Fall Cover Crop Influence on Spring Potato Production

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Introduction

At the 2012 Fruit and Vegetable Field Day held at the Iowa State University Horticulture Station, one of the major challenges highlighted by commercial vegetable growers was "weed management." Growers called for research on sustainable and environmentally conscious ways of weed management. Use of cover crops to suppress weeds was one of the outcomes of the discussion. The goal of this project was to evaluate and study the effect of fall-seeded cover crops on weed management and yield of potato crop. The three cover crops studied included cereal rye, crimson clover, and oilseed radish. Treatments were chosen based on their optimal growing season as well as ease of access for farmers.

The control treatment for the study was a no-cover crop plot in which weeds were left unchecked. The study also investigated the cover crop effect on two different potato cultivars (Red Pontiac and Yukon Gold) commonly grown in Iowa.

Materials and Methods

The plot was tilled on August 23, 2013 and August 25, 2014. Cover crops were seeded the same day using a drop spreader and were lightly tilled-in. The control plots were tilled at this time and not tilled again until cover crop termination. Supplemental irrigation was installed in 2013 to provide adequate soil moisture for seed germination. In mid-October, above-ground cover crop and weed biomass were taken using 0.5 m^2 quadrats from two locations within the control, oilseed radish, and crimson clover treatments across all four replications. The biomass was sorted into three groups consisting of cover crop, broadleaf weeds, and grass weeds. The cover crop and weed biomass was dried and weighed. Cereal rye biomass was taken in the following spring. On May 7, 2014 and March 30, 2015, cover crops were roto-tilled to a depth of 6-8 in. Later, the plot was fertilized with 50 kg/ha of nitrogen, 60 kg/ha each of K_20 and P_20_5 in both years with the exception of K_20 in 2015, which was applied at the rate of 112 kg/ha. Potatoes were planted in rows 40 in. apart with tubers 9 in. apart within the row. Planting took place on June 11, 2014 and April 23, 2015. The experimental design was a latin square split-plot design with four replications. The whole plot factor was the cover crop and potato cultivar was the subplot factor.

Plots were mechanically cultivated four weeks after planting. Prior to cultivating, weed population levels were taken by counting the weeds in 0.5m^2 quadrats laid across the plots. Approximately seven weeks after planting, the same weed population measurements were repeated. At this time, nitrogen was side-dressed at the rate of 84 kg/ha via as urea (46-0-0) and mixed in during cultivation. Seventeen weeks after planting, weed population data were again collected followed by potato harvest. Potatoes were graded by size into the A and B categories as described by the United States Standards for Grades of Potatoes. Soil samples were taken throughout the season in both years to monitor soil nitrogen, phosphorous, and potassium.

Results and Discussion

Cover crop biomass was higher in 2014 than in 2013 for all the cover crop treatments (Table 1). In 2013, cereal rye and oilseed radish produced statistically similar biomass. Oilseed radish produced higher biomass than crimson clover but there was no difference between crimson clover and cereal rye. In 2014, cereal rye had the highest biomass followed by oilseed radish and crimson clover. Broadleaf weed biomass in 2013 and 2014 was affected by the cover crops. Oilseed radish and cereal rye decreased broadleaf weed biomass compared with the crimson clover and control treatment in 2013. In 2014, cereal rye decreased broadleaf weed biomass when compared with the control. Grass weed biomass was affected by the cover crops in 2013 with oilseed radish and cereal rye suppressing weeds compared with control or crimson clover.

At the time of cover crop termination, soil nitrogen was higher in the crimson clover treatment compared with the control or cereal rye (Table 2). Soil nitrogen at potato planting was higher in the cereal rye treatment compared with the control. For the rest of the season, treatments did not influence soil nitrogen.

Weed count was affected by the cover crop treatments at cover crop termination only (Table 2). All cover crop treatments decreased weed populations compared with the control. Oilseed radish and cereal rye offered the most weed suppression followed by the crimson clover. Broadleaf weed species in the plot included common lambsquarter (*Chenopodium album*), common purslane (*Portulaca oleracea*), Pennsylvania smartweed (*Polygonum pensylvanicum*), redroot pigweed (*Amaranthus retroflexus*), and tall waterhemp (*Amaranthus tuberculatus*). Predominant grass weeds were green foxtail (*Setaria viridis*), giant foxtail (*Setaria faberi*), large crabgrass (*Digitaria sanguinalis*), witchgrass (*Panicum capillare*), and yellow foxtail (*Setaria pumila*).

The potatoes were harvested on October 8, 2014 and August 14, 2015. After harvest, potatoes were graded into three categories — Grade A, Grade B, and non-marketable. Non-marketable potatoes were the ones that did not fit the size for Grade A or B and/or potatoes that were misshapen, rotten, or had insect damage. In both years, cover crops had no effect on Grade A, B, or non-marketable potatoes (Table 3). Between the two potato cultivars studied, Red Pontiac yielded higher Grade A and B potatoes than Yukon Gold in both years. Non-marketable potatoes were also less in the Red Pontiac cultivar.

Even though no yield or quality improvement in potato production was observed through the use of cereal rye, crimson clover, or oilseed radish, no yield decline was observed. Cover crops can provide multiple benefits ranging from reduced soil erosion, increased weed suppression, increased organic matter and fertility, and reduced nutrient loss, especially nitrate leaching. Thus, integration of fall-planted cover crops for spring potato production could be used as a tool to derive various environmental benefits without any reduction in potato yields the following year.

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Table 1. Cover crop biomass and influence on weed biomass at the ISU Horticulture Research Station in fall 2013 and 2014.[z]

Cover crop treatment	Cover crop biomass (kg·ha^{-1})		Broadleaf weed biomass (kg·ha^{-1})[y]		Grass weed biomass (kg·ha^{-1})[x]	
	2013	2014	2013	2014	2013	2014
Control	-----	-----	2,400 a	459.0 a	52 a	40
Crimson cover	423 b[w]	3,050 c	2,218 a	253.0 ab	65 a	12
Oilseed radish	5,052 a	5,364 b	210 b	0.5 ab	2 b	1
Cereal rye[u]	2,326 ab	8,392 a	302 b	0.0 b	0 b	0
Significance						
Treatment	*[v]	**	***	*	*	NS
Treatment × year	**	**	***	***	NS	NS

[z]Data for control, crimson clover, and oilseed radish treatments were taken on October 16, 2013 and October 27, 2014. Data for cereal rye treatment were taken on April 16, 2014 and 31 March 31, 2015.
[y]Values represent broadleaf weed biomass in the growing cover crops at the time of cover crop biomass sampling.
[x]Values represent grass weed biomass in the growing cover crops at the time of cover crop biomass sampling.
[w]Mean separation within columns by least significant difference test (P ≤ .05). Values within each column sharing the same letter are not different.
[v]NS, *, **, *** nonsignificant or significant at P ≤ 0.05, 0.01, or 0.001, respectively, based on least significant difference test.

Table 2. Soil nitrogen and weed count in the potato crop at the ISU Horticulture Research Station in 2014 and 2015.

Treatment	Soil nitrogen (mg·kg^{-1})				Weed count/ha (×100, 000)			
	Time 1[z]	Time 2	Time 3	Time 4	Time 1[y]	Time 2	Time 3	Time 4
Control	2.3 b[x]	3.9 b	6.2	1.9	5.46 a	82.68	39.35	11.93
Crimson clover	3.0 a	5.3 ab	5.9	1.8	3.10 b	91.58	39.13	8.00
Oilseed radish	2.5 ab	4.9 ab	4.7	1.9	0.06 c	72.42	57.28	8.10
Cereal rye	1.7 c	6.3 a	4.5	1.8	0.50 c	85.20	50.22	12.10
Significance								
Treatment	***[x]	**	NS	NS	***	NS	NS	NS
Treatment × year	NS	NS	NS	NS	NS	NS	NS	NS

[z]Time 1,2,3,4 representing soil nitrogen at cover crop termination, potato planting, initiation of tuber bulking, and harvest, respectively.
[y]Time 1,2,3,4 representing weed populations at cover crop termination, potato planting, tuber bulking, and harvest, respectively.
[x]Mean separation within columns was done by least significant difference test (P ≤ .05). Values within each column sharing the same letter are not different.
[w]NS, **, *** nonsignificant or significant at P ≤ 0.01, or 0.001, respectively, based on least significant difference test.

Table 3. Effect of cover crops and potato cultivar on potato marketable and non-marketable yield at the ISU Horticulture Research Station in 2014 and 2015.

	Grade A[z]		Grade B[y]		Non-marketable[x]	
Treatments	**kg·ha^{-1}**	**ct·ha^{-1}**	**kg·ha^{-1}**	**ct·ha^{-1}**	**kg·ha^{-1}**	**ct·ha^{-1}**
Control	16,792	100,751	1,955	47,828	6,405	47,756
Crimson clover	17,509	106,456	1,938	46,088	6,835	45,693
Oilseed radish	17,635	103,693	2,009	50,573	6,387	37,297
Cereal rye	17,348	102,814	1,794	44,689	6,189	36,024
Cultivar						
Gold	9,508 b[w]	67,221 b	1,381 b	33,440 b	1,094 b	7,320 b
Red	25,134 a	139,627 a	2,476 a	61,122 a	11,661 a	76,065 a
Significance						
Treatment	NS[v]	NS	NS	NS	NS	NS
Cultivar	***	***	***	***	***	***
Treatment × cultivar	NS	NS	NS	NS	NS	NS

[z]Grade A = potatoes larger than 1.875 in. diameter.
[y]Grade B = potatoes with diameter between 1.875 in. to 0.75 in.
[x]Non-marketable potatoes included potatoes with cracks, rotting, excessive scab, insect damage, or were misshapen.
[w]Mean separation within columns between cultivars by least significant difference test ($P \leq .05$). Values within each column sharing the same letter are not different.
[v]NS, *** nonsignificant or significant at $P \leq 0.001$, respectively, based on least significant difference test.