

Effects of Rye Cover Crop on Strip-Till Pumpkin Production in Northern Illinois

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This paper reports the evaluation of rye cover crop seeding rates and nitrogen fertilizer application rates on yield and quality of jack-o'-lantern pumpkin fruits in a 2008 trial in northern Illinois.

Materials and Methods

The experiment was carried out at St. Charles Horticulture Research Center, St. Charles, Illinois, between October 3, 2007 and October 10, 2008. Grain rye, *Cereale secale*, was seeded in a field that was previously under corn on October 3, 2007 at the rates of 90 and 120 pounds (lbs) per acre on 6-foot wide strips and 5-foot wide bare ground left between the strips. Rye height and number of rye stems per 12-square-foot area was assessed between May 5 and 18, 2008. On May 23, 2008, the rye plants, which were at a height of about 4 feet tall (at flowering stage before pollination), were killed by rolling with a tractor drawn "cultimulcher" to form mulch. The strips of bare ground between the rolled areas were tilled on June 13, 2008 using a rototiller.

Three main plot treatments comprised of rye at seeding rates of 90 and 120 pounds per acre, and bare ground as control were replicated four times. Each main plot was divided into four sub-plots. Urea fertilizer grade 46-0-0 (Cooperative Plus, Burlington, Wisconsin) was applied on June 16, 2008 in a band and incorporated into the soil on the bare strips between the cover crop rows and on 5-foot-wide strips on control plots. In two sub-plots, nitrogen (N) fertilizer was applied at the rate of 45 pounds N per acre, and in the other two sub-plots at the rate of 90 pounds N per acre. Each sub-plot was 40 feet long, and pumpkin variety 'Howden' was direct seeded on a 15-foot row, and 'Magic Lantern' in another 15-foot long row with a 10-foot alleyway between the two varieties. The pumpkin seeds were planted 3 feet apart within the row (five plants of each variety per plot). The plots were 20 feet apart and were replicated four times. On June 19, 2008, pumpkin varieties 'Magic Lantern' and 'Howden' seeds were planted using a "Jab Planter." Immediately after plant emergence, two sets of tensiometers (Irrrometer Company, Riverside, California) were installed at 12 and 18 inches depths, respectively to monitor soil moisture status. The readings were taken weekly during the growing season.

Weed control in bare ground (control) plots was achieved by using Strategy[®] herbicide (Ethalfluralin and Clomazone, United Agricultural Products; Platte Chemical Company, Greeley, Colorado) applied pre-emergence at the rate of 6 pints per ac⁻¹. Sandea[®] herbicide (Halosulfuron-methyl, Gowan Company, Yuma, Arizona) was applied pre-emergence at the rate of ½ fluid ounce per ac⁻¹ to control redroot pigweed and other weeds. Weed control on strip-tilled plots was done by applying the same rates of herbicides mentioned above on the bare strips between rye mulch. Weeds that emerged on mulched areas were hand hoed once. Insect pest and disease control was done based on recommendations in the *Midwest Vegetable Production Guide for Commercial Growers*.

Aboveground weed biomass samples were taken between the rows covered with rye mulch on August 11, 2008 (about six weeks after planting). The emerged weeds such as lambsquarters, pigweed, velvetleaf, black nightshade, grass, and others were sampled using a 1-square foot

quadrat. The plants within the quadrat were cut, sorted out, labeled, put in paper bags, and dried until a constant weight was achieved. Plant tissue nitrogen status was monitored using a Cardy Sap Meter (Spectrum Technologies, Inc., Plainfield, Illinois) on August 18, 2008 and September 3, 2008 (at seven and nine weeks after emergence of pumpkin seedlings, respectively). The samples were taken according to instructions in the Cardy Sap Meter manual. Mature (orange) pumpkin fruits harvested on October 9 and 10, 2008, and then were counted and weighed. In each plot, the numbers of fruits with surfaces covered with soil was recorded. The fruits with spots that may have been due to bacterial or fungal infection were counted and their number recorded. The rotten pumpkin fruits in each treatment were recorded as well. The data was analyzed using SAS PROC GLM (SAS software Version 8e, SAS Institute Cary, North Carolina).

Results and Discussion

Rye plant height above ground was measured with a 36-inch ruler. Rye growth was very rapid within the month of May with average heights of 17 inches on May 5, to more than 40 inches prior to rolling on May 23 (Table 1). Rye seeded at the rates of 120 lbs per acre had denser stands, with 2,800 stems per 12-square-foot area than rye plots seeded at 90 lbs per acre, with 2,300 stems per 12-square-foot area, but there was no significant difference on May 15 and 19 sampling dates (Table 1).

The emergence of weeds depended on the site's weed seed population and the thickness of the rye mulch. Weeds started emerging in the rolled area early but some common weeds such as redroot pigweed and black nightshade were very few on the mulched areas. The field was previously under corn and soybean rotation, which might have led to a reduction in the seed bank of redroot pigweed and black nightshade. There were no significant differences in the dry weights of lambsquarters, Canada thistle, *Conyza canadensis*, velvetleaf, or the grass between the mulched areas in plots where rye was seeded at the rates of 120 lbs and 90 lbs per acre (Table 2). Weeds in mulched areas were hand hoed once. The tilled strips in plots with rye mulch were hand weeded once by pulling out a few weeds before the pumpkins vined out.

Petiole sap nitrate was analyzed at seven weeks after emergence (7 WAE) and at nine weeks after emergence (9 WAE) on fully expanded mature leaves using a Cardy Sap Meter. At seven weeks after emergence, pumpkin plants in control plots had seven times more petiole sap nitrate than plants in strip-tilled plots. The 'Magic Lantern' variety had significantly higher petiole sap nitrate in plots where nitrogen fertilizer was applied at the rate of 90 lbs N per acre (213 ppm) than in plots where nitrogen was applied at 45 lbs N per acre (150 ppm). A similar trend was observed nine weeks after emergence with higher in control than in strip-tilled plots for both varieties, with the highest variation between control and strip-tilled plots in 'Howden.' There was no significant difference between plots where nitrogen fertilizer was applied at the rates of 45 and 90 lbs N per acre at nine weeks after emergence in both varieties (Table 3).

There were significantly higher fruit numbers and weights in strip-tilled plots than there were in control plots. The 'Magic Lantern' variety had a higher number of fruit and greater weight per acre than the 'Howden' variety. Nitrogen application rates did not affect the yield of both varieties. The average size of orange fruits was 1-4 lbs higher in control plots than in strip-tilled plots. Nitrogen application rates did not affect fruit sizes (Table 4).

Clean pumpkin fruit is a very important quality characteristic in pumpkin production, as the growers will spend less time cleaning the fruits, and less fruit rot. Pumpkin fruits were assessed

for cleanliness by ranking the fruit surface area covered with soil (30% or more surface covered with soil is graded as dirty). There was a significantly higher percentage of dirty fruits in control plots (more than 60%) than in strip tilled plots (less than 17%) (Table 5). There was no significant difference in percentage of dirty fruits between plots with rye mulch. The fruits were also assessed for any spots on the fruit (bacterial spot infection or any other condition that can predispose the fruit to rot). Fruits in control plots had significantly more spots (more than 27%) than strip-tilled plots (less than 17%). The ‘Magic Lantern’ variety from plots where nitrogen fertilizer was applied at the rate of 90 lbs N per acre had more fruits with spots (22%) than fruits from plots with 45 lbs N per acre (14%) (Table 5).

Pumpkin fruit rots were greater in control plots than in strip-tilled plots at harvest. In control plots, the incidence was more than 20% in ‘Howden,’ and less than 9% in ‘Magic Lantern.’ The fruit rot incidence was about 2% in strip-tilled plots. The nitrogen fertilizer application rates of 45 and 90 lbs N per acre did not significantly affect fruit rot in either variety (Table 5).

A similar trial will be conducted again next year to evaluate the effects of rye cover crop fruit cleanliness, and disease management on pumpkin production.

Table 1. Average aboveground rye cover crop height and stems per 12-square-foot area in 2008.

	Treatment	Sampling Dates		
		May 5	May 15	May 19
Height above ground (inches):	Rye 90	17.3 ^a	33.8 ^a	44.5 ^a
	Rye 120	17.0 ^a	33.2 ^a	43.0 ^a
No. of stems per 12-ft ² area:	Rye 90	2,356 ^b	3,882 ^a	3,882 ^a
	Rye 120	2,859 ^a	4,248 ^a	4,248 ^a

Numbers followed by the same superscripts are not significantly different at $P \leq 0.05$.

Table 2. Weed counts and dry weights (LBS) per 12-square-foot area on August 11, 2008.

Weeds	Weed Count and Dry Weight per 12-SquareFoot Area			
	Rye 90		Rye 120	
	Counts	Dry Weight	Counts	Dry Weight
Redroot pigweed	--	--	--	--
Black nightshade	--	--	--	--
Lambsquarters	2.3 ^a	0.19 ^a	1.1 ^a	0.10 ^a
<i>Conyza canadensis</i>	0.9 ^a	0.03 ^a	0.5 ^a	0.02 ^a
Velvetleaf	0.2 ^a	0.00 ^a	0.0 ^a	0.00 ^a
Canada thistle	0.5 ^a	0.01 ^a	0.7 ^a	0.04 ^a
Grass	--	0.20 ^a	--	0.40 ^a

Numbers followed by the same superscripts are not significantly different at $P \leq 0.05$.

Table 3. The effects of strip tillage, plastic mulch, and nitrogen fertilizer application rates on petiole sap N-nitrate at seven and nine weeks after emergence (WAE) in 2008.

Treatments	N Rates/ac	'Howden'		'Magic Lantern'	
		Nitrate-N in parts per million (PPM)			
		7WAP	9WAP	7WAP	9WAP
Control		299 ^a	1465 ^a	310 ^a	1850 ^a
Rye 90		42 ^b	40 ^b	110 ^b	108 ^b
Rye 120		23 ^b	35 ^b	124 ^b	361 ^b
	45 LB N	107 ^a	547 ^a	150 ^b	719 ^a
	90 LB N	136 ^a	480 ^a	213 ^a	827 ^a

Numbers followed by the same superscripts are not significantly different at $P \leq 0.05$.

Table 4. The effects of strip tillage and nitrogen fertilizer application rates on pumpkin fruit number, weight, and weight per fruit in 2008.

	Treatments	N rates/ac	'Howden'	'Magic Lantern'
			Number per acre	
Number of fruits:	Control		1,407 ^b	1,746 ^b
	Rye 90		1,951 ^a	2,450 ^a
	Rye 120		1,838 ^{ab}	2,609 ^a
		45 LB N	1,777 ^a	2,314 ^a
		90 LB N	1,686 ^a	2,223 ^a
				Tons per acre
Weight of fruits:	Control		16.6 ^b	19.3 ^b
	Rye 90		19.8 ^{ab}	22.4 ^{ab}
	Rye 120		21.7 ^a	24.2 ^a
		45 LB N	19.6 ^a	22.5 ^a
		90 LB N	19.1 ^a	21.4 ^a
				Average weight (LBS/fruit)
Fruit size:	Control		24 ^a	22 ^a
	Rye 90		20 ^b	19 ^b
	Rye 120		23 ^a	19 ^b
		45 LB N	22 ^a	20 ^a
		90 LB N	23 ^a	20 ^a

Numbers followed by the same superscripts are not significantly different at $P \leq 0.05$.

Table 5. The effects of strip tillage and nitrogen fertilizer application rates on percent dirty fruits, fruit rots, and bacterial spot incidence on pumpkin fruits in 2008.

	Treatments	N rates/ac	'Howden'	'Magic Lantern'
Dirty Fruits (%):	Control		62 ^a	64 ^a
	Rye 90		16 ^b	16 ^b
	Rye 120		16 ^b	17 ^b
		45 LB N	30 ^a	33 ^a
		90 LB N	33 ^a	32 ^a
Spots on fruits (%):	Control		37 ^a	27 ^a
	Rye 90		14 ^b	10 ^b
	Rye 120		15 ^b	17 ^b
		45 LB N	19 ^a	14 ^b
		90 LB N	25 ^a	22 ^a
Fruit rots (%):	Control		22 ^a	8.8 ^a
	Rye 90		2 ^b	1.8 ^a
	Rye 120		2 ^b	0.9 ^a
		45 LB N	6 ^a	1.2 ^a
		90 LB N	12 ^a	6.4 ^a

Numbers followed by the same superscripts are not significantly different at $P \leq 0.05$.

Acknowledgements

This material is based on work funded by the Illinois Department of Agriculture Conservation 2000 Grant Program under Award Number SA 08-35. I thank Bill Shoemaker, Vernon Johnson, Barbara Bates, Kane County Master Gardeners, and the staff at St. Charles Horticulture Research Center for providing support.