DEVELOPING EFFECTIVE CROP ROTATION SYSTEMS TO MANAGE YELLOW NUTSEDGE IN THE TREASURE VALLEY

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Introduction

Yellow nutsedge is an introduced invasive weed that has become naturalized within the United States. It is believed that yellow nutsedge was first reported as a weed in the southwestern United States in 1889 (Defelice 2002). Abandonment of intensive crop rotations in onion producing areas may contribute to the expansion of yellow nutsedge.

Yellow nutsedge is increasingly becoming a major crop production threat in many agricultural fields in the Treasure Valley of eastern Oregon and southwestern Idaho. The severity and negative effects of yellow nutsedge on crops are especially noticeable when the land is planted to onions. Surveys conducted by Ransom et al. (2003) indicated yield reductions averaged 42 percent in heavily infested fields. Consequently, development of effective yellow nutsedge control strategies is viewed by many as the number one priority for sustainability of onion production in the area. Control of yellow nutsedge presents a challenge because of its ability to reproduce by rhizomes and tubers that are able to survive in the soil for many years. Research results at the Malheur Experiment Station indicate that millions of tubers are produced per unit area each season (Shock et al. 2006, Felix and Ishida 2007). Successful control of yellow nutsedge will require integrated approaches including effective crop rotations, tillage, fumigation, and use of proven effective herbicides. Farming activities play a significant role in yellow nutsedge distribution in infested fields (Schippers et al. 1993). This study is a first step in developing crop rotation programs to demonstrate the positive contributions of extended rotations on yellow nutsedge control.

Materials and Methods

A multi-year study was initiated during 2007 in a field heavily infested with yellow nutsedge near the Malheur Experiment Station, Ontario, Oregon. The study was a split-plot design with tillage (reduced and conventional) forming the main plots while rotational crops and herbicide treatments served as subplots. The rotations are designed so that the terminal crop in each rotation will be onion. Rotations are: (1) corn/corn/sugar beet/wheat/onions; (2) corn/sugar beet/corn/wheat/onions; and (3) corn/corn (late planting)/sugar beet/wheat/onions.

Conventionally tilled plots were moldboard plowed and disked twice before forming beds to facilitate furrow irrigation. Reduced-tillage plots were only disked twice to avoid deep tillage, which is believed to distribute tubers within the soil profile. Following soil analysis, a compound fertilizer to provide 120 lbs nitrogen (N), 30 lb phosphorus (P), 13 lb sulfate, 2 lb zinc (Zn), and 1 lb boron (B) per acre was applied on May 4, 2007. In 2008, plots were fertilized with a compound fertilizer to provide 180 lb/acre N, 20 lb/acre potassium (K), and 3 lb/acre Zn on June 16, 2008. The study area was bedded to 22-inch beds before planting. In 2007, the entire study was planted to Dekalb Roundup Ready® (RR) corn hybrid 'DK-51-39' with seeds spaced 7 inches within the row. In 2008, RR corn hybrid 'DK C52-59' and RR sugar beet variety (Beta 'CT 01RR07') were planted in respective plots on May 15 and April 18 at 7 inches within the row and 8 seeds per ft of row, respectively. Counter® 15-G insecticide at 7.4 lb/acre was applied as a band over the sugar beet row immediately after planting. Sugar beets were thinned on May 28, 2008 to 8-inch spacing within the row.

Soil sampling for initial tuber quantification was conducted during spring 2007 after bed formation and initial irrigation. Five soil core samples measuring 4.25 inches in diameter and 12 inches deep each were taken randomly from each plot. The soil was processed to recover yellow nutsedge tubers using the washing and sieving procedure. Soil was sampled on October 4, 2007 and tubers recovered on October 17, 2007. Tubers from each plot were placed in a ziplock plastic bag and stored in the dark at 40°F until they were counted and weighed. The study was furrow irrigated as needed on a calendar schedule to maintain moisture in the top 12 inches of the soil profile. Corn was harvested for yield at maturity from 20 ft of the 2 center rows of each plot. The soil cores for yellow nutsedge characterization were taken to 12-inch depth on October 20, 2008. Soil samples were stored in cold storage until they were processed using the wash and sieve method on December 22-24, 2008. Tubers from each plot were counted and weighed.

Herbicides used on corn in 2007 in each treatment were (1) untreated, (2) Dual Magnum® at 1.67 pt/acre pre-emergence (PRE), (3) Dual Magnum at 1.67 pt/acre PRE followed by 1.67 pt/acre postemergence (POST), (4) Dual Magnum at 2.5 pt/acre plus Basagran® at 1.5 pt/acre (PRE), and (5) Dual Magnum at 3 pt/acre plus Basagran at 2 pt/acre (PRE). Treatments 2-5 were followed by 2 sequential POST applications of Roundup® OriginalMax at 32 fl oz/acre plus ammonium sulfate (AMS). Treatments used in 2008 are presented in Table 2. All PRE herbicide treatments were applied on May 13, 2008, using a tractor with a sprayer boom equipped with 8002EVS Teejet nozzles calibrated to deliver 20 gal of solution per acre. The sugar beet plots were sidedressed with Temik® 15-G at 10 lb/acre on June 3, 2008 to control sugar beet root maggot and beds were recorrugated. POST herbicide treatments were applied on June 10 and June 25, 2008 using a tractor as described above. Evaluation of sugar beet plots on June 30, 2008 indicated plant wilting and sudden death that was characteristic of rhizoctonia infestation.

All plots were furrow irrigated on a calendar schedule to maintain moisture in the top 12-inch soil profile. Sugar beet plots were sprayed with recommended preventive fungicides and insecticides using an aircraft during August through September. The sugar beet plants were topped on October 10 and harvested on October 14, 2008, while corn was hand harvested on October 15, 2008. The harvested area for both corn and sugar beets was the center 2 rows and 20-ft length per plot. The data were subjected to analysis of variance and the means compared using Fisher's protected LSD at $P = 0.05$.

Results and Discussion

The study area had a relatively uniform distribution of yellow nutsedge tubers/ft^2 at the initiation of the study (Table 1). There was no difference in corn yield between treatments except for the untreated control that had very low yield due to excessive weed competition (Table 1). There was no difference between tillage treatments for corn yield, which averaged 5 and 5.7 tons/acre for conventional and reduced tillage, respectively.

Soil core samples taken during fall indicated significant reduction in the number of tubers in response to herbicide treatments used in 2007 (Table 3). There was no difference in the number of yellow nutsedge tubers between conventional- and reduced-till plots. This was expected because tillage effects do not manifest themselves until at least 4 years into the rotations (Singh et al. 1997). Soil sampling during fall 2007 indicated a trend for reduced tuber numbers in plots treated with sequential Dual Magnum at 1.67 pt/acre followed by Roundup OriginalMax at 32 fl oz/acre. Plots treated with Dual Magnum at 1.67 pt/acre followed by a combination of Roundup plus Basagran 4EC at 1.5 pt/acre did not improve yellow nutsedge control.

Details of treatments imposed on crops grown in 2008 are presented in Table 2. The crops grown in rotation in 2008 were RR corn, RR corn planted late due to poor dry-bean emergence as a result of high rhizoctonia incidence, and RR sugar beet. Soil core samples taken during fall 2008 indicated a continued decline in yellow nutsedge tubers both in conventional- and reduced-till plots (Table 3). A combination of herbicide treatments and corn planted late resulted in lower yellow nutsedge tubers especially in conventionally tilled plots. Application of Outlook® or Eradicane® as preplant incorporated (PPI) followed by Roundup PowerMax postemergence (POST) provided better yellow nutsedge control. The results indicate that the number of yellow nutsedge tubers continues to decline in response to longer crop rotation cycles. The trends suggest that by the time the plots are planted to onions in 2011 we will have significantly reduced the number of tubers in the soil.

References

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Table 1. Yellow nutsedge tuber population density (May 29, 2007) at the initiation of the tillage and rotation study and corn yield at the Malheur Experiment Station, Oregon State University, Ontario, OR, summer 2007.

		Conventional tillage			Reduced tillage		
Treatment		Tubers	Tuber weight	Corn yield	Tubers	Tuber weight	Corn yield
		--- ft^{-2} ---	oz	t/a	--- ft^{-2} ---	oz	ft^{-2}
Untreated		729	2.2	1.2	614	1.9	1.6
Dual II Magnum Roundup OriginalMax AMS	1.67 pt/a 32 fl oz/a 2% V/V	628	2.0	5.4	526	1.9	6.3
Dual II Magnum Dual II Magnum Roundup OriginalMax AMS	1.67 pt/a 1.67 pt/a 32 fl oz/a 2% V/V	641	2.3	5.5	658	2.2	6.1
Dual II Magnum Basagran Roundup OriginalMax AMS	2.5 pt/a 1.5 pt/a 32 fl oz/a 2% V/V	649	2.1	6.3	631	2.1	5.4
Dual II Magnum Basagran Roundup OriginalMax AMS	3.0 pt/a 2.0 pt/a 32 fl oz/a 2% V/V	529	1.7	6.6	430	1.5	6.5
LSD ($P = 0.05$)		346	1.0	1.5	346	1.0	1.5

Table 2. List of treatments for the rotation study for yellow nutsedge control at the Malheur Experiment Station, Oregon State University, Ontario, OR, 2008.

	Conventional and reduced tillage				Conventional and reduced tillage			
	Corn and corn late planting				Sugar beets			
	Treatment	Rate	Unit	Timing[†]	Treatment	Rate	Unit	Timing
1	Untreated				Untreated			
2	Roundup PowerMax	21.3	oz/a	POST 1	Roundup PowerMax	21.3	oz/a	POST 1
	Ammonium Sulfate	0.8	gal/a		Ammonium Sulfate	0.8	gal/a	
	Roundup PowerMax	21.3	oz/a	POST 2	Roundup PowerMax	21.3	oz/a	POST 2
	Ammonium Sulfate	0.8	gal/a		Ammonium Sulfate	0.8	gal/a	
3	Outlook	14	oz/a	PPI	Nortron	2.0	pt/a	PPI
	Roundup PowerMax	21.3	oz/a	POST 1	Roundup PowerMax	21.3	oz/a	POST 1
	Ammonium Sulfate	0.8	gal/a		Ammonium Sulfate	0.8	gal/a	
	Roundup PowerMax	21.3	oz/a	POST 2	Roundup PowerMax	21.3	oz/a	POST 2
	Ammonium Sulfate	0.8	gal/a		Eptam EC	3.5	pt/a	POST 2
					Ammonium Sulfate	0.8	gal/a	
4	Eradicane	6	pt/a	PPI	Outlook	21	oz/a	POST 1
	Roundup PowerMax	21.3	oz/a	POST 1	Roundup PowerMax	21.3	oz/a	POST 1
	Basagran	1.5	pt/a	POST 1	Ammonium Sulfate	0.8	gal/a	
	Ammonium Sulfate	0.8	gal/a		Roundup PowerMax	21.3	oz/a	POST 2
	Roundup PowerMax	21.3	oz/a	POST 2	Nortron	2.88	fl oz/a	POST 2
	Ammonium Sulfate	0.8	gal/a		Ammonium Sulfate	0.8	gal/a	
5	Outlook	18	oz/a	PPI	Dual Magnum	1.33	pt/a	POST 1
	Roundup PowerMax	21.3	oz/a	POST 1	Roundup PowerMax	21.3	oz/a	POST 1
	Basagran	2.0	pt/a	POST 1	Ammonium Sulfate	0.8	gal/a	
	Ammonium Sulfate	0.8	gal/a		Roundup PowerMax	21.3	oz/a	POST 2
	Roundup PowerMax	21.3	oz/a	POST 2	Dual Magnum	1.33	pt/a	POST 2
	Dual Magnum	1.33	pt/a	POST 2	Ammonium Sulfate	0.8	gal/a	
	Ammonium Sulfate	0.8	gal/a					

[†]PPI = Preplant incorporated (April 17, 2008); POST 1 = Herbicides applied postemergence (June 6, 2008); POST 2 = Herbicides applied postemergence (June 26, 2008). All postemergence treatments included ammonium sulfate.

Table 3. Effect of tillage, crop rotation, and herbicide treatments on yellow nutsedge tuber production and weight at the Malheur Experiment Station, Oregon State University, OR, 2008.

Treatments†	Conventional tillage‡								Reduced tillage‡							
	Corn		Corn		Corn (late)		Sugar beet		Corn		Corn (late)		Corn (late)		Sugar beet	
	Fall 2007		Fall 2008						Fall 2007		Fall 2008					
	Tubers /ft^2	Weight (oz)	Tubers /ft^2	Weight (oz)	Tubers /ft^2	Weight (oz)	Tubers /ft^2	Weight (oz)	Tubers /ft^2	Weight (oz)	Tubers /ft^2	Weight (oz)	Tubers /ft^2	Weight (oz)	Tubers /ft^2	Weight (oz)
1	1,088 a	3.4 a	1,253 a	4.3 a	958 a	2.7 a	1,703 a	5.2 a	1,147 a	3.1 a	1,664 a	5.2 a	1,005 a	2.9 a	2,247 a	6.3 a
2	270 b	0.8 b	110 b	0.5 b	108 b	0.3 b	118 b	0.4 b	223 b	0.8 b	160 b	0.6 b	112 b	0.5 b	158 b	0.6 b
3	215 b	0.8 b	127 b	0.5 b	98 b	0.4 b	75 b	0.3 b	360 b	1.2 b	139 b	0.6 b	183 b	0.7 b	111 b	0.4 b
4	429 b	1.3 b	206 b	0.6 b	117 b	0.4 b	156 b	0.5 b	284 b	0.9 b	181 b	0.7 b	139 b	0.5 b	168 b	0.6 b
5	223 b	0.7 b	196 b	0.7 b	83 b	0.3 b	197 b	0.7 b	260 b	0.9 b	195 b	0.8 b	116 b	0.5 b	102 b	0.5 b

† Treatment details are listed in Table 2.
‡ Means within a column followed by the same letter are not significantly different (LSD, $P = 0.05$)

Table 4. Corn and sugar beet yield with different tillages, crop rotation, and herbicide treatments at the Malheur Experiment Station, Oregon State University, OR, 2008.

Treatments†	Conventional tillage‡				Reduced tillage‡			
	Corn	Corn	Corn (late)	Sugar beet	Corn	Corn	Corn (late)	Sugar beet
	Fall 2007	Fall 2008			Fall 2007	Fall 2008		
	t/A	Bu/A		t/a	Bu/A	Bu/A		t/a
1	1.2 b	96 b	124 a	14 a	1.6 b	76 b	65 b	6 b
2	5.4 a	188 a	182 b	44 b	6.3 a	146 a	143 a	38 a
3	5.5 a	175 a	180 b	48 b	6.1 a	156 a	155 a	38 a
4	6.3 a	186 a	143 b	42 b	5.4 a	169 a	161 a	36 a
5	6.6 a	178 a	152 b	46 b	6.5 a	175 a	170 a	39 a

† Treatment details are listed in Table 2.
‡ Means within a column followed by the same letter are not significantly different (LSD, $P = 0.05$)