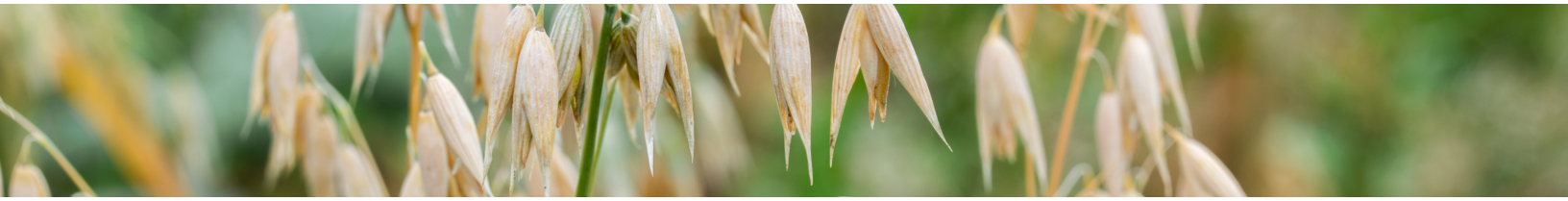
Latest Research Results

organic SCIENCE CLUSTER 3

Optimizing yield and resilience of organically grown milling oat

2023

Submitted by Dr. Steve Shirtliffe



Milling quality oats are a mainstay of organic crop production in western Canada and currently occupy 21% of organic prairie field crop area. Factors limiting oat yields under organic production include soil fertility (phosphorus, in particular) and weed interference.

The objective of this research project was to develop an organic oat production system that optimizes yield, quality and profit. To achieve this, the following sub-objectives were:

1) Identify most effective combinations of weed control practices for organic oat.

2) Identify the optimum nutrient management system for organic oat; and,

3) To optimize combined weed control and nutrient management practices for profitable organic oat production.

The objectives were addressed in 3 separate experiments.

1. Weed Management in Organic Oat

The purpose of this field trial was to determine the weed control and yield effects of integrated cultural (seeding rates) and mechanical weed management practices in organic oat. The experiment was conducted at 6 different location-years from 2019-2022. The factorial experiment was composed of 2 factors: oat seeding rate (SR) and mechanical weed control (MC). Oat seeding rates included a low and and high seeding rate of 250 plants m^{-2} and 500 plants m^{-2}, respectively. The second factor evaluated the use of mechanical weed control implements consisting of rotary hoeing (RH), inter-row cultivation (IRC), and rotary hoeing followed by inter-row cultivation (RH + IRC). Predominate weed species in the studies were wild mustard, green foxtail and common lambsquarters.

All site years received below-normal precipitation from 2019-2022. Highest oat yields were obtained at Kernen in 2020 (approximate average of 3600 kg ha^{-1}); however, 3 of the 6 site-years experienced extremely low yields (< 800 kg ha^{-1}) due to severe drought. Increasing oat seeding rate from 250 seeds to 500 seeds m^{-2} reduced weed biomass in 4 of 6 site-years, with reductions ranging from 27 to 64%. Despite the reduction in weed biomass, the higher seeding rate only resulted in a minor yield increase (5%) in 1 of 6 site-years. Under drought conditions, the higher seeding rate resulted in slightly lower yields in 2 site-years, despite reducing weed biomass. In-crop RH was very effective with minimal negative effects on oat density. Treatments that included RH reduced weed biomass by 54 to > 90% in 5 of 6 site-years (Figure 1). IRC alone was not as effective as RH as intra-row weeds were not controlled. RH + IRC provided marginal benefits over RH (2 of 6 site-years) and it is likely uneconomical to combine the two mechanical systems in oat production. Treatments that included RH improved crop yield in 3 of 6 site-years, with improvements in crop yield ranging from 9 to 21% compared to the untreated check. The benefit of higher seeding rate and mechanical weed control were more pronounced at the site-year where oat yield was > 3000 kg ha^{-1}.

Oat plot seeded at 500 seeds m^{-2} with timely rotary hoeing followed by inter-row cultivations. Treatment had negligible weed biomass under relatively good growing conditions in 2020. Photo taken August 10, 2020. (Photo by Eric Johnson)

2. Nutrient Management in Organic Oat

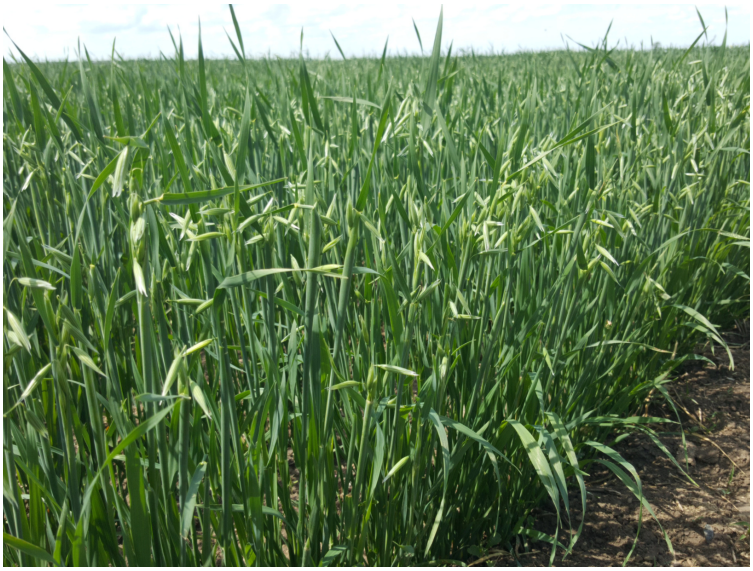
The purpose of this experiment was to evaluate the agronomic response of organic milling oat to previous crop stubbles in combination with different animal manure amendments. Additionally, we wanted to determine whether the timing of manure application influences oat's response by evaluating the residual effects of manure applied before the previous crop or before the subsequent oat crop. The 2-year experiment was conducted at 4 different locations from 2018 -2021. The first trial starting in 2018 consisted of 2 factors: previous crop types and animal manure amendments. The previous crop types included wheat, fababean for seed, fababean green manure cover crop (GM), and summer fallow (fallow). Manure treatments included composted cattle manure, raw chicken manure, and an untreated control that was applied in the fall before the oat crop the following spring. The remaining 3 trials were carried out in the same way; however, two timings of manure application were included as a factor. Manure applications were applied in the fall prior to the previous crop or prior to the subsequent oat crop.

At all 4 sites, oat seeded on fababean GM and fallow resulted in a 22 to 62% higher biomass than oat seeded on wheat, which produced the lowest biomass. Fababean grown for seed led to oat biomass quantities that were comparable to GM at 2 of the 4 sites. Additionally, there were interactions at specific site-years. In Kernen 2019, oat grown on fallow without manure resulted in the highest biomass weights. However, when chicken manure wascombined with fallow, it led to a reduction in biomass, while chicken manure applied to wheat stubble improved oat biomass weights compared to their corresponding untreated checks. Additionally, in two of the site-years (Kernen and Goodale 2020), oat biomass following the green manure and fallow treatment were found to be comparable, regardless of manure application. Oat grown on wheat stubble without manure resulted in the lowest biomass but was improved with the addition of manure.

Oat seed yields were highest at Kernen in 2020 (on average 4600 kg ha^{-1}), while heat and drought stress caused extremely low yields in 2021 (on average 660 kg ha^{-1}). Treatments seeded on fallow and GM resulted in the highest oat yields at 3 of the 4 sites and were 19 to 93% higher than the fababean grown for seed and wheat treatments. At 1 site, the application of cattle manure prior to the oat crop improved oat yields by 55% compared to cattle manure applied before the previous crop; however, the application of manure did not result in any yield benefits when compared to the untreated check.

3. Combined Nutrient and Weed Management in Organic Oat

Two experiments conducted in 2022 attempted to integrate the best treatments from experiments 1 and 2. Factors included previous crop (wheat and lentil green manure), fall chicken manure pellet application (0, 1000, and 2000 kg ha^{-1}), and as required weed control (timely RH, IRC). Residual effects of severe drought in 2021 and terminal drought in 2022 resulted in very low seed yields, with yield benefits only derived from weed control.



Conclusions

Oat demonstrated a stronger response to the previous cropping system than to manure amendments. The fababean green manure cover crop showed to be equally beneficial for oat production as summer fallow, even under drought conditions and could be considered an effective alternative to fallow. In terms of weed control, higher oat seeding rates reduced weed biomass but provided limited yield benefit under the droughty conditions experienced during this study. Timely rotary hoeing was highly effective in reducing weed interference in oat, with only marginal benefits achieved by combining it with inter-row cultivation.

Weed infestation in untreated oat check (top) and control with min-till rotary hoe (bottom). Kernen Research Farm. June 9, 2022. (Photo by Eric Johnson)

Researchers:

Steve Shirtliffe (Principal Investigator, University of Saskatchewan)
Eric Johnson (Co-Investigator, University of Saskatchewan)
Racquelle Peters (University of Saskatchewan)

Technical Staff
Shaun Campbell
Sydney Beresh

Contributing Partner:

Western Grains Research Foundation

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