

12-04

ROGRESS REPORT

1. **TITLE:** Integrating IMI-resistant wheat into Oklahoma Wheat Production Systems for Jointed Goatgrass Management.
2. **PERSONNEL:** Tom Peeper, Raymond Sidwell. Oklahoma State University.
3. **TIME LINE:** Began July 2001. Planned duration -5 years. We are on schedule.
4. **ORIGINAL HYPOTHESIS:** Jointed goatgrass (JGG) can be effectively and selectively controlled in hard red winter wheat in the Southern Great Plains by applications of imidazolinone herbicides if wheat is seeded that is tolerant to these herbicides. Such control would be superior to control obtainable by cultural methods.
5. **SUMMARY OF PROGRESS:** The first three years of treatments have been completed as planned. Beyond herbicide failed to control JGG over 91% in 2002, which was too low to search for tolerant or resistant individuals. In 2003 control again averaged 91% in treatments with two consecutive annual applications and only 39% in the treatment that received Beyond only in 2002-03. Lower than expected control was attributed to late emergence, poor competition from the crop, and drought conditions in 2002. Dry conditions again prevailed in 2003, with only two precipitation events greater than 0.5 inches between October and April. Two annual Beyond applications reduced JGG spikelets in harvested grain to 2500 or less per bushel versus 193,000/ bushel in untreated plots. Application of Beyond only to the 2002-03 crop reduced JGG spikelets to 43,000/bushel. Currently, intensive cultural practices are continuing to reduce JGG spikelets to very low numbers. In 2004, no JGG spikelets were found in the harvested grain from treatments that received three consecutive annual applications of Beyond herbicide. JGG density appeared poised to rebound in plots that received two consecutive annual applications of Beyond herbicide then none the third year.
6. **OBJECTIVES:** (1) Conduct field research under conditions that expose JGG to pollen from imi-tolerant wheat, and investigate whether JGG x imi-wheat hybrids emerge that are herbicide resistant. (2) Determine the effect of varying degrees of selection pressure, due to varying management systems, on emergence of imi-tolerant JGG biotypes. (3) Use the information obtained above to develop management recommendations designed to perpetuate the usefulness if IMI-tolerance technology.
7. **EXPERIMENTAL DESIGN:** The experimental design includes 7 replicated (4 reps) treatments. Variables included in different treatments include tillage system, (conventional or stubble mulch tillage), imi-wheat or conventional wheat, and the timing and frequency of use of Beyond herbicide. For comparison with conventional methods, one treatment includes BMP's for management of JGG in conventional wheat, i.e. early maturing competitive cultivar, high seeding rate, narrow rows, and banded started fertilizer. Another treatment has conventional BMPs alternating with Clearfield wheat and Beyond herbicide application.

8. PROGRESS/CONCLUSIONS. The field research is underway, and there have been 0, 1, 2, or 3 applications of Beyond herbicide to date. We are learning a lot about how JGG responds to various cultural systems. First, in October '01 the density of JGG seedlings in the conventionally tilled plots (moldboard plowed) was 6 plants/m² versus 29 plants/m² in the stubble-mulched plots. In September, 03, where Beyond has not been applied, there was 52 JGG plants/m² in the conventional tillage versus 322 in the stubble mulch tillage plots. So, conventional tillage suppresses but does not eliminate JGG.

I have been surprised that a single Beyond treatment is not controlling the JGG better than it is. In 2002 visual ratings at harvest were 90 to 91% despite the fact that the JGG was relatively small (10% 3-leaf, 20% 4-leaf, 50% main stem plus 1-tiller, 20% main stem plus 2 tillers) and was an open target when the herbicide was applied. On average, we had 745 JGG spikelets per bushel in the grain harvested from Beyond treated plots compared to 3720/bushel in similar plots that did not receive Beyond. So, Beyond® only reduced JGG spikelets by 80%. In 2003, we applied the Beyond 19 days earlier than in 2002, but control was as low as 39%. It was dry both years, but there was some shallow soil moisture at application in 2003. Precipitation for 30 days before application in 2003 totaled 0.43 inches. Rainfall for 30 days after application totaled 1.02 inches scattered over 7 events. We may need to bump the rate to 6 oz, but that is almost cost-prohibitive. Data collected thus far indicates that three consecutive annual applications of Beyond are needed to eliminate JGG.

These results support our earlier observations that a dense wheat canopy is often essential to get good weed control with Beyond, but I am getting increasingly concerned about how consistent this herbicide will be in drier years and in the drier parts of Oklahoma, where JGG is a bigger problem. Two years ago, Alex questioned whether we applied the Beyond right. I suppose that was a logical question when performance isn't up to par. In 2002 the Beyond was applied at 4 fl oz/acre with a tractor mounted sprayer in 19.2 GPA of water with 0.25% v/v AG-98 nonionic surfactant + 1.25% v/v 28-0-0, using Turbo TeeJet 11003 tips and 40 psi pressure. In 2003, we upped the spray pressure to 48 and volume to 24.75 GPA, but that didn't seem to be of any benefit. We are not off label as far as application timing. Few if any of our wheat growers are willing to apply herbicides in the fall. The third sequential application in 2004 did reduce the JGG in the wheat to zero. We are concerned that we are seeing a JGG population rebound after only 1 or 2 annual applications.

The grain yields were not very high in 2002, but considering the dry weather in 2003, yields were really good (averaging 50 bu/A in clean plots). Yields in 2004 were about average for the region. In 2002 the yields were lower with the Clearfield Jagger than the regular Jagger. In 2003, yields were very similar, but test weights of both were really poor. Remember that the "Clearfield Jagger" is a relatively early cross, not a purified variety. However, low test weights are a problem for the Clearfield wheats I am familiar with. The conventional tillage Jagger lodged bad in May, which reduced its test weights. Increased lodging is always a risk when seeding rate is increased to produce a more competitive crop. Low test weights in 2004 were unexpected but were often reported across the state, and were assumed to be a result of a brief period of 100+ temperatures in late May.

The evidence is clear that intensive cultural practices can reduce JGG density and keep it suppressed to a nonexistent problem. The reliability of Beyond under field conditions is still an open question.

Plots were examined for hybrids twice in 2002 and once in 2003, and none were found. In 2003, much of the JGG was leaning before harvest, but the plots were inspected carefully, and not a single hybrid was found in any plot. The plots were checked for hybrids again in 2004 and 4 total hybrids were found in two plots from treatment 6 and 3 hybrids were found in one plot from treatment 3.

PROGRESS BY OBJECTIVE:

Objective 1: Determine whether wheat x jgg hybrids appear that are herbicide tolerant. This past spring was the first time we were able to locate any hybrids in the field. Prior to harvest, four hybrids were tentatively identified in treatment 6, which was seeded with Clearfield wheat the previous year. They would most likely have had Clearfield wheat as a parent. Also 3 hybrids were found in treatment 3, which was also seeded with Clearfield wheat the previous year. Therefore, they could have been carrying the gene for IMI tolerance. However, at harvest, none of those plants tentatively identified as a hybrid was collected. In May-June 2005 we will collect all hybrids when we first see them, and not wait until harvest. However, it was noted that all of the hybrid plants found were growing in areas near the edges of the plots where jointed goatgrass was abundant. So, in spite of the fact that the plots where the hybrids were first located were plots that had been treated with Beyond, we can not ascertain that they were in fact IMI-tolerant. Research that we published in 2004 demonstrated that the viability of wheat x jgg hybrids is only about 1%. Also, since the chromosome numbers of the hybrids are quite variable, it is unlikely that most hybrids would be able to perpetuate themselves.

Objective 2: Determine the effect of selection pressure and management on emergence of IMI-tolerant jgg biotypes. Our data to date do not suggest that biotypes of jgg tolerant to the herbicide have begun to emerge. We can make this statement based on the lack of jgg spikelets in harvested grain in treatments 3 and 4 (both have had Beyond applied 3 years in a row) in June 04, and the very low numbers of jgg seedlings found in those plots prior to seeding the 04-05 crop. If resistant biotypes are going to show up, jgg density should start increasing in those plots next year.

Objective 3: Develop management recommendations: We published an OSU Extension Fact Sheet last year entitled "Clearfield Wheat Production Systems in Oklahoma" which discussed the available Clearfield cultivars, the potential for developing resistant weeds, explained why seed should not be saved for replanting and contained color photos to help identify jgg and hybrids. As we wrap up the five year project, we will have the data to write fact sheets detailing jgg management options and the strengths and weaknesses of depending on one herbicide to control jgg in continuous wheat.

9. PUBLICATIONS: Stone, A.E., and T.F. Peeper. 2004. Characterizing jointed goatgrass (*Aegilops cylindrica*) x winter wheat hybrids in Oklahoma. *Weed Sci.* 52:742-745.

10. TECHNOLOGY TRANSFER ACTIVITIES. Dr. Case Medlin joined our faculty as State Extension Weed Specialist in late summer of 2001. His first big project was to set up 8 on-farm demonstrations of Clearfield wheat across the state. Two of these sites were with jointed goatgrass as the main target. He is currently preparing a journal article on this research. In addition he has written an OSU Fact Sheet on the use of Clearfield technology for grass control in wheat and presented information at several wheat growers meetings. This is the first time in 10 years that we can truly say that we now have an effective wheat-weed control extension program. He has been aggressively developing web-based ID information and control recommendations that should prove very useful. Our farmers and applicators still have difficulty in distinguishing among the various winter annual grasses that infest our wheat.

Briefly stated, our basic recommendations for JGG in wheat are (1). Try Clearfield wheat sprayed with Beyond on a trial basis only, because the variety choice is currently very poor for most of Oklahoma, (2) Use intensive cultural practices as we are doing in this project (Moldboard 7 to 8 inches deep, keep subsequent tillage shallow, seed 120 lb/acre of a competitive cultivar in narrow rows with banded started fertilizer, and harvest as soon as possible before the JGG shatters). and, (3) Consider alternatives to wheat grain production, such as crop rotation, graze-out, or harvesting the wheat for hay when it is feasible. We also stress the importance of clean seed. We are working hard on crop rotations as an economically sustainable approach.

11. BUDGET: We are requesting \$19,393 for FY-2005. This project has been budgeted annually for \$18,000, most of which is for a half-time graduate research assistant with the balance for supplies and traveling back and forth to the research site. We probably did not budget enough for travel, since our motor pool is charging me \$0.56/mile now when we drive our pickups to haul equipment back and forth (about \$90/trip), and there is nothing budgeted for travel to attend the annual review.

	FY-2001	FY-2002	FY-2003	FY-2004	FY-2005	Total
Requested	\$18,000	\$18,000	\$18,000	\$18,000	\$19,393	\$91,393
Received	\$18,000	\$18,000	\$18,000	\$18,000		

12. STATEMENT OF WORK TO BE CONDUCTED. Funds requested are to support the fifth year of this five-year research project. The timeline of basic activities is somewhat as follows: Late winter '05, apply Beyond herbicide to appropriate treatments. Record JGG and wheat responses. Search for hybrid plants before wheat harvest. Harvest subsamples from each plot, determine treatment effects on wheat yield and quality. Determine treatment effect on JGG spikelets in harvested grain by hand separating spikelets from grain samples. Apply tillage variables beginning right after harvest each summer. Seed the plots in October each year with the appropriate cultivars, seeding rates, row spacings etc. Monitor JGG seedling density, wheat stand density, and

obtain other appropriate data. If hybrids are discovered in 2005 or 2006, they will be collected and efforts made to determine whether they are herbicide tolerant.

Budget Justification:

Requesting assistance for one half-time graduate research assistant at \$14,000, with fringe benefits figured at the current FY06 rate of 2.57% (\$360) with the balance of the funds to be spent in supplies (\$1,033) such as seed, stakes, harvest supplies, and routine maintenance of field research equipment, and travel (\$4,000) to the research site. Our increased budget in travel will help offset the increase in gasoline prices. Currently our trips to the research site run on the average of \$90/trip, based on our department price of \$0.60 per mile.

Peeper-Integrating imi-resistant wheat-OK

Some of the data collected from 5 year jointed goatgrass management experiment at Lahoma, Oklahoma

Table 1.

Treatment	Jgg plants/ 1/4M2				Wheat yield bu/acre			Wheat tw lb/bu		
	Oct 01	Oct 02	Sept 03	Oct 04	June 02	June 03	June 04	June 02	June 03	June 04
1	0.8	1.9	13.0	1	33.9	44.8	45.5	54.8	49.9	51.0
2	3.5	30.1	80.8	16	21.0	26.5	37.9	52.4	41.9	51.7
3	5.5	19.0	12.0	1	16.1	50.8	41.6	51.5	52.7	49.1
4	8.8	14.3	19.5	1	20.6	50.7	41.2	52	52.5	51.3
5	14.8	18.3	28.5	3	17.8	50.7	45.8	51.9	53.5	52.2
6	5.3	47.1	38.5	5	26.0	38.7	46.3	51.8	49.8	51.5
7	1.8	4.1	0.0	3	25.3	50.8	46.3	53.4	51.3	50.5
LSD 0.05	NSD	15.4	30.9	3.8	9.2	8.6	3.43	2.3	5.3	NSD

Treatment 1: Conventional tillage (moldboard plowing), competitive traditional wheat, high seeding rate, narrow row spacing, banded starter fertilizer and no herbicide any year.

Treatment 2: Stubble mulch tillage, Clearfield wheat, normal seeding practices, and no herbicide any year.

Treatment 3: Stubble mulch tillage, Clearfield wheat, normal seeding practices, and Beyond applied each year at 4 fl oz/acre.

Treatment 4: Stubble mulch tillage, Clearfield wheat, normal seeding practices, and Beyond applied at 4 fl oz/acre in 2001-2002 and 2002-2003, and 2003-2004. In 2004-2005 and 2005-2006, traditional wheat with no herbicides.

Treatment 5: Stubble mulch tillage, Clearfield wheat, normal seeding practices, sprayed with Beyond at 4 fl oz/acre in 2001-2002 and 2002-2003. In 2003-2004, 2004-2005, 2005-2006, traditional wheat with no herbicides.


Treatment 6: Stubble mulch tillage, traditional wheat and seeding practices in 2001-2002, 2003-2004, and 2005-2006 with no herbicides, Clearfield wheat in 2002-2003 and 2004-2005 sprayed with Beyond at 4 fl oz/acre.

Treatment 7: Conventional tillage, competitive traditional wheat, high seedling rate, narrow row spacing in 2001-2002, 2003-2004, and 2005-2006. Clearfield wheat in 2002-2003 and 2004-2005 with high seeding rate, narrow row spacing and no herbicides.

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Table 2. Jgg spikelets in 200 grams of grain

Treatment	June 02	June 03	June 04	2005	2006
1	15.5	0	0		
2	27.3	44.5	148.8		
3	7.3	0.1	0		
4	4.8	0.1	0		
5	4.3	0.3	2.4		
6	45.3	6.7	8.8		
7	31.3	0.1	0		
LSD	18.2	17.5	96.72		

 The numbers with blue shading indicate data collected (or will be collected) following an application of Beyond herbicide at 4 oz/a.