IMPROVING WINTER WHEAT YIELD AND QUALITY BY CONTROLLING ITALIAN RYEGRASS (*Lolium multiflorum* LAM.) IN WINTER CANOLA

By

JERRY CHAD WEBB

Bachelor of Science

Oklahoma State University

Stillwater, Oklahoma

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Thesis Approved:

Dr. Case R. Medlin

Thesis Advisor

Dr. Tom F. Peeper

Dr. Jeff Edwards

Dr. Gordan Emslie

Dean of the Graduate College

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This manuscript is written to facilitate publication in *Weed Technology*, a referred journal of the Weed Science Society of America.

CHAPTER 1

Improving Winter Wheat Yield and Quality

by Controlling Italian Ryegrass

(*Lolium multiflorum* Lam.)

in Winter Canola.

INTRODUCTION

Italian ryegrass (*Lolium multiflorum* Lam.) has spread across south central and north central Oklahoma wheat fields since the mid 1980's and is becoming a widely distributed weed and crop throughout the United States (Stone et al. 1999). Prior to Italian ryegrass invading south central Oklahoma (i.e. late 1980's), Stephens and Jefferson county wheat producers were planting approximately 16,000 to 22,000 ha of wheat and harvesting 8,000 to 10,000 ha for grain (NASS 2006). In 2005, approximately 19,000 and 23,000 hectares were planted but 4,600 to 4,800 ha were harvested for grain. The drop in wheat hectares harvested for grain was largely due to the high infestation of ryegrass reducing wheat yield and quality[1].

Italian ryegrass is not only a serious winter annual weed in wheat but in other small grains as well (Khodayari et al. 1983). Italian ryegrass has been listed as one of the 10 most troublesome weeds of wheat in 10 of the 13 southern states (Elmore 1988). Italian ryegrass like winter wheat is a cool-season annual grass. Wheat yield reductions have been attributed to Italian ryegrass competition during wheat tillering, severe lodging at wheat maturity, and interference with wheat harvesting due to its later maturity as compared to wheat (Justice et al. 1994). Due to these characteristics severely infested fields are often abandoned for small grain production (Ritter and Menbere 2002).

Selective herbicide options for Italian ryegrass control in wheat are limited. Diclofop applied POST (postemergence to the crop) can control Italian ryegrass 81 to 100%, and

[1]Personal communications with Stephen and Jefferson County, OK, producers and grain buyers, 2004

increase winter wheat yield up to 60% (Griffin 1986; Khodayari et al. 1983). However, intensive use of diclofop has led to resistant biotypes of Italian ryegrass in at least nine states (Heap 2003). In addition, diclofop previously had a full season grazing restriction which limited its use on wheat intended for grazing (Peeper et al. 2000).

Metribuzin can be applied POST to winter wheat for control of annual grasses and dicot weeds (Griffin 1986; Schroeder et al. 1985; Shaw and Wesley 1991). Metribuzin can control Italian ryegrass effectively but is not labeled for use in all states and some winter wheat cultivars are extremely sensitive to metribuzin (Runyan et al. 1982; Schroeder et al. 1985; Shaw and Wesley 1991) and cannot be planted if metribuzin is to be applied (Bridges 2000). Therefore careful management, including proper winter wheat cultivar selection and timely application, is required to achieve acceptable crop tolerance and weed control with metribuzin.

Recently, flucarbazone sodium+chlorosulfuron has been registered for control of light to moderate populations of Italian ryegrass 1 leaf to 2 tiller (Dupont Technical Update 2006). However, reports indicate that flucarbazone sodium+chlorosulfuron controlled Italian ryegrass only 76% in Oklahoma when applied in the fall of 2004 (WERA077, 2005).

Mesosulfuron-methyl applied at 15 to 18 g/ha to 2 to 3 leaf and 2 to 3 tiller Italian ryegrass, controlled it 86% and 82%, but when applied to 4 to 5 tiller ryegrass control increased to 97% in Virginia (Bailey et al. 2003). In contrast, Italian ryegrass control in Texas with mesosulfuron did not exceed 70% (WERA077, 2005).

Two thirds of the wheat in Oklahoma is produced in a dual-purpose system, in which wheat is grazed and harvested for grain in the same growing season (Epplin et al. 1998;

Khalil et al. 2002). In many states of the mid south, Italian ryegrass is occasionally seeded with winter wheat and utilized as forage to lengthen the grazing season for cattle. However, it becomes a competitive weed when production goals shift from forage to grain (Peeper and Wiese 1990).

Wheat growers have had difficulty controlling Italian ryegrass because control options have not performed consistently (Barnes et al. 2001). In Oklahoma, cultural practices for Italian ryegrass control have proven to be less effective than herbicides (Justice et al. 1994). Oklahoma summers are often too hot and dry for profitable summer crop production and summer crops could interfere with fall wheat production (Peeper et al. 2005). In western Oklahoma, corn and soybean rotations are very risky due to intense heat, high energy prices, and high irrigation needs.

Mengel (2005) reported that winter canola is especially suited for farms from south central Kansas to southern Oklahoma where winter wheat is the major crop, the climate is harsh, hot, and dry, and where other crops don't produce well. Winter canola may provide the Oklahoma wheat grower with a profitable winter broadleaf rotational crop with additional options to control difficult grassy weeds. This could lead to improved yield and quality of winter wheat planted after a canola rotation. In some regions wheat yields have improved when wheat was planted after canola (Boyles and Peeper 2005).

The objective of this research was to evaluate the potential of improving winter wheat yield and quality by controlling Italian ryegrass in winter wheat-winter canola rotations using appropriate herbicides.

MATERIALS AND METHODS

A field experiment was established at five locations during the 2004-2005 winter crop production season and continued through the 2005-2006 crop year. The experimental design for each year and location was a randomized complete block with four replications. Three locations (Amber, Chattanooga, and Perry, OK) were on producer fields. Other locations were the South Central Research Station in Chickasha, OK and at the Lake Carl Blackwell Research Experiment Unit near Marena, OK.

Fertilizer was applied to satisfy soil test recommendations for a 2700 kg/ha yield goal for winter wheat and a 2800 kg/ha yield goal for winter canola. For winter canola production, 1/3 of the nitrogen and the full phosphorous, potassium, and sulfur requirements were broadcast applied and incorporated in the fall prior to planting, with the remainder of nitrogen applied in the spring, before bolting of canola (Table 1). The soil at Amber was a Norge silt loam (fine-silty, mixed, themic Udic Paleustolls) with pH 5.8 and 1% o.m. and a Zonial group Foard silt loam (silt loam to clay loam, association with Tillman, Waurika, and Vernon) with pH 6.6 and 1.4% o.m. at Chattanooga. The soil at Chickasha was a Dale silt loam (Stephenville-Noble-Windhorst association) with pH 6.5 and 1% o.m. The Marena soil consisted of a Pulaski series (coarse-loamy, mixed, nonacid, thermic Typic Ustifluvents) with pH 5.4 and 1.3% o.m. The Perry soil was a Kirkland (fine, mixed, thermic Udertic Paleustolls) with pH 5.3 and 1.8% o.m.

Crop rotations evaluated included continuous hard red winter wheat, hard red winter wheat followed by winter canola, continuous winter canola, and winter canola followed by hard red winter wheat. Winter wheat varieties included ‘Deliver’, a conventional variety, and the imidazolinone-tolerant wheat varieties ‘AgriPro 502 CL’ (2004-05) and

‘Okfield’ (2005-06). Winter canola varieties included ‘Wichita’, a conventional variety, and ‘Dekalb DKW 13-86’ a glyphosate-tolerant variety. A description of field operations complete with equipment used and dates are in Table 1.

Data collected included Italian ryegrass density before and after herbicide application, visual weed control ratings, wheat and canola grain yield, and Italian ryegrass dockage in the harvested grain for each growing season of the experiments. Populations were determined by counting Italian ryegrass plants in a 0.5 m^2 quadrat, in each plot. Visual ratings were determined by evaluating each plot and estimating a percentage of plants controlled compared to the nontreated check. Plots were harvested with a small plot combine with air flow adjusted accordingly between wheat and canola plots. Each sample of wheat and canola was cleaned, using a small commercial seed cleaner to remove the Italian ryegrass and chaff for determining yield and dockage. Grain yields were taken from a clean sample and evaluated with a small grain analyzer. Dockage (%) was calculated as ((initial field weight – clean weight) / field weight) * 100. Data were subjected to ANOVA using SAS procedures. Means were separated using Fisher’s Protected LSD at P = 0.05. Weed density data were square root transformed before analyses; however, nontransformed data are presented. Due to significant location by treatment interactions, data are presented by location.

RESULTS AND DISCUSSION

Italian ryegrass density after treatments.

All first year treatments reduced Italian ryegrass populations at Amber and Chattanooga compared to the nontreated checks which had 194 (SD = 74) and 148 (SD = 29) plants/m^2, respectively (Table 2). This trend was similar at Marena except for the glyphosate application in glyphosate-tolerant canola where 253 (SD = 67) plants/m^2, remained after treatment compared to 369 plants/m^2 in the nontreated check and less than 90 plants/m^2 in all other treatments. Poor control in the glyphosate-tolerant canola plots was due to inadequate coverage brought about by low sprayer boom height, delayed treatment forced by an extended period of rainfall soon after crop and weed emergence, and the low glyphosate application rate labeled for canola in 2004. Similar results were observed at Chickasha where Italian ryegrass densities in the glyphosate-treated plots were similar to the nontreated check. Due to the lack of control at Chickasha and Marena, sequential applications of 530 g ai/ha of glyphosate were applied at these locations. Except at Perry, mesosulfuron applied in wheat and quizalofop applied in canola reduced the Italian ryegrass infestation as well as or better than other treatments. Imazamox reduced Italian ryegrass density as well as any treatment at Amber, Chattanooga, and Marena but at Chickasha where weed densities were 3707 (SD = 861) plants/m^2 in the nontreated checks, it failed to control the weed.

Italian ryegrass densities from the 2005-06 season are reported as result of cropping system by herbicide treatment (Table 3). Low rainfall conditions in the fall of 2005-06 (Table 4) resulted in lower Italian ryegrass populations than in the previous growing season, however, treatment effects were similar across years regardless of cropping system or herbicide used at Amber and Chattanooga. Italian ryegrass populations were reduced regardless of cropping system or herbicide treatment used compared to the nontreated check. At Chattanooga, including winter canola in the rotation eliminated Italian ryegrass from the sample locations. At Chickasha, Marena, or Perry, where quizalofop was applied to canola and mesosulfuron was applied to wheat, regardless of order, Italian ryegrass densities were reduced as well as any treatment. Similarly, where glyphosate-tolerant canola was planted in consecutive years or followed by mesosulfuron in wheat the second year, Italian ryegrass stand reduction was maximized compared to all other treatments. However, glyphosate applied to glyphosate-tolerant canola and followed by wheat without herbicide resulted in Italian ryegrass densities similar to the nontreated check at Chickasha and Marena. Although not statistically different, the same trend was observed at Amber and Perry where Italian ryegrass counts were 13 and 18 plants/m^2 in this treatment compared to 37 and 40 in respective nontreated checks. This indicated that more than one growing season of glyphosate-tolerant canola will be needed to effectively lower Italian ryegrass populations. Regardless of cropping system or herbicide used, Italian ryegrass density reductions were not superior to continuous wheat with mesosulfuron applied each year.

Italian ryegrass control.

Visual Italian ryegrass control (Table 5 and 6) was visually estimated at harvest. Also, first year Italian ryegrass control ratings (Table 5) were recorded after the second application of 530 g ai/ha was applied to glyphosate-tolerant canola plots at Chickasha and Marena.

At Amber and Chattanooga where Italian ryegrass populations were moderate, all treatments controlled the weed at least 95% except for glyphosate in glyphosate-tolerant canola at Amber which controlled Italian ryegrass 87%. At Chickasha, Marena, and Perry where Italian ryegrass populations were high, control was poor with all treatments. Imazamox and mesosulfuron controlled moderate Italian ryegrass populations at Amber and Chattanooga 99% but only 40% to 60% of high infestations at Chickasha, Marena, and Perry. Similarly, quizalofop applied in canola controlled moderate Italian ryegrass infestations 95% and 99% at Amber and Chattanooga, but only 62%, 51%, and 69% of higher infestations at Chickasha, Marena, and Perry.

Experiments did not receive significant rainfall from December 2005 until May 2006 (Table 4), which greatly reduced Italian ryegrass infestations at all locations (Table 3), especially Chickasha, Marena, and Perry, which in turn resulted in higher Italian ryegrass control ratings (Table 6) at harvest in 2006. At Amber, Chattanooga, and Chickasha, Italian ryegrass control with herbicidies applied each year in a canola-wheat rotation was as good as or better than continuous wheat with mesosulfuron or imazamox. However, the most consistent cropping systems for Italian ryegrass across all locations was canola treated with either quizalofop or glyphosate followed by wheat treated with mesosulfuron.

At Marena and Perry when canola was in the second half of the rotation, ryegrass control ranged from 8% to 70%. Poor control in these plots resulted from poor canola stands and vigor due to lack of rainfall at both locations and low soil pH at Perry. Therefore, existing populations or new flushes of Italian ryegrass were able to use the moisture at Marena and Perry, while the more vigorous canola stands at Amber, Chattanooga and Chickasha used available moisture and assisted with control.

Crop yields.

The 2004-05 wheat yields were typical for the Amber, Chattanooga, Chickasha and Marena (Table 7). Across all locations canola yields were lower than expected, this was largely due to lack of rainfall, after topdress fertilizer application (2/3 of the nitrogen requirement for the crop was applied topdress) in late January 2005, that was needed to move the nutrients into the canola root zone. At Perry, wheat and canola yields were low due to low soil pH conditions which impacted the growth of most varieties planted; therefore, yields at the Perry location will not be discussed. At all locations, mesosulfuron or imazamox applied to wheat increased yield compared to the nontreated check. In general, wheat yields were higher under moderate Italian ryegrass infestations (i.e Amber and Chattanooga) where control was consistently higher (Table 5) than under high Italian ryegrass infestations (i.e. Chickasha and Marena) where control was poor. At Amber and Chickasha canola yields were higher with quizalofop than glyphosate (Table 7) due to better Italian ryegrass control with quizalofop at these locations (Table 5).

Due to the drought conditions from December 2005 to May 2006 (Table 4) crop yields (Table 8) were much lower across all locations than in 2004-05. At Amber, Chattanooga, Chickasha, and Perry canola treated with quizalofop followed by wheat with mesosulfuron yielded numerically the highest. More importantly, at Amber, Chattanooga, and Perry, yields in this cropping system were 38% to 49% higher than yields in continuous wheat with mesosulfuron applied. Although wheat yield increases due to rotations with summer crops in western Oklahoma have been documented, their success is usually limited. Stone et al. (2006) reported wheat yield increase in a sorghum followed by soybean followed by wheat rotation. Additional research is needed under typical Oklahoma growing conditions and rainfall patterns to validate these results and determine if rotating wheat with winter canola increases yield in the following wheat crop.

Dockage.

In 2004-05, wheat and canola grain dockage ranged from 0.4% to 5% at Amber, Chattanooga and Chickasha, but no differences among treatments were present. Higher grain dockage at Marena and Perry was explained by high infestations of Italian ryegrass (Table 2) brought about by low crop stands which was due to acid sensitive varieties planted in low pH soil, low control ratings (Table 5), and low yield (Table 7). In 2005-06, dockage in the canola grain was not collected. Dockage in the wheat grain ranged from 0.7% to 11.7% across all locations with no differences among treatments at each location.

The advantage of crop rotation was evident in this study, even though further evaluations are needed. A cropping system with wheat followed by canola or canola followed by wheat reduced the Italian ryegrass population at harvest and increased yield as compared to continuous wheat or continuous canola. Furthermore, in densely populated areas of Italian ryegrass, one growing season of glyphosate-tolerant canola did not control Italian ryegrass the following growing season. In this study, regardless of cropping order, Italian ryegrass control in a glyphosate-tolerant canola-wheat rotation with herbicides used in each crop was better than and yielded higher than sequential growing seasons of glyphosate-tolerant canola, or glyphosate-tolerant canola followed by nontreated wheat at most locations. In the continuous wheat system, imazamox and mesosulfuron were equivalent at most locations.

The varieties evaluated in this study were representative of the best option available to wheat and canola growers, but were not isogenetic lines. This inherant variety variability may have impacted results obtained between the two wheat and two canola production systems within a given year. For example, the acidic soil conditions at Marena and Perry most likely impacted the growth of both 'AgriPro 502 CL' and 'Deliver' the first growing season (Edwards et al. 2006). However, 'Okfield', planted the second growing season, was more tolerant to the acid soil conditions than were the conventional wheat variety 'Deliver'. For these reasons, results obtained with future improved wheat and canola varieties included in similar crop rotations may differ. Similarly, due to the limited rainfall conditions in 2005-06, reduced breakdown of sulfonylurea herbicides applied to the first-season wheat plots may have persisted into the second-season canola plots impacting its growth and development. Therefore, continued investigations into the potential of canola-wheat rotations for weed management and improving crop yield and quality are warranted.

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Table 1. Field operations by date and location.

Field operation	Location				
	Amber	Chattanooga	Chickasha	Marena	Perry
Prepared seedbed[1]	10/4/04	10/20/04	10/5/04	10/5/04	10/8/04
Seeded[2] crops	10/4/04	10/20/04	10/5/04	10/5/04	10/8/04
Applied treatments[3, 4]	12/3/04[4]	12/3/04[4]	10/26/04[3]	11/9/04[3]	12/17/04[4]
Applied topdress fertilizer[5]	1/27/05	1/27/05	1/27/05	1/26/05	1/26/05
Applied 2nd glyphosate application[17]	-	-	2/22/05	2/22/05	-
Applied insecticide[6]	3/30/05	3/30/05	3/30/05	-	-
Harvested wheat[7]	6/16/05	6/9/05	6/16/05	6/6/05	6/7/05
Harvested canola[7]	6/16/05	6/9/05	6/16/05	6/15/05	6/15/05
Chisel plowed[8]	6/21/05	6/9/05	6/21/05	6/15/05	6/15/05
Field cultivated	-	-	8/12/05[23]	8/11/05[19]	8/11/05[19]
Tilled with offset disc[9]	7/21/05	7/21/05	7/21/05	7/18/05	7/18/05
Burndown[10]	9/9/05[10]	-	-	9/8/05[10]	9/8/05[10]
Prepared seedbed[1]	10/3/05	9/30/05	10/4/05	9/22/05	9/23/05
Applied fall fertilizer[20]	10/3/05[20]	9/30/05[21]	10/4/05[22]	9/22/05[22]	9/23/05[22]
Seeded[11] crops	10/3/05	9/30/05	10/4/05	9/22/05	9/23/05
Applied treatments[12,13]	11/10/05[12]	11/18/05[13]	11/10/05[12]	11/16/05[12]	11/5/05[12]
Applied topdress fertilizer	1/11/06[14]	1/10/06[15]	1/11/06[22]	1/11/06[14]	1/11/06[21]
Applied sprinkler irrigation[16]	1/12/06 & 1/13/06	1/12/06	1/13/06 & 1/17/06	1/11/06	1/18/06 & 1/19/06
Applied insecticide	2/9/06[18]	2/28/06[18]	2/9/06[18]	2/13/06[18]	2/8/06[18]
Applied insecticide	-	-	-	4/27/06[24]	-
Harvested wheat[7]	5/24/06	5/25/06	5/26/06	6/6/06	6/7/06
Harvested canola[7]	6/13/06	6/13/06	6/14/06	6/6/06	6/7/06

Table 1. Continued

1) Used a small plot tractor and cultivator with rolling baskets.
2) Used a small plot planter with 18 cm row spacing, 101 kg/ha wheat at a 1 cm depth for canola
3) Used tractor mounted, compressed air sprayer with 50 cm nozzle spacing calibrated at 5km/h, 140 l/ha, at 269 kPa to 3 tiller to 8 tiller winter wheat, 4 leaf to 6 leaf winter canola, and 2 leaf to 3 tiller Italian ryegrass.
4) Used tractor mounted, compressed air sprayer with 50 cm nozzle spacing calibrated at 140 l/ha, 5km/h, at 269 kPa to 3 tiller to 4 tiller winter wheat, 3 leaf to 4 leaf winter canola, and 3 tiller Italian ryegrass.
5) Applied using a pto driven broadcast spreader, to spread 112 kg/ha 46-0-0.
6) Aerially applied cyhalothrin at 33 g a.i./ha with 1 %V/V of nonionic surfactant for aphid control.
7) Massey Ferguson 35 combine.
8) Tilled 15 cm deep.
9) Small plot disk with 145 kg wt.
10) Applied paraquat at 110 g a.i./ha in 280 l/ha water carrier.
11) Used a small plot planter, 18 cm row spacing, 101 kg/ha wheat at a 1 cm depth and 6 kg/ha winter canola at a 1 cm depth.
12) Used tractor mounted, compressed air sprayer with 50 cm nozzle spacing calibrated at 5km/h, 140 l/ha, at 269 kPa to 3 tiller to 5 tiller winter wheat, 4 leaf to 6 leaf winter canola, and 1 tiller to 4 tiller Italian ryegrass.
13) Used tractor mounted, compressed air sprayer with 50 cm nozzle spacing calibrated at 5km, 140 l/ha, at 269 kPa to 4 tiller to 8 tiller winter wheat, 5 leaf to 8 leaf winter canola, and 2 tiller to 5 tiller Italian ryegrass.
14) Applied using a pto driven broadcast spreader, to spread 46-0-0 at 93 kg/ha.
15) Applied using a pto driven broadcast spreader, to spread 46-0-0 at 103 kg/ha.
16) Applied 136000 l/ha
17) Used tractor mounted, compressed air sprayer with 50 cm nozzle spacing calibrated at 5km, 140 l/ha, at 269 kPa to 3 tiller to 3 leaf winter wheat, 4 leaf to 6 leaf winter canola, and 1 tiller to 3 tiller Italian ryegrass (treatments 7, 8, and 9).
18) Applied proaxis at 33 g a.i./ha with 1 %V/V of nonionic surfactant for aphid control.
19) Cultivated using JD 2030 with field cultivator.
20) Applied using a pto driven broadcast spreader, to spread 224 kg/ha 46-0-0.
21) Applied using a pto driven broadcast spreader, to spread 314 kg/ha 46-0-0.
22) Applied using a pto driven broadcast spreader, to spread 413 kg/ha 46-0-0.
23) Tilled using Deutz Allis 8570/field cultivator.
24) Applied malathion to canola at 1% using a backpack sprayer to control harlequin beetle.

Table 2. Italian ryegrass density, 12 weeks after treatment, 2004-05.

Crop	Herbicide Treatment	Rate	Location Amber	Chattanooga	Chickasha	Marena	Perry
		g ai/ha	plants/m^2				
Wheat							
	nontreated check	-	194	148	3707	369	1072
	mesosulfuron	15	61	25	530	54	725
	imazamox	35	20	3	2224	86	659
Canola							
	quizalofop	60	56	32	17	34	655
	glyphosate	530	75	39	3473[1]	253[1]	0
LSD (0.05)			108	42	1257	137	217
STD			74	29	861	67	149

1. Data represents Italian ryegrass count after first glyphosate application. Due to high Italian ryegrass stand densities, due to inadequate coverage brought about by low sprayer boom height, a sequential glyphosate treatment was applied 2 weeks after plants were counted.

Table 3. Italian ryegrass density, 12 weeks after treatment, 2005-06

First crop	Herbicide	Herbicide Rate	Second crop	Herbicide	Herbicide Rate	Amber	Chattanooga	Chickasha	Marena	Perry
		g ai/ha			g ai/ha			plants/m^2		
Wheat	nontreated	-	Wheat	nontreated	-	37	6	5	11	40
Wheat	mesosulfuron	15	Wheat	mesosulfuron	15	2	1	1	4	13
Wheat	imazamox	35	Wheat	imazamox	35	2	1	3	5	18
Canola	quizalofop	60	Wheat	mesosulfuron	15	3	0	2	7	4
Canola	glyphosate	530	Wheat	mesosulfuron	15	7	0	1	4	17
Canola	glyphosate	530	Wheat	nontreated	-	13	0	6	15	18
Canola	quizalofop	60	Canola	quizalofop	60	3	0	4	8	8
Canola	glyphosate	530	Canola	glyphosate	771	4	0	1	4	1
Wheat	mesosulfuron	15	Canola	quizalofop	60	2	0	1	4	2
LSD (0.05)						15	2	3	7	13
STD						10	1	2	5	9

Table 4. Average monthly temperature and rainfall data by location in 2004-06.

Month/Year	Location					
	Amber and Chickasha		Chattanooga		Marena and Perry	
	Temp °C	Rainfall (cm)	Temp°C	Rainfall (cm)	Temp°C	Rainfall (cm)
Sept-04	23.5	1.8	24.6	3.9	23.2	4.4
Oct-04	17.3	13.3	18.5	9.5	17.1	12.8
Nov-04	9.8	14.0	11.0	15.1	9.7	16.3
Dec-04	5.0	0.9	5.9	1.1	5.2	2.4
Jan-05	3.4	4.6	5.1	5.0	2.6	6.5
Feb-05	7.0	5.3	7.9	5.5	7.1	3.8
Mar-05	9.9	0.2	10.8	1.8	10.2	2.0
Apr-05	15.3	0.8	16.2	1.6	15.7	1.1
May-05	15.3	6.0	21.3	7.9	20.0	6.9
June-05	25.5	13.1	27.6	3.6	25.0	15.3
July-05	27.0	4.2	27.9	9.4	26.2	11.1
Aug-05	26.3	16.0	27.2	9.6	25.9	24.6
Sept-05	24.5	4.3	25.5	5.3	23.7	8.9
Oct-05	16.3	3.2	17.5	5.6	16.1	5.8
Nov-05	10.9	0.0	12.1	0.0	11.4	0.0
Dec-05	3.1	0.8	4.7	0.4	2.9	0.3
Jan-06	8.1	0.7	9.4	0.1	8.6	1.8
Feb-06	5.3	0.8	6.6	0.2	4.7	0.3
Mar-06	12.4	6.8	13.7	4.6	11.7	4.7
Apr-06	19.1	10.3	20.4	2.4	18.9	11.0
May-06	22.1	5.6	23.8	5.4	21.4	3.8
June-06	26.1	4.2	28.0	1.4	25.5	7.0

Table 5. Italian ryegrass control (%) at harvest 2004-05.

Crop	Herbicide Treatment	Rate	Location: Amber	Chattanooga	Chickasha	Marena	Perry
Wheat		g ai/ha			%		
	mesosulfuron	15	99	99	53	57	50
	imazamox	35	99	99	40	60	58
Canola							
	quizalofop	60	95	99	62	51	69
	glyphosate[1]	530	87	99	32[1]	53[1]	74
LSD (0.05)			6	NS	18	22	14
STD			4	0.0	17	15	10

1. Glyphosate (530 g ai/ha) applied Nov. 9, 2004 and Oct. 26, 2004 with a second application applied Feb. 22, 2005 and Feb. 22, 2005 at Chickasha and Marena, respectively.

Table 6. Italian ryegrass control (%) at harvest 2005-06

Cropping System						Location				
First crop	Herbicide	Herbicide Rate	Second crop	Herbicide	Herbicide Rate	Amber	Chattanooga	Chickasha	Marena	Perry
		g ai/ha			g ai/ha			%		
Wheat	mesosulfuron	15	Wheat	mesosulfuron	15	84	46	97	90	33
Wheat	imazamox	35	Wheat	imazamox	35	84	85	97	91	81
Canola	quizalofop	60	Wheat	mesosulfuron	15	91	96	98	86	84
Canola	glyphosate	530	Wheat	mesosulfuron	15	94	97	93	91	86
Canola	glyphosate	530	Wheat	nontreated	-	0	93	54	0	0
Canola	quizalofop	60	Canola	quizalofop	60	93	99	95	8	13
Canola	glyphosate	530	Canola	glyphosate	771	94	99	95	65	43
Wheat	mesosulfuron	15	Canola	quizalofop	60	93	96	98	70	8
LSD (0.05					6.0	6	29	20	5	28
STD						6	27	13	16	19

Table 7. Grain yields (kg/ha) 2004-05.

Crop	Herbicide Treatment	Rate	Amber	Chattanooga	Chickasha	Marena	Perry
			Location				
Wheat		g ai/ha			kg/ha		
	nontreated check	-	1659	1184	114	209	25
	mesosulfuron	15	2540	2684	1594	2357	363
	imazamox	35	2643	2620	970	1931	449
LSD (0.05)			476	543	783	333	218
Canola							
	quizalofop	60	815	1603	988	526	141
	glyphosate[1]	530	519	1633	244[1]	404[1]	181
LSD (0.05)			281	NS	237	NS	NS

1. Glyphosate (530 g ai/ha) applied Nov. 9, 2004 and Oct. 29, 2004 with a second application applied Feb. 22, 2005 and Feb. 22, 2005 at Chickasha and Marena, respectively.

Table 8. Grain yields (kg/ha), 2005-06.

Cropping System						Location				
First crop	Herbicide	Herbicide Rate g ai/ha	Second crop	Herbicide	Herbicide Rate g ai/ha	Amber	Chattanooga	Chickasha	Marena	Perry
						(kg/ha)				
Wheat	nontreated	-	Wheat	nontreated	-	413	119	383	5	894
Wheat	mesosulfuron	15	Wheat	mesosulfuron	15	738	131	436	5	1432
Wheat	imazamox	35	Wheat	imazamox	35	879	146	617	5	2199
Canola	quizalofop	60	Wheat	mesosulfuron	15	1438	212	915	4	2407
Canola	glyphosate	530	Wheat	mesosulfuron	15	835	174	234	3	2349
Canola	glyphosate	530	Wheat	nontreated	-	397	183	182	4	1799
LSD (0.05						395.2	70.4	693.5	1.8	442.1
STD						254	46	425	1	279
Canola	quizalofop	60	Canola	quizalofop	60	246	513	259	152	0[1]
Canola	glyphosate	530	Canola	glyphosate	771	66	520	163	57	0[1]
Wheat	mesosulfuron	15	Canola	quizalofop	60	180	827	426.4	138	0[1]
LSD (0.05						NS	220	NS	95	NS
STD						122	127	214	55	0.0

1. Canola was subject low pH, pH sensitive varieties, drought and densely population of Italian ryegrass.

Name: J. Chad Webb Date of Degree: July 2006

Institution: Oklahoma State University Location: Stillwater, Oklahoma

Title of Study: IMPROVING WINTER WHEAT YIELD AND QUALITY BY CONTROLLING ITALIAN RYEGRASS (*LOLIUM MULTIFLORUM* LAM.) IN WINTER CANOLA

Pages in Study: 24 Candidate for the Degree of Master of Science

Major Field: Plant and Soil Sciences

Scope and Method of Study: Winter annual grasses are common weeds in Oklahoma's wheat production systems. To evaluate the extended control of Italian ryegrass, experiments were established in Oklahoma winter wheat fields in the fall of 2004. Cropping systems evaluated included continuous wheat, continuous canola, wheat followed by canola, and canola followed by wheat. In-season wheat herbicide treatments included imazamox applied to imidazolinone-tolerant wheat and mesosulfuron applied to conventional wheat, while in-season canola herbicides included quizalofop applied to conventional canola and glyphosate applied to glyphosate-tolerant canola.

Findings and Conclusions: A cropping system including both wheat and canola with herbicide sprayed in each crop reduced Italian ryegrass density at harvest and increased yield when compared to continuous wheat. Control in a rotation with glyphosate-treated canola and mesosulfuron-treated wheat or two seasons of mesosulfuron-treated wheat controlled Italian ryegrass and yielded higher than consecutive seasons of glyphosate-treated canola or glyphosate-treated canola followed by nontreated wheat at most locations.

ADVISER'S APPROVAL: ______________________________

VITA

Jerry Chad Webb

Candidate for the Degree of

Master of Science

Thesis: IMPROVING WINTER WHEAT YIELD AND QUALITY BY CONTROLLING ITALIAN RYEGRASS (*LOLIUM MULTIFLORIUM* LAM.) IN WINTER CANOLA.

Major Field: Plant and Soil Science

Biographical:

Personal Dates: Born in Hollis, Oklahoma, on September 25, 1967, the son of Jerry and Judy Webb. Married to Robin A. Schuster, on January 7, 1990. One son, Jerry Chase born on June 19, 1992, and one daughter, Justin Cheyenne, born October 15, 1994.

Education: Graduated from Hollis High School, Hollis Oklahoma, May 1986; received Associate of Science degree from Western Oklahoma State College, December 1989; received Bachelor of Science degree in Agricultural Economics from Oklahoma State University, Stillwater, Oklahoma, December 1992. Completed the requirements for Master of Science degree with a major in Plant and Soil Science / Weed Science at Oklahoma State University, July 2006.

Experience: Worked for cousin, a farmer and rancher, in Hollis, Oklahoma, throughout junior high, high school and early college career; worked for the Hollis Livestock Commission during high school and early college career; employed with USDA-Agriculture Research Service throughout the pursuit of a Bachelor of Science degree at Oklahoma State University; Agriculturalist for the Agronomy Research Station from May 1995 to August 2004; Extension Weed Science Technician, Oklahoma State University, Department of Plant and Soil Sciences, September 2004 to present.

Professional Membership: Weed Science Society Science of America