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Diversified cropping strategies to improve sustainability of organic crop production in the Brown soil zone

2023 Submitted by Dr. Myriam Fernandez

Most organic producers in the Canadian Prairies rely on legume green manures for N input, soil health, and weed suppression, although some still practice summer fallow. However, there can be disadvantages to growing legume only crops as green manures for N supply. Legume species can be particularly sensitive to very dry or very wet growing conditions, they have low competitiveness to weeds and other crops, they decompose rapidly thus not contributing much to organic matter, and the most common legumes grown in the western Prairies are susceptible to Fusarium and Aphanomyces root rot. Thus, organic production based on intensive legume-only cropping for N supply might not be sustainable, especially under a scenario of climate change. There is a need to investigate practices with mixes of legumes and other crops, such as cover crop mixtures and intercrops, for their many benefits. These alternative practices would be important components of more sustainable, resilient and profitable organic crop production systems.

There is not much information on cover cropping in the semi-arid regions in Canada, or other parts of the world, especially under organic management. There is also a belief that cover cropping could not be successfully practiced in western Canada, mostly due to the fact that crops not adapted to the region have been unsuccessfully grown by producers.

The motivation for our organic cover crop project was to increase the sustainability, resilience and profitability of organic production in the Brown soil zone.

Main Objectives:

The main objectives of this project were to increase soil nutrients and quality, to control weeds and other crop pests, and to improve yield and quality of cash crops grown after cover crops. We were also interested not only in determining the impact that non-legume crops might have on disease development in legumes when grown together, but also in identifying species with better resistance to root rot than the most commonly grown legumes in this region.

This investigation is relevant to organic producers not only in the Brown soil zone, but also in other regions where similar environmental conditions occur, and which are becoming increasingly common due to climate change.

(Photo by Organic Research Program at the Swift Current Research and Development Centre)

Methodology:

The selected annual monocrop cover crops grown in these trials were the brassicas badger radish, forage rape, turnip rape and collards, the grasses Japanese millet and oat, the legumes forage pea, chickling vetch, crimson clover, subterranean clover and Indianhead lentil, and the Forb phacelia.

The three main mixtures (hereafter called blends) grown were dominated by grasses (Blend 1), brassicas (Blend 2) or legumes (Blend 3), using the same species as in the monocrops.

All monocrops and blends were seeded in the spring and mowed at flowering to early seed set. They were then followed by a cash grain crop (durum wheat) seeded the following spring after light cultivation.

Each cover crop-durum cycle was on a different piece of organic land. Extensive samplings and measurements were taken throughout the growing season in both phases of this crop sequence.

Highlights of Results from the Cover Crop trials:

- The years in which these trials were conducted (2017-2022) were dry to very dry, which allowed us to determine the performance of cover crops under not very favourable growing conditions. Selection of the most adapted species to our environment was mostly done in the first two years of this project.

- There was a significant difference among monocrops and blends for most parameters measured throughout the 6 years, and total of 7 trials.

- There was variability in weed growth within plots and among replicates. The highest weed biomass was in the clovers, and in Blend 3 among the blends, while the lowest weed biomass was in oat and Blend 2, followed by badger radish, Blend 1 and forage pea.

- Overall, the grass monocrops had high crop biomass, followed by most of the brassicas and the blends. In contrast, depending on the species and environment, overall the legumes tended to have less than optimal growth, with the lowest biomass observed in the clovers. The latter also had the lowest root rot levels of all legumes.

- Crop biomass was not significantly different among the three blends. Similar biomass in Blends 1 and 3 could be attributed to the presence of Grasses in the latter.

(Photos by Organic Research Program at the Swift Current Research and Development Centre)

Highlights of Results from the growing season following the Cover Crops:

- In all cases, the impacts of the cover crops were carried over to the following year. In the spring following the cover crops, only NO_3^- at all soil depths was significantly different among treatments. In soil sampled in the spring, NO_3^- levels were lower after the brassicas than the legumes, and higher after Blend 3 than the other blends.

- For weed biomass in the following durum wheat crop, the high variability within plots and among replicates resulted in no significant differences among functional groups. Durum wheat grown after Blend 2 had a lower weed biomass than when grown after Blend 3.

- Crop biomass of durum wheat was highest after the legumes. There was no significant difference in grain yield, but contrasts showed that grain yield was lower after the brassicas than the grasses or legumes. The lowest grain weight was after the Brassicas, while grain protein concentration was highest in durum wheat grown after the Legumes and Blend 3.

Highlights of Conclusions:

Most cover crop species we selected for these trials were able to perform well under our dry conditions, proving that it is possible to grow cover crops successfully in this region and prevailing environment.

Considering that a given set of species is not going to perform equally across soil zones and regions it is important to rely on one's species selection and not include those that are shown not to be adapted to one's conditions, as monocrops or in mixtures with more competitive species.

In addition, in general, proportions of cover crops in mixtures are usually calculated based on seeding rates. However, depending on the functional group and species, some crops might dominate while others might perform poorly. Their growth rate can be highly variable depending on the other crops in the mixture, soil zone and environment. Thus, it is advisable to mix cover crop species based on their expected biomass in the area, and forecasted weather if possible.

(Photos by Organic Research Program at the Swift Current Research and Development Centre)

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