots of flax and sweetclover have the potential to contribute to the MAOM pool, while the flax straw would break down and be stored in aggregates as POM.
 - I think it is very innovative how you use the legume green manure to help breakdown flax straw.

How to access papers on-line:

The screenshot shows a Google Scholar search for "biederbeck legume green fallow". The search results are displayed in a list format. The first result is titled "Soil microbial populations and activities as influenced by legume green fallow in a semiarid climate" by VO Biederbeck, RP Zentner, and CA Campbell, published in Soil Biology and Biochemistry in 2005. The second result is titled "Long-term assessment of management of an annual legume green manure crop for fallow replacement in the Brown soil zone" by CA Campbell and VO Biederbeck, published in the Canadian Journal of Soil Science in 2004. The search interface includes filters for time, type, and citations, and a search bar at the top.

4.

Designing Cropping Systems with a Focus on Nutrient Management January 5, 2023

Does alfalfa dry out in the soil?

See Dr. Entz's response in the Agronomy Training – Response to Questions file

How can one avoid disease in pulse crops, with pulses in rotation on sort intervals: How long should the interval be between pulse crops or green manures?

See Dr. Entz's January 6 Response to Questions file

What crop or crops are used in the green manure in SK?

See Dr. Entz's response in the Agronomy Training – Response to Questions file

What has been the most beneficial termination process of the green manure for maximum nutrient availability? (i.e. moldboard plow, roller crimping...)

See Dr. Entz's response in the Agronomy Training – Response to Questions file

What should nodules on alfalfa root look like in organics?

See Dr. Entz's response in the Agronomy Training – Response to Questions file

How leachable in green manure N?

See Dr. Entz's response in the Agronomy Training – Response to Questions file

Where is a good source for cover crop seeds? Such as clover for example. Are there sources for small scale producers using small volumes?

See Dr. Entz's response in the Agronomy Training – Response to Questions file

How would grazing or swathing (for later grazing) compare in terms of nitrogen contribution from green manures?

See Dr. Entz's response in the Agronomy Training – Response to Questions file

Is this for all crops? Or only wheat?

See Dr. Entz's response in the Agronomy Training – Response to Questions file

If a Yellow Blossom clover is harvested for hay or silage will any N be produced? I always thought 50% of the N was in the below ground portion.

See Dr. Entz's response in the Agronomy Training – Response to Questions file

A participant shared a link to: [A survey of green manure productivity on dryland](#)

[organic grain farms in the eastern prairie region of Canada \(cdnsiencepub.com\)](http://cdnsiencepub.com)

Is the C:N ratio the same for conventional farms where chemical nitrogen is added: Or are those fields carbon deficient?

See Dr. Entz's response in the Agronomy Training – Response to Questions file

What varieties of beans don't produce nitrogen?

See Dr. Entz's response in the Agronomy Training – Response to Questions file

How often should we test our soil in a year to confirm there is enough N in the soil?

See Dr. Entz's response in the Agronomy Training – Response to Questions file

If you don't see a lot of nodules on the alfalfa root, how much N might you still be fixing or providing for the following year's crop through plowing alfalfa biomass under?

See Dr. Entz's response in the Agronomy Training – Response to Questions file

Participant comment: Check out the work of Dr. Stephanie Yarwood at U of Maryland. When measuring N type in soil, nitrate-N is less than 1% of the total N. And we tend to focus on it. For example, average total soil N in Manitoba and Saskatchewan cropland is approximately 9,000 lbs./acre! This is measured to 1 foot depth. So lots of N just not available. Why? Lack of cycling by soil biology.

See Dr. Entz's response in the Agronomy Training – Response to Questions file

Participant comment: And any discussion of N needs to include C. They are deeply interconnected. Carbon is the more fundamental nutrient than N or P. Carbon to build soil aggregation will create a home for the free-living nitrogen fixers (Diazotrophs) that do not require legume. Also poorly aggregated soils do not allow gas exchange and therefore poor N fixation from legumes and poor performance from legume inoculants (rhizobium).

What are some of the challenges with underseeding companion legumes with the 'extractive' crops; i.e. underseeding red clover in wheat (not as an intercrop for seed production, but instead just including it for N contribution). I'm wondering why there isn't more of that happening?

Comments on timing of a green manure termination vs. timing of N mineralization/N availability for subsequent crop? If green manure terminated late might not get N

mineralization in green manure year, but will get N mineralization in subsequent crop year be available in time for grain crop needs (and not reduce yield)?

What about dissolved and diluted then spread as a liquid (phos in acid). I guess that would be phosphoric acid?

See Dr. Entz's response in the Agronomy Training – Response to Questions file
What manure is higher than pigs?

Participant responded to the question above – poultry. Dr. Entz responded Correct!

Can you source pelleted poultry manure easily? If so, where?

See Dr. Entz's response in the Agronomy Training – Response to Questions file

What are the consequences of using manure from non-organic operations to organic fields?

See Dr. Entz's response in the Agronomy Training – Response to Questions file

How many chickens would be required to ensure higher concentration of P in an acre?

Response Crabtree: If you can afford to buy it.

See Dr. Entz's response in the Agronomy Training – Response to Questions file

Participant comment: I think the difference between manure and fert P is biology.

See Dr. Entz's response in the Agronomy Training – Response to Questions file

Does composting non-organic manure leave it organic?

See Dr. Entz's response in the Agronomy Training – Response to Questions file

Can you get sulphur besides from manure?

See Dr. Entz's response in the Agronomy Training – Response to Questions file

Participant comment: All tillage is not equally destructive

Participant comment: Note that Chilean nitrate is not approved for organic use in Canada.

See Dr. Entz's response in the Agronomy Training – Response to Questions file

I'm just starting to get into regenerative agriculture any sources that can be recommend would be appreciated

See Dr. Entz's response in the Agronomy Training – Response to Questions file

Participant comment: For sure there is a huge range of consequences from different tillage operations and timing. Key is understanding

What if I try and attract the ducks and geese to my land every spring and late fall in their migration instead of using chicken or rumen manure? Would I get a significant benefit of N and pH?

See Dr. Entz's response in the Agronomy Training – Response to Questions file

When appropriate tillage facilitates diverse crops and green manure, the net impact is positive

See Dr. Entz's response in the Agronomy Training – Response to Questions file

It seems to me that sustainable agriculture cannot be done without livestock?

See Dr. Entz's response in the Agronomy Training – Response to Questions file

Participant comment: Try using a chaff saver, the accumulation of seeds would lure flocks

See Dr. Entz's response in the Agronomy Training – Response to Questions file

How much N is in the legume green manure roots?

See Dr. Entz's response in the Agronomy Training – Response to Questions file

I've had the rotation in the past of a nitrogen fixing clover crop followed by three crops nitrogen using crops with the third under seeded back to a clover. How would I use a catch crop in a rotation? Would I underseed that crop?

How is the flax straw managed in the rotation

See Dr. Entz's response in the Agronomy Training – Response to Questions file

Where do you source black medic seed?

Laura note: couldn't find any sources for this.

Can you please discuss or comment on using alfalfa/hay mixtures for green manures so as to allow for grazing?

How could you use human waste as an organic fertilizer not being able to regulate the source. Wouldn't it be similar to municipal grass clippings off lawns pelleted to be used as a fertilizer?

See Dr. Entz's response in the Agronomy Training – Response to Questions file

Crop Establishment and Seeding Systems, Tillage and Weed Control January 6, 2023

In the notes for the first session it says, "Each hay bale weighing 1000 lb (400 kg) contains approximately 15 lb of P2O5 ; this is true for both alfalfa and pure grass bales." However, in the presentation slides the consistent figure is 15lbs of P/ton. That seems like a significant difference. Can you clarify?

See Dr. Entz's response in the Agronomy Training – Response to Questions file

Were same-variety comparisons made between conventional production and organic systems in the same/nearby location/same year?

See Dr. Entz's response in the Agronomy Training – Response to Questions file

Is there any guidance to the nutrients removed by weeds? Can it be based on the weighed dockage?

See Dr. Entz's response in the Agronomy Training – Response to Questions file

Organic and natural fertilizer suppliers tell us that, although rock phosphate is inert, they have found that if combined with sulphur and with sufficient moisture and organic matter as a determining factor in microbial activity, the sulphur along with microbes can have a similar effect to sulfuric acid (which is how conventional phosphorus is solubilized) and greatly increase the solubility of rock phosphate. Are you aware of third-party tests verifying this?

In our soils which are high in potassium and magnesium, using cattle can result in a growing excess of these nutrients. Some scientists claim that this will create a nutrient imbalance that can have various negative effects such as electrical bonding of more soil colloids to smaller potassium cations causing lack of soil aeration, etc. Is there a noticeable difference in plant based and animal manure-based compost in this regard? What can be done to manage for excess nutrients?

See Dr. Entz's response in the Agronomy Training – Response to Questions file

Should we consider different (lower) seed rate when intercropping? Such as oat with pea, etc.

See Dr. Entz's response in the Agronomy Training – Response to Questions file

I am interested to improve marginal land in northern Ontario. Please advise if switchgrass, as with great biomass and environment friendly, may also be a good choice

for cover crop or livestock feed applications? Kindly provide some avail data or study result. Enhancement of biodiversity and soil improvement are some of our goals for newly cleared land. Thanks. Adolph Ng, Acme Agriculture & Food Ltd. Vaughan, and Haileybury Ontario.

See Dr. Entz's response in the Agronomy Training – Response to Questions file

Surprised that the 2009 soybean seeding rate study from Carman, MB wasn't referred to. It matches on- farm trials and experiences from ON organic growers showing significant yield and profit advantages to increased seeding rates. Sorry, those Carman MB trials were completed in 2014 and 2015.

See Dr. Entz's response in the Agronomy Training – Response to Questions file

Do you consider semi deep furrow with a hoe drill vs the use of a single disc drill with no option to make a furrow?

See Dr. Entz's response in the Agronomy Training – Response to Questions file

Do packers encourage weed re-establishment?

See Dr. Entz's response in the Agronomy Training – Response to Questions file

Are there any comparisons of organic wheat vs organic spring wheat? Or comparisons of yield/dockage of organic vs conventional winter wheat?

What is research on early seeding vs. delayed to allow termination of the first flush of weeds with a single tillage pass prior to seeding? We have found that the advantage of improved weed control outweighs that of earlier seeding... to a point.

See Dr. Entz's response in the Agronomy Training – Response to Questions file

If feeding hay is such a good source of phosphorus, what are best practices for achieving uniform distribution? I have experimented with bale grazing, and find it results in very patchy results that take many years to even out. Is there a better way?

See Dr. Entz's response in the Agronomy Training – Response to Questions file

Is there a maximum to seeding rates, where increased rate leads to yield decreases?

See Dr. Entz's response in the Agronomy Training – Response to Questions file

Does seeding the forage at same time as oqt seed, rob moisture first thing in spring?

See Dr. Entz's response in the Agronomy Training – Response to Questions file

Have you ever left a plot go to weeds then monitored the results in soil tests relative soil nutrients and organics? Have you ever left a plot to weeds over a long term (5+ years)?

See Dr. Entz's response in the Agronomy Training – Response to Questions file

How much of the soil biology is killed by tillage?

See Dr. Entz's response in the Agronomy Training – Response to Questions file

Cultivator to terminate red clover would never work in our area :(Too many very large rocks

See Dr. Entz's response in the Agronomy Training – Response to Questions file

Are you suggesting that I don't terminate a 2-foot alfalfa green manure with a vertical tiller but maybe leave all that top growth all season long. Terminate with the farmer made cultivator/disc and try and direct seed into that alfalfa biomass next spring?

Comment from participant: We use a light tillage pass, as early as possible in spring to stimulate uniform emergence of small-seeded annual weeds. Then, our seeders have sweeps that terminate (most of) the weeds at "white-root" stage 7-10 days later. We have observed significant yield penalty if we eliminate the pre-tillage, or seed too early or late after pre-tilling- from greater weed competition.

See Dr. Entz's response in the Agronomy Training – Response to Questions file

How aggressive of a setting do you have on the tines?

See Dr. Entz's response in the Agronomy Training – Response to Questions file

RE the Scandinavian data on tillage - was there any measurement of soil temperatures? Sometimes in early spring, our soils are still very cold and germination of seeds may be delayed.

See Dr. Entz's response in the Agronomy Training – Response to Questions file

Is the use of a chaff saver another way to control wild oats?

See Dr. Entz's response in the Agronomy Training – Response to Questions file

How long do you have to leave alfalfa down to deplete wild oat banks and thistles?

See Dr. Entz's response in the Agronomy Training – Response to Questions file

With the rye/soybean combinations of till/no till, what was the actual yields of rye and

soybeans from each system and dollar values per acre achieved?

See Dr. Entz's response in the Agronomy Training – Response to Questions file

Could you please elaborate on the benefits of perennial grass strips (mentioned in the context of soil conservation in drylands)?

See Dr. Entz's response in the Agronomy Training – Response to Questions file

Participant comment: The "Noble blade" works beautifully to terminate shallow-seeded green manures... under proper soil moisture. They do not work well if either too wet or too dry. SO, you need back-up plans

See Dr. Entz's response in the Agronomy Training – Response to Questions file

Anyone using a Kelly Harrow for weed control, post emergent?

Not answered

Chickling vetch? Is it a resistant species?

See Dr. Entz's response in the Agronomy Training – Response to Questions file

How does intercropping affect the number of years between a crop in a rotation?

See Dr. Entz's response in the Agronomy Training – Response to Questions file

The rotation to avoid disease applies to monocrop growing. What is the impact of mulit spp cover crop or intercropping to rotations for disease management?

See Dr. Entz's response in the Agronomy Training – Response to Questions file

Have there been any studies in relation to tillage and reduction in root rot susceptibility?

See Dr. Entz's response in the Agronomy Training – Response to Questions file

Is there any difference for disease management or avoidance between pulses taken to harvest, terminated as green manure or inter-seeded in other crops?

See Dr. Entz's response in the Agronomy Training – Response to Questions file

Green, yellow and maple peas would all have equivalent problems with root rot? about winter peas/winter lentils, do they have the same equivalent problem?

See Dr. Entz's response in the Agronomy Training – Response to Questions file

Why are my oat stems sometimes very narrow?

See Dr. Entz's response in the Agronomy Training – Response to Questions file

I see piles of screenings (mostly weed seeds) lying around a lot and farmers are happy to get rid of them. Can these be composted to ensure weed seeds are denatured and used as a source of nutrients? What is the nutrient content of composted seeds as opposed to animal manure?

See Dr. Entz's response in the Agronomy Training – Response to Questions file

I have heard that cattle grazing can result in a buildup of salts. Is this just anecdotal or are there studies about this connection?

See Dr. Entz's response in the Agronomy Training – Response to Questions file

Pest Management with a Focus on Disease, Insects (and Weeds) January 10, 2023

It's my observation as well. Also that pests do not like red leafed plants vs green leafed.

See Dr. Entz's response in the Agronomy Training – Response to Questions file

Rather, my experience in organic vs conventional in market gardening also supports a pest advantage in organic systems.

See Dr. Entz's response in the Agronomy Training – Response to Questions file

Has there been an effort to extract spray type chemicals from the deterrent plants?

See Dr. Entz's response in the Agronomy Training – Response to Questions file

Participant comment: We have been growing organic hemp. The grain is absolutely loaded with lady bugs. It makes us wonder what levels would be there if the lady bugs were not there.

See Dr. Entz's response in the Agronomy Training – Response to Questions file

That is what levels of aphids would be there without the ladybugs?

See Dr. Entz's response in the Agronomy Training – Response to Questions file

What are your thoughts on insects being repelled by plants with a high brix?

See Dr. Entz's response in the Agronomy Training – Response to Questions file

Participant comment: Years ago when I worked as a summer research assistant I witnessed Colorado potato beetles swarming all over wild tomato plants. I could see the benefit of keeping these weeds to lure pests away. I also saw tachinid flies emerging from

potato beetle larva. Very interesting to watch parasitoids at work

See Dr. Entz's response in the Agronomy Training – Response to Questions file

Participant comment: That was a picture of our farm. We strip crop 12,509 acres- 240-360' crop strips with 20-30' perennial strips between each crop strip. Crop strips feature alternate portions of the seven-year crop rotation. We observe many advantages, but do not have capacity to quantify.

See Dr. Entz's response in the Agronomy Training – Response to Questions file

Participant comment: Interesting articles for biological control of soybean aphids in Manitoba (including increasing landscape complexity, having extra field habitats).

<https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0218522>

<https://www.sciencedirect.com/science/article/abs/pii/S0167880918301245>

Is there an advantage of having a pea/oat intercrop instead of a monocrop of peas for grasshoppers? Peas seem to be a deterrent and they love oats.

See Dr. Entz's response in the Agronomy Training – Response to Questions file

Can polycrops be a substitute for rotation? Could you grow the same polycrop/intercrop every year, if they are diverse enough?

See Dr. Entz's response in the Agronomy Training – Response to Questions file

Is there a specific mycorrhizal seed treatment for potatoes? I tried it one year and I got extremely scabby spuds?

See Dr. Entz's response in the Agronomy Training – Response to Questions file

Participant comment: Try adding sulfur with your potatoes

Is there edge benefit for both crops? Or mostly for the taller species?

See Dr. Entz's response in the Agronomy Training – Response to Questions file

Is it the leaves and stems of the mustard that contains the biofumigate??? is there some benefit from the roots and chaff?

See Dr. Entz's response in the Agronomy Training – Response to Questions file

Do these oat fungicides take care of basal rot in onions?

See Dr. Entz's response in the Agronomy Training – Response to Questions file

Are you aware of any research that supports benefits of biodynamic preparations, in terms of disease management?

See Dr. Entz's response in the Agronomy Training – Response to Questions file

Insects and thistle control. Please talk about that.

See Dr. Entz's response in the Agronomy Training – Response to Questions file

What would the "ECOTEA" PRODUCTS be classified as?

See Dr. Entz's response in the Agronomy Training – Response to Questions file

Other Comments received outside of the live recording:

Participant comment: In horticultural conditions, it's been my observation that insect pressure on plants is most often the result struggling plant growth as a result of fertility imbalance, temperature/growth imbalance, and seasonal progression. It seems to me that these problems can be mitigated by varietal selection. What kind of work has been done on varietal selection and identification for pest resistance?

Not answered

Soil Management for Organic Production: Putting Theory into Practice January 12, 2023

Soil tests from my better land are always closer to balance by William Albrecht's principles. Why are his principles not followed within organics? Any thoughts on his principles of balance?

See Dr. Entz's response in the Agronomy Training – Response to Questions file

How does one measure soil carbon in the biology of the soil?

See Dr. Entz's response in the Agronomy Training – Response to Questions file

Could Dr. Entz provide the reference for the study that looked at forage-grain rotation increase in DOM at Glenlea?

See Dr. Entz's response in the Agronomy Training – Response to Questions file

I thought the dissolved carbon could be 10 to 70% of total photosynthate.

See Dr. Entz's response in the Agronomy Training – Response to Questions file

Are the implications of tillage soil type dependent regardless of Nitrogen level?

See Dr. Entz's response in the Agronomy Training – Response to Questions file

When is it best to soil sample - spring, fall or both. What are your recommendations as

to soil labs? And what about plant tissue testing?

See Dr. Entz's response in the Agronomy Training – Response to Questions file

Wouldn't carbon capture correlate with the ability of the land to grow certain types of vegetation? i.e., wouldn't the ecosystem change to fit the climate?

See Dr. Entz's response in the Agronomy Training – Response to Questions file

What is the impact of fallow- either tilled or chemical imposed on SOM?

See Dr. Entz's response in the Agronomy Training – Response to Questions file

So soil shading (cover crops) with added carbon (low tillage incorporating cover crops back into soil organic matter) especially with nitrogen (legume mixture) incorporation would be the best option? See Dr. Entz's response in the Agronomy Training – Response to Questions file

What is it about bio-dynamic farming makes a greater impact than organics?

See Dr. Entz's response in the Agronomy Training – Response to Questions file

Why would AMF colonization be so low in forage-grain organic plus manure?

See Dr. Entz's response in the Agronomy Training – Response to Question

Are conventional soils becoming more acidic because of synthetic fertilizers?

What is the mechanism for the pH drop in conventional?

See Dr. Entz's response in the Agronomy Training – Response to Questions file

Any the slippage Carbon in the conventional system? Lost to the air?

See Dr. Entz's response in the Agronomy Training – Response to Questions file

Would the metabolic quotient (krause slide) be related to the C:N ratio of the plant residue?

See Dr. Entz's response in the Agronomy Training – Response to Questions file

Can a Biodynamic System be defined?

Marla Carlson: <https://www.demeter-usa.org/>

An abundance of resources on biodynamic farming <https://www.demeter-usa.org/learn-more/> More info on demeter biodynamic certification

<https://www.demeter-usa.org/certification/>

Re Kong and Six is that due to nitrogen fert boosting microbial 'processing' of soil carbon?

See Dr. Entz's response in the Agronomy Training – Response to Questions file

Could you duplicate the grazing study by mowing and leaving mulch on surface. which

stimulates the root to send up new shootslike mowing your lawn???

See Dr. Entz's response in the Agronomy Training – Response to Questions file

Cow drool as a natural biostimulant? Has there been studies?

See Dr. Entz's response in the Agronomy Training – Response to Questions file

Participant comment: You need the cow and her rumen.

Oxygen levels at 2m?

See Dr. Entz's response in the Agronomy Training – Response to Questions file

To follow up on my earlier comment.... or using light tillage (discing), for example on alfalfa that stimulates more growth

See Dr. Entz's response in the Agronomy Training – Response to Questions file

History: In regards to sweet clover having a poor catch vs great catch within a mile of each other.

See Dr. Entz's response in the Agronomy Training – Response to Questions file

Same year, same seed, same inoculant, different prior land management. 20-year wheat/fallow repeat rotation vs. wheat/fallow/oats/fallow/sweet clover/fallow repeat rotation.

See Dr. Entz's response in the Agronomy Training – Response to Questions file

What is the conversion of nitrogen to carbon?

See Dr. Entz's response in the Agronomy Training – Response to Questions file

Is long term use of sweet clover removing a trace mineral required by biology for adequate nodulation? Molybdenum, manganese, cobalt &/or other? I have read aforementioned are important in nitrogen processes.

See Dr. Entz's response in the Agronomy Training – Response to Questions file

Other Comments received outside of the live recording:

Dr. Entz mentioned doing a feed test on green manures to determine phosphorus level and said they should be .2% or higher. Is there an amount we should see in the test for other nutrients like K, S or Ca for example? Are there any data or trials you may have for using elemental sulfur to acidify soil and make soil phosphorus or added rock phosphorus more plant available? When do you typically do soil testing, spring or fall? Have you noticed much difference between the two?

See Dr. Entz's response in the Agronomy Training – Response to Questions file

1. I believe that low pH soils are capable of converting rock phosphate (that is in abundance at least in my soil) into a plant useable form. To what extent should we try to lower the pH by including buckwheat in our rotation for example?

2. I prefer sweet clover as a green manure crop. When I started a long time ago establishing and producing a good crop was easy now it seems to be getting more difficult. I believe the sweet clover weevil is a major part of the problem. What other reasons may there be?

3. I often seed the clover along with flax. Incorporating the sweet clover green manure along with the flax stubble and straw with a discer the next year results in the flax trash decomposing rapidly and completely. Does this mean that the flax straw contributes to mineralized carbon rather than particulate carbon?

See Dr. Entz's response in the Agronomy Training – Response to Questions file



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The **Canadian Organic Ingredient Strategy (COIS)** provides farmers with tools and support to incorporate organic farming practices that help meet the growing demand for organic foods in Canada. The tools developed as part of this project will help Canadian farmers benefit from increased knowledge and skills in organic farming methods, which can improve soil health and boost farm resilience in the face of changing markets and climate change.

Visit www.pivotandgrow.com to learn more about the tools created as part of COIS.