



19-06

PROGRESS REPORT

1. TITLE: Determining and Confirming Imazamox-Resistant Jointed Goatgrass

2. PERSONNEL: Principal Investigators: Frank L. Young
Joseph P. Yenish
Cooperators: Robert S. Zemetra
Laylah Bewick
Donn Thill
John Burns
Carol Mallory-Smith

3. TIME LINE: Initiation: July 1, 2006
Termination: July 1, 2008

4. ORIGINAL HYPOTHESIS: Extensive use of imi-resistant wheat technology will select for herbicide-resistant jointed goatgrass.

5. SUMMARY OF PROGRESS: An objective of a previous proposal (Determining Best Crop Rotation for Effective Jointed Goatgrass Control Using Imidazolinone Resistant Wheat) in the Pacific Northwest, was to determine the possibility of imi-resistant jointed goatgrass/winter wheat hybrids and/or imi-resistant jointed goatgrass populations developing in plots planted to imi-resistant winter wheat and sprayed with imazamox herbicide. A greenhouse experiment was initially conducted on jointed goatgrass spikelets collected in 2004 from the Pullman site and the Pasco N site, and recently from samples collected in 2005 from the Pasco S site. As in the past, spikelets from the 2005 Pasco S site were planted in flats and emerged plants were sprayed twice with 4 oz/A of imazamox herbicide. The Pasco S site produced 9 phenotypical jointed goatgrass plants that survived herbicide screening, and 1 surviving hybrid. Using spikelets from a susceptible jointed goatgrass plant and spikelets from a suspected “resistant” plant from each location (Pullman and Pasco N) that survived two, 4 oz applications of imazamox, a dose-response study was conducted to evaluate if herbicide resistance has been naturally selected for in jointed goatgrass. Basically all plants were killed in both the susceptible and “resistant” populations. Additionally, spikelets from open-pollinated and self-pollinated spikes were provided to Drs. Zemetra and Mallory-Smith to conduct genetic and isogenetic analysis to confirm jointed goatgrass resistance.

6. OBJECTIVES:

1. Confirm imazamox resistance in jointed goatgrass via herbicide dosage-response experiments.
2. Determine if imazamox-resistant jointed goatgrass/winter wheat hybrids and populations of resistant jointed goatgrass biotypes are present at the third location (Pasco S) of the on-going study. A follow-up dose-response experiment will be conducted to confirm resistance in surviving plants at this location.

7. EXPERIMENTAL DESIGN:

Objective 1: The dose response experiment is a randomized complete block design with a two-factor factorial arrangement. The first factor is site and has three levels – Pasco-Resistant, Pullman-Resistant, and Pasco-Susceptible. The second factor is dose and has 7 levels – 0, 1, 2, 4, 6, 8, and 16 oz Beyond/acre. Blocks are benches and are random effects (runs not repeated on the same benches). Treatment factors are randomly assigned to each block. Blocks were replicated 4 times and the experiment was repeated (referred to as Run 1 and Run 2). The two experiments are run at the same time in different greenhouses. The plants from the two experiments were sprayed the same day but were sprayed separately (Run 1 was sprayed first and then a new batch of herbicide doses were mixed and Run 2 was sprayed). To grow plants for the dose response study, five spikelets were planted in pots filled with commercial potting soil. Plants were fertilized bi-weekly with a nitrogen-based fertilizer. Prior to treatment, plants were thinned to four plants per pot. When plants were in the 3 to 4-leaf stage, they were treated with 0, 1, 2, 4, 8, or 16 oz/A of imazamox + 2.5% UAN v/v + 0.25% surfactant v/v. After treatment, plants were evaluated visually at weekly intervals for percent control (0 = no injury and 100 = dead). At 4 weeks after treatment plants were harvested, dried at 40 C for 4 days, and weighed.

Objective 2: Jointed goatgrass spikelets were collected from the Pasco S site (third and final site) in 2005 and were used for initial screening for resistance in the greenhouse as was done with the 2004 Pullman and Pasco N spikelets. The spikelets for each sample were counted and up to 100 spikelets representing each plant at each 10-foot plot mark were planted into 8- x 12-inch, 2-inch deep flats. Flats were placed in a greenhouse with the temperature ranging from 68 to 86°F and artificial light set on a 16-hour light-dark cycle. Plants were fertilized every 2 weeks with a nitrogen-based fertilizer. Various flushes of jointed goatgrass emergence and number of times plants have been sprayed were noted by the use of colored toothpicks. When plants reached the 3- to 5-leaf stage, they were counted and sprayed with an application of imazamox (4 oz/A) + 2.5% UAN (v/v) + 0.25% surfactant (v/v). Prior to the second application of imazamox (same rate as first application and two to three weeks following the first application), plants were counted again, differentiating between live and dead plants. Prior to any further applications of imazamox, the process was repeated but the plants that survived the two prior imazamox applications were transplanted to pots and transferred to a cold room where they remained for at least 60 days to vernalize. The cold room was maintained at 4°C with a 12-hour light cycle. After vernalization, the resistant plants were transferred back to the greenhouse to resume growth. Before anthesis, two spikes per plant were enclosed in bags to ensure self-pollination. After plants had flowered and senesced, spikes and spikelets were collected and counted. A dose-response study, as previously described, will be conducted using potential resistant representatives from these collections. Plant materials (self and open pollinated) have been provided to Drs. Zemetra and Mallory-Smith to conduct genetic and isogenic analysis to confirm herbicide resistance.

8. PROGRESS/CONCLUSIONS:

Objective 1. In greenhouse dosage-response experiments, progeny from all three jointed goatgrass plants tested from the Pasco N and Pullman sites were severely injured at the two-week evaluation, and all plants at all rates were dead at the four-week evaluation (Table 1).

Objective 2. In greenhouse trials conducted at Pullman, WA, 9 phenotypical jointed goatgrass plants and 1 wheat x jointed goatgrass hybrid grown from the Pasco S site seed survived spraying and vernalization. At the University of Idaho, Dr. Robert Zemetra evaluated the progeny of three Pasco N site-origin jointed goatgrass plants. Two plants' progeny from Pasco N site plot #107 tested by Dr. Zemetra were either killed by an initial 5 oz imazamox application or did not survive vernalization. However, seven progeny from a plot #206 plant screened by Dr. Zemetra survived the spray chamber imazamox application and vernalization with differential response to the herbicide treatment. Dr. Zemetra will include his results in more detail in his report. Further dose response studies will be conducted based on his findings and crosses.

9. PUBLICATIONS: None.

10. TECHNOLOGY TRANSFER ACTIVITIES: None.

11. BUDGET:

	Requested 1 July 06-30 June 07	Received 1 July 06-30 June 07	Requested 1 July 07-30 June 08	Received 1 July 07-30 June 08
Salary/Benefits	\$22,805	---	\$22,805	
Travel	\$1,375	---	\$1,500	
Materials & Supplies	\$585	---	\$330	
Publication	\$600		---	
Total	\$25,365	\$25,000	\$24,635	

Total proposed budget for project: \$50,000. Total received:

12. STATEMENT OF WORK TO BE CONDUCTED: Dose response studies will be conducted on open-pollinated remnant seed from a plant identified as 206 10'-3 from the Pasco N site, as well as seed collected from this plant in the field. Seed from this plant was used in Dr. Zemetra's research where he found variable resistance. We will also conduct dose response studies from homozygous plants identified from Dr. Zemetra's research. In addition we have enough seed left from 19 plants, which were collected in the field, to conduct dose response studies in the greenhouse. We must make a decision on how many of these need to be conducted. Dr. Zemetra will be provided seed from selfed plants from Pasco S that survived greenhouse herbicide applications and subsequent vernalization.

Table 1. Percent jointed goatgrass injury in the greenhouse dosage response study.

Plant	Rate (oz/A)	Percent control	
		2 wks	4 wks
Pasco S ^a Resistant	0 (Control)	0	0
	1	79	100
	2	93	100
	4	95	100
	6	95	100
	8	95	100
	16	95	100
Pullman ^b Resistant	0 (Control)	0	0
	1	89	100
	2	90	100
	4	95	100
	6	95	100
	8	95	100
	16	95	100
Susceptible	0 (Control)	0	0
	1	83	100
	2	90	100
	4	95	100
	6	95	100
	8	95	100
	16	95	100

^a Progeny of plant discovered in Pasco S plot #206 at 10' mark number 3.

^b Progeny of plant discovered in Pullman plot #201 at 10' mark number 10.