Spring Application of Winter Rye for Weed Control in Plasticulture Onions

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Introduction

Plasticulture production of onions is increasing in the Northeast providing farmers with in-row weed control, soil moisture regulation and season extension. However, the bare row middles in this system require herbicide or cultivation which increase environmental impacts and labor inputs. In 2012 the Cornell Vegetable Program was awarded a NESARE grant to evaluate winter rye between plastic-mulched beds of onions on a cooperating farm. The farmer provided cultivation and herbicide treatments to enable us to compare weed control, yield and pest and disease impacts.

MATERIALS AND METHODS:

Onion transplants (var: Candy) were produced on farm and transplanted by hand on April 16. Onions were planted into reflective silver plastic mulch beds, 4 rows per bed, with 6 inch in-row spacing. Herbicide (Prowl H20-pendimethalin at label rates) and rye (3 bu/A) were applied to either side of the onion beds on April 10. A foliar application of Movento (spirotretamat) at label rate for thrips control was made to all plots in early July. Data was collected on plant height, insects, disease, foliar nutrients and weed biomass throughout the season. Statistical differences among treatments was determined by General Analysis of Variance (ANOVA) with mean separation by an LSD test with a $p \leq 0.05$.

Results

Onions plots with rye middles were significantly the tallest on 3 out of 4 dates (Table 1). Cultivation was consistently the shortest treatment. Rye treated plots had the fewest number of leaves.

The onions had minor infestations of Onion Thrips (*Thrips tabaci*) and Botrytis Leaf Blight (*Botrytis squamosa*). While there were no differences in leaf disease, there was a difference in pest pressure. On June 12, there were significantly less onion thrips in the herbicide plots than in the rye and cultivated plots, with the cultivated plots having the most thrips.

Table 1. Onion Plant Growth and Pest Pressure.

ONION	**Plant Height (cm)**				**Number of Leaves**				**Pest Pressure.** Jun 12	
	May 22	*June 12*	*July 3*	*July 24*	*May 22*	*June 12*	*July 3*	*July 24*	*No. BLB Lesions/Leaf*	*No. Onion Thrips/Plant*
Rye	21.3 a	57.8	76.6 a	71.9 a	4.1	7.0 b	8.8 b	7.6 b	2.92	4.22 ab
Cultivation	19.3 b	56.4	71.1 b	68.2 b	4.3	7.6 a	9.0 b	8.4 a	2.92	5.07 a
Herbicide	20.5 ab	57.7	73.1 b	72.8 a	4.1	7.4 a	9.6 a	8.5 a	2.42	3.01 b
pValue	*0.0488*	*NS*	*0.0009*	*0.0108*	*NS*	*0.0071*	*0.0124*	*0.0032*	*NS*	*0.0342*

Cultivation and Herbicide plots were significantly the highest yielding for marketable bulbs, with 84.26 and 83.5 pounds per 10 feet of bed, respectively (Table 2). These plots had twice as many colossal sized onions than the rye plots.

Table 2. Onion Yield in Pounds per 10 feet of bed

ONION	Colossal	Jumbo	Medium	Small	Cull	Cull-Rot	Total Marketable
Rye	29.49 b	34.28 a	2.29 a	0.14	1.71	1.63	66.19 b
Cultivation	60.11 a	23.45 b	0.66 b	0.04	1.15	0.46	84.26 a
Herbicide	64.38 a	18.13 b	0.96 ab	0.04	0.61	0.00	83.50 a
pValue	*0.0008*	*0.0261*	*NS*	*NS*	*NS*	*NS*	*0.0001*

The rye plots had the lowest amount of weeds, however, there were not statistical significant differences on any of the three collection dates (Table 3).

Table 3. Weed Biomass taken from row middles in grams.

	Fresh weight of weeds in grams		
	May 22	*June 12*	*July 3*
Rye	0.03	1.28	0.00
Cultivation	1.75	1.15	3.35
Herbicide	0.68	20.58	1.45
pValue	*NS*	*NS*	*NS*

Foliar nutrient levels did differ between the treatments (Table 4). Nitrogen and Potassium were lower in rye treated plots on both sample dates than cultivated and herbicide treated.

Table 4. Onion foliar nutrient levels.

	July 3, 2012			July 24, 2012		
	Rye	Cultivated	Herbicide	Rye	Cultivated	Herbicide
Nitrogen	2.65%	3.21%	3.29%	2.64%	2.92%	2.75%
Phosphorus	0.47%	0.45%	0.35%	0.35%	0.25%	0.23%
Potassium	3.38%	3.96%	3.82%	3.35%	4.16%	4.09%
Magnesium	0.30%	0.23%	0.29%	0.42%	0.33%	0.33%
Calcium	1.79%	1.22%	1.82%	3.59%	3.30%	3.13%
Sulfur	0.73%	0.97%	0.89%	0.67%	0.85%	0.79%
Boron	27 ppm	27 ppm	25 ppm	31 ppm	33 ppm	32 ppm
Zinc	13 ppm	15 ppm	15 ppm	13 ppm	13 ppm	10 ppm
Manganese	54 ppm	69 ppm	71 ppm	75 ppm	109 ppm	118 ppm
Iron	81 ppm	101 ppm	116 ppm	117 ppm	146 ppm	144 ppm
Copper	6 ppm	6 ppm	6 ppm	15 ppm	7 ppm	6 ppm

KEY:
Deficient
Low
Sufficent
High
Excessive

Results and discussion

Rye as an inter-row cover crop presented challenges in this project. Yield loss was over 18 lbs per 10 linear feet of row when compared to cultivation. Calculating onion economics is difficult as there are price differentials related to grade (bulb size) and market. However, rye treated plots yielded less than half than number of colossal bulbs (≥ 4" diameter) of herbicide and cultivation plots. The value of these bulbs is often $ 0.40 more than the next class, representing a loss of over $21 per 10 linear feet of bed.

What is causing this yield loss is not understood. Mid-summer rainfall was scarce, and thus water competition is possible. Nutrient competition is also possible, with nitrogen and potassium at times lower in the rye plots, although trends are not clear. Allelopathy from the rye has been suggested, although rye roots did not extend underneath the plastic mulch.

Rye did provide very good weed control performing as well or better than herbicide and cultivation until harvest. There was an unexpected disease in the rye, leaf rust, caused by *Puccinia recondita tritici*. Although this disease did not impact the onion crop it reduced rye stands. Labor associated with managing rye vigor was minimal. The cooperating farmer reports mowing 1 time mid-season.

Rye reduced the environmental impact in this study by reducing erosion and replacing herbicides. On the cooperating farm eliminating an application of pendamethalin reduces the field Environmental Impact Quotient (EIQ) by 33.9 points per acre. It should be noted that cultivation would also eliminate the EIQ of the herbicides, but with a higher labor input.

Conclusions

In this study, winter rye as an inter-row cover crop provided weed control comparable to cultivation and herbicides. However the yield loss prevents promotion of the system at this time. A similar trial with tomatoes saw increased pest pressure. The mechanism in which rye reduced yield warrants further attention. Future work will examine other winter grains as inter-row cover crops and higher fertility/irrigation rates for the onion crop to eliminate potential competition.

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