ORGANIC RESEARCH RESULTS 2016

COMPARISON OF UNDERSEEDING VS. POST-HARVEST COVER CROP FOR ORGANIC OATS

PROJECT OVERVIEW:

Organic oats are often seeded with a legume or legume/grass underseeding. Depending on oat yield goal, the planned following crop in the rotation, and weed pressure, farmers may prefer to till after grain harvest and plant a mixed species cover crop. In 2016, two organic grain farmers compared either alfalfa or medium red clover seeded with organic oats to tilling and planting a mixed species cover crop, including Sunn hemp, yellow sweetclover, medium red clover, and tillage radish. The effects on pre harvest weed biomass, oat grain yield and test weight, and fall biomass growth of the cover crop treatments were evaluated.

KEY FINDINGS:

Neither alfalfa nor red clover underseedings with oats compared to where there was no underseeding affected pre harvest weed biomass. Underseeded red clover, however, reduced oats grain yields by 12 bu/A on Alert's. Alfalfa underseeded at Madsen's did not affect oat grain yields. The legume underseedings had no effect on grain test weight. Late season biomass differed by farm and was highly influenced by planting date At Alert's, late-season biomass from the underseeded red clover was approximately six times higher when compared to the mixed species, likely due to late planting for the post-harvest cover crop. Conversely, at Madsen's, the mixed species cover crop biomass was approximately two and one half time greater that the alfalfa. Impact of the different cover crop options on corn are being evaluated in 2017.

COOPERATORS:

Doug Alert, Hampton; Vic Madsen, Audubon

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WEB LINK: http://bit.ly/IOAresearch

PROJECT BACKGROUND:

Within extended rotations, small grains, such as oats (*Avena sativa* L.), provide income and value from grain and straw, as food, feed, seed, or bedding. Oats are often sown with underseeded legumes, primarily clovers (*Trifolium spp.*) and alfalfa (*Medicago sativa* L.) which contribute to weed suppression, nitrogen fixation and soil quality improvement (Liebman and Davis, 2000; Anderson, 2010). Underseeding is common practice with oats, but some farmers prefer to sow oats alone and follow the mid-season harvest with a single or multiple-species cover crop. Mid-season cover crops provide a similar benefits to underseeded legumes and also provide a window for soil disturbance which disrupts growing weeds in addition to suppressing later emerging weeds. (Blanco-Canqui et al., 2015). What about competition from the legume underseeding? When oats is sown with an underseeded legume, competition for water, light and nutrients may reduce grain yield (Sheaffer, 2005). The underseeded legume species may also be important. In a long-term study conducted in central Iowa, oat yield when sown with medium red clover was significantly lower than when sown with alfalfa (Liebman, unpublished data). When using an underseeded legume or a post-harvest cover crop with oats, there may also be effects on the following crop. Practical Farmers of Iowa, from 2012 to 2014, assessed differences in biomass quantity and quality (nitrogen content) between seeding a mid-season cover crop mixture after a small grain compared with frost-seeding a legume into the small grain (Gailans, 2014). Results demonstrated that the frost-seeded red clover produced more biomass and contained more nitrogen than the mid-season cover crop mixture, which included cowpea (*Vigna unguiculata* (L.) Walp.), crimson clover (*Trifolium incarnatum* L.), berseem clover (*Trifolium alexandrinum* L.), sunn hemp (*Crotalaria juncea* L.), oilseed radish (*Raphanus sativus* L.) and oat. Corn yields following the frost-seeded vs. mid-season cover crop treatments were not

different at two of the three sites and were greater following the frost-seeded red clover at the third site.

The goal of this research was to determine the effects of an underseeded legume on organic oat grain yield and test weight; and differences in weed biomass and end of season biomass between the underseeded legume and the mid-season cover crop treatments.

METHODS:

Research was conducted on Doug Alert's farm in northcentral Iowa near Hampton, in Franklin County and on Vic Madsen's farm in southwestern Iowa near Audubon, in Audubon County. Treatments were: oats sown with an underseeded legume and oats sown without an underseeding followed by post-harvest tillage and seeding of a mid-season cover crop. On both farms, oats were sown at 29 plants/ft2. using a calibration equation from the University of Minnesota (Wiersma et al., 2005):

$$Desired\ Planting\ Rate\ (\frac{lb.}{acre}) = \frac{Desired\ Plant\ Stand\ \div (1 - expected\ loss(\%))}{\frac{Seeds}{lb.}\ x\ PLS}$$

$$PLS = Pure\ Live\ Seed$$

Estimated stand loss was 15%. Each farmer determined seeds per pound by counting and weighing out 1000 seeds. Germination percent and pure seed was obtained from seed bag tags and Pure Live Seed (PLS) calculated (germination percent x pure seed). Underseeded legume species were chosen by farmers based on their normal rotation and management practices. Cooperating farmers discussed and agreed upon the multi-species mid-season cover crop mix for use on both farms. Field operations timing, oat variety, legume and mid-season cover crop species and seeding rates are listed in Table 1.

Table 1. Operation timing, oat, underseeding and mid-season cover crop (MSCC) species and quantities.

Farmer	Oat Variety	Underseeding		Planting Date	(Swathing Date) Harvest Date	MSCC		MSCC Planting Date
		Species	lbs./A			Species	lbs./A	
Madsen	Shelby 427	Alfalfa	12	4/2/2016	7/26/2016	Sunn hemp	3	8/9/2016
						Yellow sweet clover	3	
Alert	Saber	Medium red clover	12	4/16/2016	(8/3/2016) 8/17/2016	Medium red clover	3	9/5/2016
						Tillage radish	2	

Table 2. Rainfall and oat growing degree-days (GDD, base 32°F) for 2016 and long-term averages for Audubon and Hampton.

	Audubon[a]				Hampton[a]			
	Rainfall (in.)		GDD		Rainfall (in.)		GDD	
Mon.	2016	Avg.[b]	2016	Avg.[b]	2016	Avg.[b]	2016	Avg.[b]
Mar.	1.18	2.08	406.5	266.4	3.81	2.03	333.5	192.7
Apr.	3.94	3.45	550.5	548.8	1.76	3.54	521.5	477.8
May	7.73	4.48	787	885.3	4.42	4.59	829.5	843
Jun.	2.23	4.86	1198	1126.6	6.42	5.41	1184.5	1096.3
Jul.	4.09	4.04	1219.5	1269.5	7.06	4.9	1248	1237.1
Aug	5.6	4.23	1196	1211.3	4.24	4.07	1215.5	1174.5
Total	24.87	23.14	5357.5	5307.9	27.71	24.55	5332.5	5021.3

[a]Data from Audubon and Hampton were accessed from the Iowa Environmental Mesonet (2016).

[b]Avg. represents average values from 1951-2015.

Both farms established five replicates of the two treatments in a randomized, complete block design, totaling 20 plots. Plot widths ranged from 15 to 24 ft. and plot lengths from 370 to 500 ft. Initial field measurements were taken when oat plants were in the early dough (Z8.0) stage of development (Zadoks et al., 1974); July 15 at Madsen's farm and July 22 at Alert's farm. Five subsamples were taken from each experimental unit by walking in an M-W pattern across the unit and randomly selecting a subsample area using a 0.5 m2 quadrat. In order to assess weed biomass in season, all vegetative material, oat plants, legume underseeding and weed biomass, was clipped and removed from above the soil surface using garden shears. Above ground oat plant biomass and underseeding biomass were separated out and discarded. Weed biomass was then dried at 140°F to a constant weight and then weighed. A similar sampling protocol was used to collect underseeding biomass from both the underseeded and mid-season cover crop seeded plots in the mid fall; October 16 on Madsen's farm and October 14 on Alert's farm.

Yields were determined by combining one strip down the middle of each plot and weighing grain in weigh wagons. Yields are expressed at the 32 pound test weight per bushel standard. Subsamples of approximately one quart of grain were taken from each harvested strip and used to measure grain moisture content and test weight using a. a DICKEY-john 2500-AGRI Grain Analysis Computer. Reported grain yield numbers were all normalized to 13% moisture. David Weisberger analyzed data using the GLIMMIX procedure in SAS 9.4 (SAS Institute, 2013) to evaluate the effect of underseeding vs. no underseeding on oat grain yield, test weight panicle number and weed biomass. Factors were considered to be significant at $p \leq 0.05$.

RESULTS & DISCUSSION:

Total rainfall (by month) and oat growing degree days (GDD, base 32°F) are given for Audubon, IA (4 miles from Madsen's farm) and Hampton, IA (5 miles from Alert's farm) (Table 2).

Grain Yield and Test Weight

Grain yield between treatments was different at Alert's farm ($p = 0.02$); oats underseeded with red clover yielded 13% less than those seeded alone (Fig. 1, Table 3). There was no difference in oat yields between treatments at Madsen's farm where alfalfa was used as the underseeded crop. Both treatments at Madsen's yielded approximately 89 bushels/acre. There were no treatment effects on test weight at either farm. Overall, test weight was higher at Madsen's farm than at Alert's (36 and 33 lbs./bushel respectively).

Weed Biomass

Pre harvest weed biomass did not differ between treatments at either farm. The two farms differed ($p = 0.05$) in the over-

Figure 1. Oat grain yield. Oats were harvested in mid-August at Alert's farm and in late July at Madsen's farm. For each farm, columns with different letters are significantly different ($P < 0.05$).

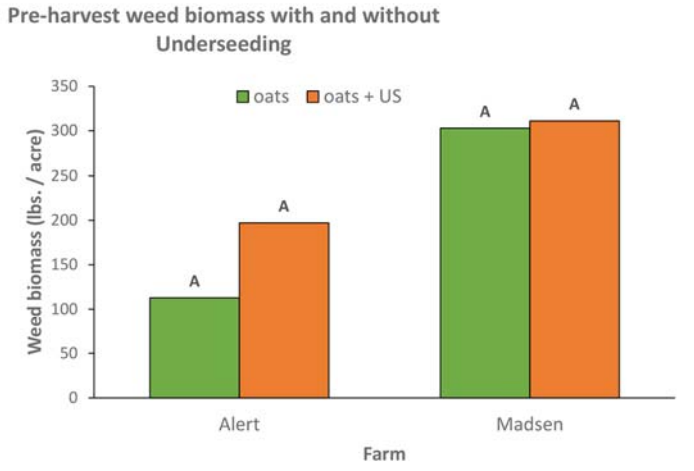

Figure 2. Pre-harvest weed biomass with and without an underseeding. Samples were taken in mid to late July when oat plants were in the soft dough stage. For each farm, columns not followed by the same lowercase letter are different ($P < 0.05$).

all quantity of weed biomass. Average weed biomass across treatments at Alert's farm was lower than that of Madsen's farm (155 and 307 lbs. / acre respectively) (Fig. 2). Lower mean weed biomass at Alert's farm may be attributable to the fact the field used in this trial was recently transitioned to organic production compared to the Madsen site, which had been under certified organic production since 2002. Differences were evident in the observed weed species at Alert's farm, which consisted almost exclusively of yellow foxtail (Setaria pumila (Poir.) Roem & Schultgiant) versus those at Madsen's farm, which were more numerous and diverse, and also included annuals yellow and giant foxtail (Setaria faberi Herrm.), in addition to sunflower (Helianthus annuus L.) and the perennial, Canada thistle (Cirsium arvense L. Scop.).

End of Season Legume and Mid-season Cover Crop Biomass

There were differences in end of season biomass between

Red clover underseeding regrowth in October at Doug Alert's.

the underseeded legumes and the MSCC at both farms ($p < 0.001$). At Alert's farm there was almost six times more biomass where red clover had been underseeded with oats in the spring (1154 vs. 195 lbs./acre). At Madsen's farm the opposite was true, though to a lesser effect. Plots that had been undersown with alfalfa averaged 510 lbs. / acre of biomass while those that had been seeded to the MSCC averaged 1303 lbs. / acre of biomass. (Fig. 3). Volunteer red clover made up some of Madsen's underseeding biomass. The large variation in these results are attributable to environmental, management and legume species differences at each site. Differences in MSCC biomass were probably most attributable to differences in planting date at Madsen's farm (Aug. 9) and Alert's farm (Sept. 5). The majority of Madsen's MSCC biomass was tillage radish and volunteer oats. While these species have been shown to provide benefits such as soil compaction alleviation and erosion control, they do not provide atmospherically fixed nitrogen like clover or alfalfa (Chen and Weil, 2010, De Baets et al., 2011).

CONCLUSIONS & MANAGEMENT IMPLICATIONS:

Results from this study were highly site specific. While direct comparisons cannot be made as to the effects of a given underseeing species on oat grain yield, these two trials, coupled with information from the previous long-term study here in Iowa point to the competitive nature of a red clover underseeding and its possible negative impact on grain yield. Farmers who use red clover for multiple agronomic and economic goals in a given season may have to carefully consider tradeoffs between crop yield and establishment of a green manure. Those seeking to maximize oat yield and are considering a mid-season cover crop should plan to plant as early as is possible following oat harvest. Choice of a given MSCC species mixture will depend on a combination of management goals, environmental constraints and economics. Similarly, if neither red clover nor a MSCC is of interest, those using an alfalfa underseeding may be satisfied in the results of this trial, as Vic Madsen was, "The alfalfa does good things for soil conservation and making nitrogen for the next year's crop so we're happy it doesn't hurt the oats".

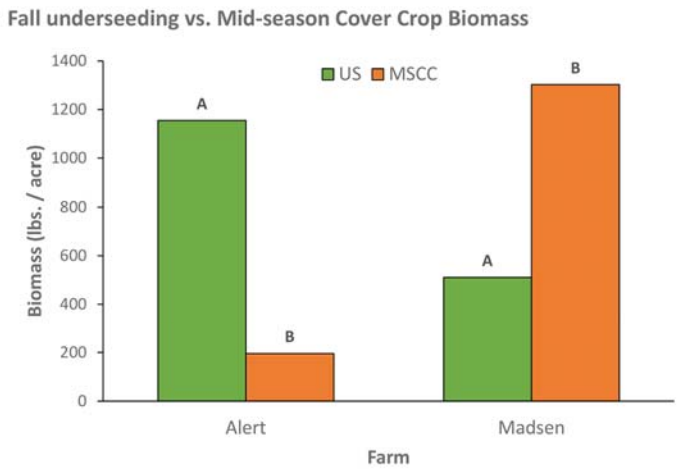

Figure 3. Fall underseeding (US) and mid-season cover crop (MSCC) biomass. Samples were taken in mid-October at both farms, after a killing frost had occurred. For each farm, columns with different letters are significantly different ($P < 0.05$).

Mixed species cover crop planted post oat harvest. October growth at Vic Madsen's.

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