Integrated Pest Management on Alfalfa Seed: A Two-Year Report 2008-2009

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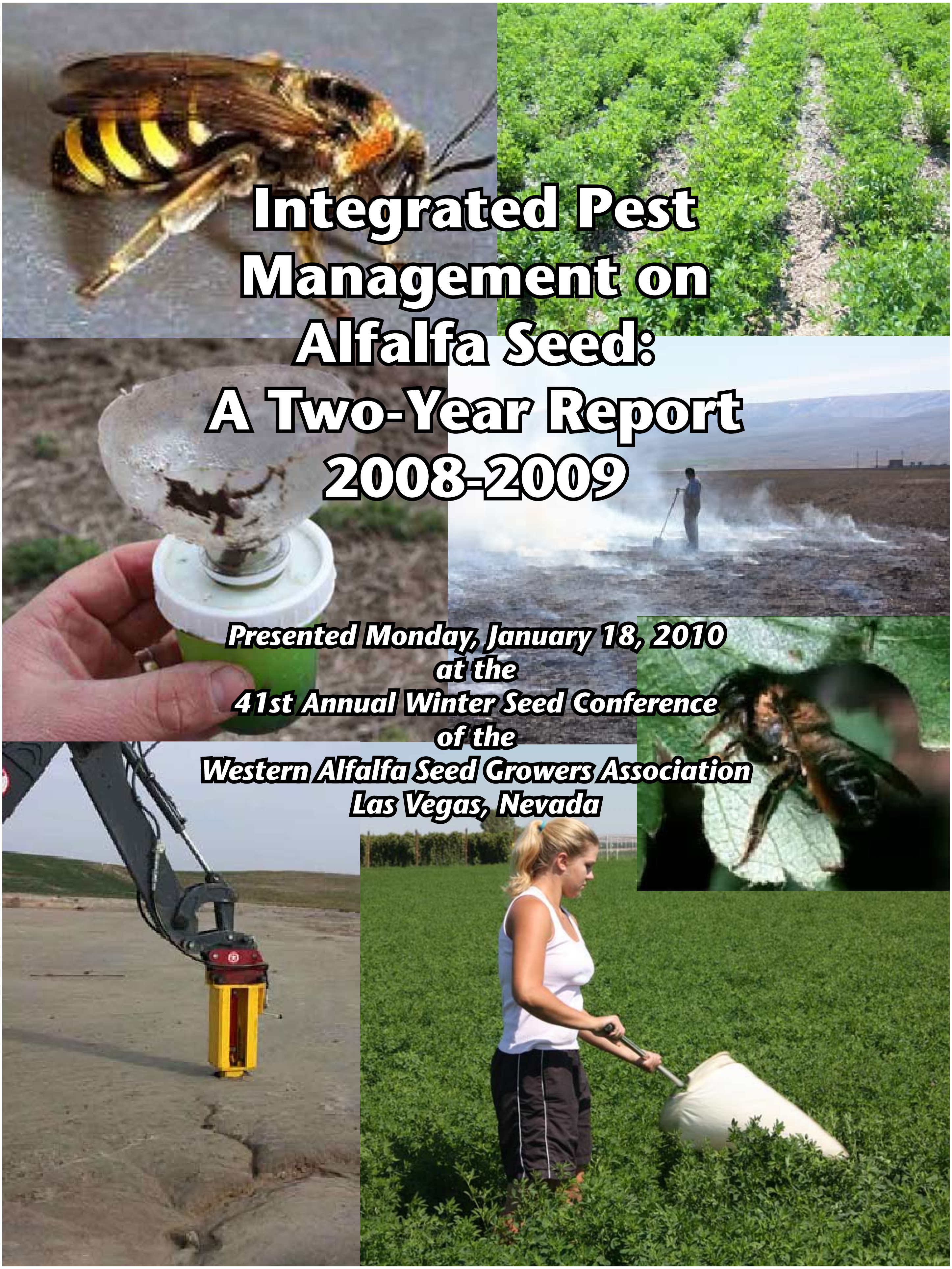

Integrated Pest Management on Alfalfa Seed: A Two-Year Report 2008-2009

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Arthropod Studies

Weed Studies

Combined Studies

Washington State University Extension
Western Alfalfa Seed Growers Association
Agricultural Research Service

Section I
Insecticide Efficacy Trials 2008-2009

Insecticides were screened for their ability to control Lygus bugs and aphids in alfalfa seed fields in 2008 and 2009. In early spring of each year, field plots were established at Prosser, Touchet, and Othello in Washington State, USA. Plots were 18 ft. wide and 20 ft. long and treatments were replicated 4 times in a complete random block design. Treatments were applied to mimic grower timing at pre-bloom period, using a CO_2-powered backpack sprayer equipped with a four-nozzle boom using 15 gallons of water per acre as a carrier. Five 180° sweeps per plot were used to sample arthropod abundance.

Lygus/Alfalfa Seed Pre-Bloom Treatments 2008	
Product	**Rate/Acre**
Rimon 0.83 EC (novaluron)	12 oz.
Dimethoate 4 EC	1 pt
Assail 70 WP (acetamiprid)	1.7 oz
Lorsban 4E (chlorpyrifos)	2 pt
Bifenture EC (bifenthrin)	6.4 fluid oz
Lorsban and Bifenture	Rates as above
Beleaf 50SG (flonicamid)	2.8 oz
Warrior w/ Zeon Technology (lambda-cyhalothrin)	3.8 fluid oz
Mustang Max EC (zeta-cypermethrin)	4.0 fluid oz
Metaflumizone	0.25 lb ai/acre
Belay 2.13SC (clothianidin)	3.8 fluid oz
Untreated check	
Application Dates: Prosser 6/2/2008, Touchet 6/2/2008, Othello 6/4/2008	

Lygus/Alfalfa Seed Pre-Bloom Treatments 2009	
Product	**Rate/Acre**
Actara (thiamethoxam)	4 oz
Actara and Bifenture	4 oz & 6.4 fl oz
Alverde (metaflumizone)	0.25 lb ai
Assail 70 WP (acetamiprid)	1.7 oz
Belay 2.13SC (clothianidin)	3.8 fl oz
Beleaf 50SG (flonicamid)	2.8 oz
Bifenture EC (bifenthrin)	6.4 fl oz
Dimethoate 4 EC	1 pt
Lorsban 4E (chlorpyrifos)	2 pt
Lorsban and Bifenture	2 pt & 6.4 fl oz
Rimon 0.83 EC (novaluron)	12 oz.
Warrior w/ Zeon Technology (lambda-cyhalothrin)	3.8 fl oz
Untreated check	
Application Dates: Prosser 6/12/2009, Touchet 5/29/2009, Othello 6/12/2009	

2008 Othello Pre-Bloom Sprays: Adult Lygus						
Treatment/ (active ingredient)	**Rate**	**6/9/08**	**6/13/08**	**6/24/08**	**7/2/08**	**7/10/08**
Assail 70 WP (acetamiprid)	1.7 oz.	6.75	5.75*	5.50	2.00	0.25
Belay 2.13SC (clothiandin)	3.8 fluid oz.	4.25*	7.75	6.00	1.75	3.25
Beleaf 50SG	2.8 oz.	3.25**	4.75*	6.25	0.50	5.50
Bifenture EC (bifenthrin)	6.4 fluid oz.	1.25**	3.00**	5.00	1.50	0.75
Dimethoate 4 EC	1 pt.	4.50*	6.25	7.50	1.50	2.25
Lorsban 4E (chlorpyrifos)	2 pt.	5.50	5.75*	5.25	0.50	3.25
Lorsban and Bifenture	2 pt.+6.4 oz	1.50**	2.50**	5.00	3.25	1.75
Metaflumizone	0.25 lb ai/A	4.50*	6.25	4.5	4.00	2.50
Mustang Max EC (z-cypermethrin)	4.0 fl oz.	1.25**	2.00**	5.00	2.00	3.00
Rimon 0.83 EC (novaluron)	12 oz.	8.25	4.25**	8.25	1.75	1.75
Warrior (lambda-cyhalothrin)	3.8 fluid oz.	2.25**	0.75**	5.50	2.00	1.75
Untreated check		9.00	10.25	5.00	3.75	4.00

***/ Insect population is significantly ($p<0.05$) lower in insecticide treated plots than in untreated control.**
****/ Insect population is significantly ($p<0.01$) lower in insecticide treated plots than in untreated control.**

2009 Othello Pre-Bloom Sprays: Adult Lygus					
Treatment/ (active ingredient)	**Rate**	**6/18/09**	**7/2/09**	**7/8/09**	**7/16/09**
Actara (thiamethoxam)	4 oz	8.7±3.8	4.3±1.7	3.0±0.6	1.0±1.0
Actara and Bifenture	4oz & 6.4oz	7.5±1.5	1.7±0.6	2.5±0.9	1.0±0.5
Alverde (metaflumizone)	0.25 lb ai	9.2±3.9	3.7±1.3	0.7±0.7	0.7±0.5
Assail 70 WP (acetamiprid)	1.7 oz	18.2±1.1	2.7±2.0	4.5±2.2	0.2±0.2
Belay 2.13SC (clothianidin)	3.8 fl oz	8.0±3.5	5.7±1.4	0.3±0.3	1.7±0.9
Beleaf 50SG (flonicamid)	2.8 oz	8.5±1.9	2.2±0.8	1.7±0.2	2.0±0.9
Bifenture EC (bifenthrin)	6.4 fl oz	8.2±1.8	2.5±1.5	1.2±0.5	1.7±0.8
Dimethoate 4 EC	1 pt	13.5±3.9	3.5±1.0	2.0±0.4	1.5±0.6
Lorsban 4E (chlorpyrifos)	2 pt	8.2±3.4	3.0±0.9	4.0±1.8	0.2±0.2
Lorsban and Bifenture	2pt & 6.4oz	6.3±0.9	0.7±0.7	1.0±0.5	1.7±1.2
Rimon 0.83 EC (novaluron)	12 oz.	10.7±2.9	2.7±0.9	1.3±0.3	0.7±0.3
Warrior (lambda-cyhalothrin)	3.8 fl oz	6.2±1.1	2.5±1.1	0.2±0.2	1.0±0.4
Untreated check		7.6±1.0	2.6±0.8	1.6±0.7	0.9±0.4

2008 Othello Pre-Bloom Sprays: Lygus Nymphs						
Treatment/ (active ingredient)	**Rate**	**6/9/08**	**6/13/08**	**6/24/08**	**7/2/08**	**7/10/08**
Assail 70 WP (acetamiprid)	1.7 oz.	4.00**	1.00**	0.25	1.25	6.75
Belay 2.13SC (clothiandin)	3.8 fluid oz.	3.00**	1.25**	0.25	0	5.25
Beleaf 50SG	2.8 oz.	4.00**	4.50	4.25	0.75	5.50
Bifenture EC (bifenthrin)	6.4 fluid oz.	0.25**	0.25**	0	1.00	6.25
Dimethoate 4 EC	1 pt.	6.25*	1.25**	0	2.00	7.50
Lorsban 4E (chlorpyrifos)	2 pt.	2.00**	0.25**	1	1.00	5.25
Lorsban and Bifenture	2 pt.+6.4 oz	0.75**	0	0.25	1.00	4.75
Metaflumizone	0.25 lb ai/A	3.00**	3.00**	0	0.50	5.75
Mustang Max EC (z-cypermethrin)	4.0 fluid oz.	0.50**	0.50**	0.25	0.75	3.50
Rimon 0.83 EC (novaluron)	12 oz.	7.50	5.00	0	0.75	6.00
Warrior (lambda-cyhalothrin)	3.8 fluid oz.	0**	0**	0.75	0	3.50
Untreated check		11.25	5.50	0.25	1.00	6.75

***/ Insect population is significantly ($p<0.05$) lower in insecticide treated plots than in untreated control.**
****/ Insect population is significantly ($p<0.01$) lower in insecticide treated plots than in untreated control.**

2009 Othello Pre-Bloom Sprays: Lygus Nymphs					
Treatment/ (active ingredient)	**Rate**	**6/18/09**	**7/2/09**	**7/8/09**	**7/16/09**
Actara (thiamethoxam)	4 oz	0.7±0.6	0.3±0.3	0.3±0.3	2.0±1.6
Actara and Bifenture	4oz & 6.4oz	0	0.5±0.5	0	3.0±1.7
Alverde (metaflumizone)	0.25 lb ai	0	0.3±0.3	0.5±0.3	3.5±1.7
Assail 70 WP (acetamiprid)	1.7 oz	1.0±0.6	0	0.5±0.3	6.3±2.3
Belay 2.13SC (clothianidin)	3.8 fl oz	1.0±1.0	0	0	4.7±1.3
Beleaf 50SG (flonicamid)	2.8 oz	0.7±0.5	0.7±0.2	0	7.0±0.9
Bifenture EC (bifenthrin)	6.4 fl oz	1.7±0.8	0.2±0.2	0.5±0.5	5.5±1.3
Dimethoate 4 EC	1 pt	1.0±0.7	0	0.5±0.3	5.8±2.0
Lorsban 4E (chlorpyrifos)	2 pt	1.2±1.2	0	0.5±0.5	7.5±2.4
Lorsban and Bifenture	2pt & 6.4oz	0	0.3±0.3	0	4.0±1.5
Rimon 0.83 EC (novaluron)	12 oz.	1.0±1.0	0	0	4.7±0.9
Warrior (lambda-cyhalothrin)	3.8 fl oz	0	0.2±0.2	0	1.5±0.9
Untreated check		0.6±0.3	0.1±0.1	0.3±0.2	5.0±1.3

2008 Othello Pre-Bloom Sprays: Aphids						
Treatment/ (active ingredient)	Rate	6/9/08	6/13/08	6/24/08	7/2/08	7/10/08
Assail 70 WP (acetamiprid)	1.7 oz.	6.50	4.75**	60.25	225.50	306.25
Belay 2.13SC (clothiandin)	3.8 fluid oz.	5.00	5.00**	55.50	290.00	408.75
Beleaf 50SG	2.8 oz.	3.50	1.00**	14.75**	122.00**	300.00
Bifenture EC (bifenthrin)	6.4 fluid oz.	0.75**	0**	0.50**	41.25**	119.25**
Dimethoate 4 EC	1 pt.	9.25	0.75**	8.50**	94.75**	275.00
Lorsban 4E (chlorpyrifos)	2 pt.	4.50	1.00**	28.75**	173.00*	407.50
Lorsban and Bifenture	2 pt.+6.4 oz	0.25**	0**	1.25**	47.00**	153.50*
Metaflumizone	0.25 lb ai/A	21.75	21.75	114.00[z]	257.75	300.00
Mustang Max EC (z-cypermethrin)	4.0 fluid oz.	0.50**	1.50**	36.75*	369.75	647.50
Rimon 0.83 EC (novaluron)	12 oz.	16.50	21.75	120.75[zz]	421.25	451.25
Warrior (lambda-cyhalothrin)	3.8 fluid oz.	0**	0.75**	9.75**	151.75**	575.00
Untreated check		11.75	21.00	77.50	341.00	600.00

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****/ Insect population is significantly (p<0.01) lower in insecticide treated plots than in untreated control.**

2009 Othello Pre-Bloom Sprays: Aphids					
Treatment/ (active ingredient)	Rate	6/18/09	7/2/09	7/8/09	7/16/09
Actara (thiamethoxam)	4 oz	84.3± 7.6	93.6±11.9	166.7± 20.2	290.0± 85.1
Actara and Bifenture	4oz & 6.4oz	53.2±40.3	125.0±65.5	223.7±114.5	219.2± 25.2
Alverde (metaflumizone)	0.25 lb ai	118.0±35.3	81.7±31.3	246.5± 77.9	350.0± 59.0
Assail 70 WP (acetamiprid)	1.7 oz	121.0±17.0	102.2±24.2	227.7± 43.2	307.0± 81.0
Belay 2.13SC (clothianidin)	3.8 fl oz	114.0±47.5	135.3±49.1	565.3±217.0	395.0± 36.4
Beleaf 50SG (flonicamid)	2.8 oz	39.0±17.8	83.5±12.8	180.5± 34.6	314.5± 43.1
Bifenture EC (bifenthrin)	6.4 fl oz	68.8±23.0	107.8±20.5	132.5± 36.7	266.0± 99.5
Dimethoate 4 EC	1 pt	36.5±14.2	130.0± 6.9	21.5± 33.9	348.0± 52.6
Lorsban 4E (chlorpyrifos)	2 pt	56.0±28.0	122.0±22.5	169.2± 16.5	428.2±120.8
Lorsban and Bifenture	2pt & 6.4oz	28.0±19.5	115.3±27.1	83.0± 13.0	162.0± 49.7
Rimon 0.83 EC (novaluron)	12 oz.	117.3±42.0	53.7±31.2	296.0± 64.5	396.3± 47.0
Warrior (lambda-cyhalothrin)	3.8 fl oz	21.0± 7.1	79.5±23.8	161.0± 55.3	253.5± 82.7
Untreated check		122.0± 32.4	139.0±42.8	219.2± 50.0	294.0± 63.2

2008 Touchet Pre-Bloom Sprays: Adult Lygus					
Treatment/ (active ingredient)	Rate	6/9/08	6/13/08	6/24/08	7/2/08
Assail 70 WP (acetamiprid)	1.7 oz.	0	0.50	1.50	2.00
Belay 2.13SC (clothiandin)	3.8 fluid oz.	0	0.50	1.75	0.25
Beleaf 50SG	2.8 oz.	0.50	0.50	1.00	1.25
Bifenture EC (bifenthrin)	6.4 fluid oz.	1.00	0.50	1.75	0.25
Dimethoate 4 EC	1 pt.	0	1.25	0.25	0.00
Lorsban 4E (chlorpyrifos)	2 pt.	0.50	0.75	3.25	0.25
Lorsban and Bifenture	2 pt.+6.4 oz	0	0.25	1.00	0
Metaflumizone	0.25 lb ai/A	0	0	2.50	0.50
Mustang Max EC (z-cypermethrin)	4.0 fl oz.	0	1.00	0.75	0
Rimon 0.83 EC (novaluron)	12 oz.	0	0.50	2.25	0
Warrior (lambda-cyhalothrin)	3.8 fluid oz.	0.50	0.75	0.50	0
Untreated check		0	1.00	2.75	0.50

***/ Insect population is significantly (p<0.05) lower in insecticide treated plots than in untreated control.**
****/ Insect population is significantly (p<0.01) lower in insecticide treated plots than in untreated control.**

2009 Touchet Pre-Bloom Sprays: Adult Lygus					
Treatment/ (active ingredient)	**Rate**	**6/18/09**	**7/2/09**	**7/8/09**	**7/16/09**
Actara (thiamethoxam)	4 oz	1.0±1.0	1.7±0.9	1.3±0.6	2.0±1.3
Actara and Bifenture	4oz & 6.4oz	1.7±1.0	2.2±0.8	2.7±0.8	1.5±0.5
Alverde (metaflumizone)	0.25 lb ai	2.0±0.7	0.5±0.3	0.2±0.2	1.5±1.2
Assail 70 WP (acetamiprid)	1.7 oz	1.2±0.6	1.0±0.7	0.2±0.2	1.7±0.8
Belay 2.13SC (clothianidin)	3.8 fl oz	1.0±0.4	1.0±0.6	2.0±0.7	1.5±0.3
Beleaf 50SG (flonicamid)	2.8 oz	2.0±0.7	1.5±0.5	1.5±0.9	0
Bifenture EC (bifenthrin)	6.4 fl oz	1.0±0.7	1.0±0.4	0	2.7±1.5
Dimethoate 4 EC	1 pt	1.0±0.4	0.7±0.5	0.7±0.2	1.5±0.6
Lorsban 4E (chlorpyrifos)	2 pt	1.2±0.9	1.2±0.7	0.2±0.2	3.5±1.6
Lorsban and Bifenture	2pt & 6.4oz	0.7±0.5	1.0±1.0	2.0±0.9	1.0±0.5
Rimon 0.83 EC (novaluron)	12 oz.	4.0±1.7	2.3±1.3	1.2±0.2	0.7±0.7
Warrior (lambda-cyhalothrin)	3.8 fl oz	0.2±0.2	1.5±0.9	0.7±0.5	1.0±0.6
Untreated check		1.8±0.7	0.9±0.3	1.0±0.5	0.5±0.3

2008 Touchet Pre-Bloom Sprays: Lygus Nymphs				
Treatment (active ingredient)	**Rate**	**6/9/08, 6/13/08**	**6/24/08**	**7/2/08**
Assail 70 WP (acetamiprid)	1.7 oz.	0, 0	0	0.25
Belay 2.13SC (clothiandin)	3.8 fluid oz.	0, 0	0	0.50
Beleaf 50SG	2.8 oz.	0, 0	0	0.25
Bifenture EC (bifenthrin)	6.4 fluid oz.	0, 0	0	0.25
Dimethoate 4 EC	1 pt.	0, 0	0	0
Lorsban 4E (chlorpyrifos)	2 pt.	0, 0	0.25	0
Lorsban and Bifenture	2 pt.+6.4 oz	0, 0	0	0
Metaflumizone	0.25 lb ai/A	0, 0	0	0
Mustang Max EC (z-cypermethrin)	4.0 fl oz.	0, 0	0.25	0
Rimon 0.83 EC (novaluron)	12 oz.	0, 0	0	0
Warrior (lambda-cyhalothrin)	3.8 fluid oz.	0, 0	0	0
Untreated check		0, 0	0	0

Adult Lygus bug

2009 Touchet Pre-Bloom Sprays: Lygus Nymphs					
Treatment/ (active ingredient)	**Rate**	**6/18/09**	**7/2/09**	**7/8/09**	**7/16/09**
Actara (thiamethoxam)	4 oz	0	0.3±0.3	1.2±0.5	4.7±2.1
Actara and Bifenture	4oz & 6.4oz	0	0	0.7±0.5	3.0±1.3
Alverde (metaflumizone)	0.25 lb ai	0	0	0.2±0.2	3.0±1.1
Assail 70 WP (acetamiprid)	1.7 oz	0	0	0	3.7±0.8
Belay 2.13SC (clothianidin)	3.8 fl oz	0.2±0.2	0.3±0.3	0.2±0.2	3.5±1.0
Beleaf 50SG (flonicamid)	2.8 oz	0	0	1.5±0.9	2.7±0.6
Bifenture EC (bifenthrin)	6.4 fl oz	0	0.5±0.5	1.2±0.6	2.7±1.0
Dimethoate 4 EC	1 pt	0	0	0	4.2±0.6
Lorsban 4E (chlorpyrifos)	2 pt	0	0.5±0.5	0.7±0.2	3.7±0.5
Lorsban and Bifenture	2pt & 6.4oz	0.5±0.3	0	0.5±0.3	6.0±0.7
Rimon 0.83 EC (novaluron)	12 oz.	0.2±0.2	0.3±0.3	0.7±0.5	2.7±0.5
Warrior (lambda-cyhalothrin)	3.8 fl oz	0	0	0	0.5±0.5
Untreated check		0.2±0.2	0.1±0.1	0.2±0.2	3.3±0.8

2008 Touchet Pre-Bloom Sprays: Aphids					
Treatment/ (active ingredient)	**Rate**	**6/9/08**	**6/13/08**	**6/24/08**	**7/2/08**
Assail 70 WP (acetamiprid)	1.7 oz.	6.00	8.00*	156.75	6.75
Belay 2.13SC (clothiandin)	3.8 fluid oz.	8.50	18.75	200.75	6.00
Beleaf 50SG	2.8 oz.	5.00	7.00*	130.75	4.75
Bifenture EC (bifenthrin)	6.4 fluid oz.	0	2.00**	105.75	4.75
Dimethoate 4 EC	1 pt.	0	0.50**	28.00**	1.75
Lorsban 4E (chlorpyrifos)	2 pt.	0.5	1.50**	55.75**	1.75
Lorsban and Bifenture	2 pt.+6.4 oz	0	0**	27.00**	2.75
Metaflumizone	0.25 lb ai/A	6.50	4.75**	149.50	0.75
Mustang Max EC (z-cypermethrin)	4.0 fl oz.	1.50	2.25**	79.75*	1.50
Rimon 0.83 EC (novaluron)	12 oz.	6.00	5.25**	146.25	1.00
Warrior (lambda-cyhalothrin)	3.8 fluid oz.	1.00	0.75**	66.25**	2.00
Untreated check		3.50	19.25	170.75	13.75

***/ Insect population is significantly ($p<0.05$) lower in insecticide treated plots than in untreated control.**
****/ Insect population is significantly ($p<0.01$) lower in insecticide treated plots than in untreated control.**

2009 Touchet Pre-Bloom Sprays: Aphids					
Treatment/ (active ingredient)	**Rate**	**6/18/09**	**7/2/09**	**7/8/09**	**7/16/09**
Actara (thiamethoxam)	4 oz	48.3±19.7	161.0±24.6	103.0±26.5	19.5±11.9
Actara and Bifenture	4oz & 6.4oz	38.7±12.9	161.0±28.6	84.0±15.5	20.0± 7.4
Alverde (metaflumizone)	0.25 lb ai	76.2±13.7	254.0±73.1	103.2±16.7	59.8±50.5
Assail 70 WP (acetamiprid)	1.7 oz	45.2± 8.0	161.7±40.5	68.0±15.2	10.5± 2.2
Belay 2.13SC (clothianidin)	3.8 fl oz	66.2± 7.6	19.80±40.5	119.0±22.6	9.7± 2.6
Beleaf 50SG (flonicamid)	2.8 oz	27.7± 7.2	139.2±35.5	116.5±42.2	22.0±12.7
Bifenture EC (bifenthrin)	6.4 fl oz	92.5±29.5	204.7±35.9	98.5±17.1	74.7±37.1
Dimethoate 4 EC	1 pt	38.5±13.0	196.2±37.8	91.7±10.1	33.0±11.5
Lorsban 4E (chlorpyrifos)	2 pt	48.2±11.1	128.7±36.6	71.0± 6.5	12.5± 0.5
Lorsban and Bifenture	2pt & 6.4oz	96.5±72.8	97.7±9.2	115.0±20.4	29.0± 8.4
Rimon 0.83 EC (novaluron)	12 oz.	120.0±12.9	193.3±35.4	73.7± 4.3	50.0±24.0
Warrior (lambda-cyhalothrin)	3.8 fl oz	30.7± 8.2	181.5±34.8	187.7±25.9	124.2±42.0
Untreated check		76.7±12.4	170.3±17.8	78.2±11.4	22.1±11.1

2008 Prosser Pre-Bloom Sprays: Adult Lygus					
Treatment/ (active ingredient)	**Rate**	**6/9/08**	**6/13/08**	**7/3/08**	**7/10/08**
Assail 70 WP (acetamiprid)	1.7 oz.	2.75	17.00	1.00	0.50
Belay 2.13SC (clothiandin)	3.8 fluid oz.	3.25	15.00	1.75	0
Beleaf 50SG	2.8 oz.	5.50	13.50	8.75	0.50
Bifenture EC (bifenthrin)	6.4 fluid oz.	1.00	14.75	28.00	3.00
Dimethoate 4 EC	1 pt.	4.25	14.25	2.75	0
Lorsban 4E (chlorpyrifos)	2 pt.	7.00	13.50	7.75	0
Lorsban and Bifenture	2 pt.+6.4 oz	1.50	17.25	14.00	1.50
Metaflumizone	0.25 lb ai/A	5.50	11.75	1.25	0.50
Mustang Max EC (z-cypermethrin)	4.0 fl oz.	1.50	15.25	4.00	0
Rimon 0.83 EC (novaluron)	12 oz.	4.00	8.75	2.50	0.75
Warrior (lambda-cyhalothrin)	3.8 fluid oz.	1.25	6.75	8.00	1.00
Untreated check		3.75	8.25	4.50	0.25

2009 Prosser Pre-Bloom Sprays: Adult Lygus					
Treatment/ (active ingredient)	**Rate**	**6/18/09**	**7/2/09**	**7/8/09**	**7/16/09**
Actara (thiamethoxam)	4 oz	6.3±0.3	7.7±2.3	10.3±0.7	45.7±16.3
Actara and Bifenture	4oz & 6.4oz	7.0±0.9	5.5±2.1	9.0±1.7	55.5± 8.8
Alverde (metaflumizone)	0.25 lb ai	7.0±1.8	7.5±2.2	13.5±2.9	47.7±12.1
Assail 70 WP (acetamiprid)	1.7 oz	8.5±1.8	7.7±2.8	12.0±3.2	58.7±26.3
Belay 2.13SC (clothianidin)	3.8 fl oz	7.3±2.0	3.7±1.0	9.0±2.6	59.0±26.5
Beleaf 50SG (flonicamid)	2.8 oz	8.5±2.9	4.5±1.5	7.2±1.5	43.7±7.6
Bifenture EC (bifenthrin)	6.4 fl oz	9.5±3.2	6.2±2.4	7.2±1.6	69.5±23.2
Dimethoate 4 EC	1 pt	6.7±3.5	6.2±1.6	11.7±2.6	58.2±17.6
Lorsban 4E (chlorpyrifos)	2 pt	10.7±3.4	2.2±1.6	6.0±1.1	42.7±13.5
Lorsban and Bifenture	2pt & 6.4oz	3.7±2.0	2.3±1.5	7.3±1.7	54.0±10.6
Rimon 0.83 EC (novaluron)	12 oz.	8.0±2.0	6.7±1.7	4.3±0.7	57.7±29.7
Warrior (lambda-cyhalothrin)	3.8 fl oz	3.7±1.0	7.5±3.3	3.7±1.4	43.7±6.3
Untreated check		7.6±1.5	10.2±1.9	12.1±1.8	49.0±14.4

2008 Prosser Pre-Bloom Sprays: Lygus Nymphs					
Treatment/ (active ingredient)	**Rate**	**6/9/08**	**6/13/08**	**7/3/08**	**7/10/08**
Assail 70 WP (acetamiprid)	1.7 oz.	4.00*	7.00	13.75	5.00
Belay 2.13SC (clothiandin)	3.8 fluid oz.	3.25**	6.50	9.50	4.25
Beleaf 50SG	2.8 oz.	3.25**	11.25	17.75	5.25
Bifenture EC (bifenthrin)	6.4 fluid oz.	0**	0**	25.25	8.75
Dimethoate 4 EC	1 pt.	1.00**	6.00	10.50	2.75
Lorsban 4E (chlorpyrifos)	2 pt.	2.50**	2.50*	14.25	1.25
Lorsban and Bifenture	2 pt.+6.4 oz	1.00**	0.25	32.00	3.75
Metaflumizone	0.25 lb ai/A	5.50	5.00	10.00	2.00
Mustang Max EC (z-cypermethrin)	4.0 fl oz.	1.50**	3.25	4.00*	1.75
Rimon 0.83 EC (novaluron)	12 oz.	8.25	4.75	16.25	2.50
Warrior (lambda-cyhalothrin)	3.8 fluid oz.	0.50**	1.50	11.50	3.50
Untreated check		8.25	6.75	23.00	6.00
/ Insect population is significantly ($p<0.05$) lower in insecticide treated plots than in untreated control.** */ Insect population is significantly ($p<0.01$) lower in insecticide treated plots than in untreated control.**					

2009 Prosser Pre-Bloom Sprays: Lygus Nymphs					
Treatment/ (active ingredient)	**Rate**	**6/18/09**	**7/2/09**	**7/8/09**	**7/16/09**
Actara (thiamethoxam)	4 oz	4.6±1.2	6.3±3.1	21.3±5.6	35.6±4.3
Actara and Bifenture	4oz & 6.4oz	1.2±0.7	1.0±1.0	7.2±1.6	26.5±4.9
Alverde (metaflumizone)	0.25 lb ai	5.5±1.3	7.5±1.8	11.2±0.6	40.5±5.3
Assail 70 WP (acetamiprid)	1.7 oz	4.5±0.5	7.2±1.8	16.2±3.1	37.0±9.3
Belay 2.13SC (clothianidin)	3.8 fl oz	3.0±0.5	1.3±0.8	18.3±6.1	24.7±8.9
Beleaf 50SG (flonicamid)	2.8 oz	5.0±1.0	8.2±3.6	15.5±1.8	32.7±7.4
Bifenture EC (bifenthrin)	6.4 fl oz	1.5±0.5	3.0±1.7	6.0±2.0	37.2±11.0
Dimethoate 4 EC	1 pt	3.5±0.5	5.7±2.2	11.2±3.4	29.0±5.8
Lorsban 4E (chlorpyrifos)	2 pt	5.7±1.9	4.7±2.7	15.0±4.3	31.8±8.9
Lorsban and Bifenture	2pt & 6.4oz	1.3±1.3	0.3±0.3	8.0±2.3	28.0±12.4
Rimon 0.83 EC (novaluron)	12 oz.	2.7±1.3	5.0±1.0	13.3±2.9	38.0±19.7
Warrior (lambda-cyhalothrin)	3.8 fl oz	0	0.2±0.2	0.2±0.2	5.5±2.5
Untreated check		4.5±1.5	5.1±1.4	11.1±1.9	30.5±4.6

2008 Prosser Pre-Bloom Sprays: Aphids					
Treatment/ (active ingredient)	**Rate**	**6/9/08**	**6/13/08**	**7/3/08**	**7/10/08**
Assail 70 WP (acetamiprid)	1.7 oz.	3.50	29.00	7.75	1.00
Belay 2.13SC (clothiandin)	3.8 fluid oz.	2.50	20.50	7.00	0.75
Beleaf 50SG	2.8 oz.	0.75	5.50*	16.75	2.00
Bifenture EC (bifenthrin)	6.4 fluid oz.	0	0.50**	11.50	0.00
Dimethoate 4 EC	1 pt.	0.25	3.25**	7.50	3.25
Lorsban 4E (chlorpyrifos)	2 pt.	0	0.50**	11.00	1.50
Lorsban and Bifenture	2 pt.+6.4 oz	0	0.25**	21.50	0.25
Metaflumizone	0.25 lb ai/A	7.25	61.25	7.25	0
Mustang Max EC (z-cypermethrin)	4.0 fl oz.	0	7.75*	5.25	0
Rimon 0.83 EC (novaluron)	12 oz.	15.00	44.00	11.00	1.00
Warrior (lambda-cyhalothrin)	3.8 fluid oz.	0	10.00*	10.25	0.25
Untreated check		5.25	41.00	14.00	3.50

***/ Insect population is significantly ($p<0.05$) lower in insecticide treated plots than in untreated control.**
****/ Insect population is significantly ($p<0.01$) lower in insecticide treated plots than in untreated control.**

2009 Prosser Pre-Bloom Sprays: Aphids					
Treatment/ (active ingredient)	**Rate**	**6/18/09**	**7/2/09**	**7/8/09**	**7/16/09**
Actara (thiamethoxam)	4 oz	15.0±14.0	11.0± 5.0	43.3±16.6	67.0±10.8
Actara and Bifenture	4oz & 6.4oz	0.2± 0.2	3.2± 1.4	15.0± 3.7	43.0± 9.1
Alverde (metaflumizone)	0.25 lb ai	60.5± 8.4	50.5± 3.8	83.0± 5.5	61.2± 9.0
Assail 70 WP (acetamiprid)	1.7 oz	10.0± 1.6	19.0±11.8	46.2±11.6	88.7±26.0
Belay 2.13SC (clothianidin)	3.8 fl oz	6.0± 1.1	33.3±15.6	50.0± 7.3	47.0±10.6
Beleaf 50SG (flonicamid)	2.8 oz	2.7± 0.9	12.2± 3.0	70.0±50.0	64.7± 9.2
Bifenture EC (bifenthrin)	6.4 fl oz	2.5± 1.8	5.0± 0.9	7.2± 2.4	62.2±12.9
Dimethoate 4 EC	1 pt	2.7± 1.3	9.0± 3.8	22.2± 1.3	54.5±14.1
Lorsban 4E (chlorpyrifos)	2 pt	0.7± 0.5	6.5± 1.9	16.0± 5.4	56.0± 9.3
Lorsban and Bifenture	2pt & 6.4oz	0.3± 0.3	4.3± 1.4	10.7± 4.1	59.0±19.5
Rimon 0.83 EC (novaluron)	12 oz.	101.7±59.8	77.0±17.6	114.0±28.8	53.0±14.7
Warrior (lambda-cyhalothrin)	3.8 fl oz	0.5± 0.5	1.5± 0.6	7.2± 1.9	44.0± 7.2
Untreated check		40.7± 9.1	53.3±15.3	79.5±13.2	58.3± 8.4

In 2008, insecticides were applied at bloom period as well. Details of this application and the resulting impacts on arthropod abundance were presented to the Northwest Alfalfa Seed Growers Association in January 2009 and are available upon request. Population abundance of other arthropods including spiders, big-eyed bugs, minute pirate bugs, assassin bugs, lace wings, lady bird beetles, and weevils was also assessed in some of these field trials. The data for the main target pests of Lygus (adult and nymph) and aphids are detailed in this report. Abundance counts for the other arthropods can be provided on request.

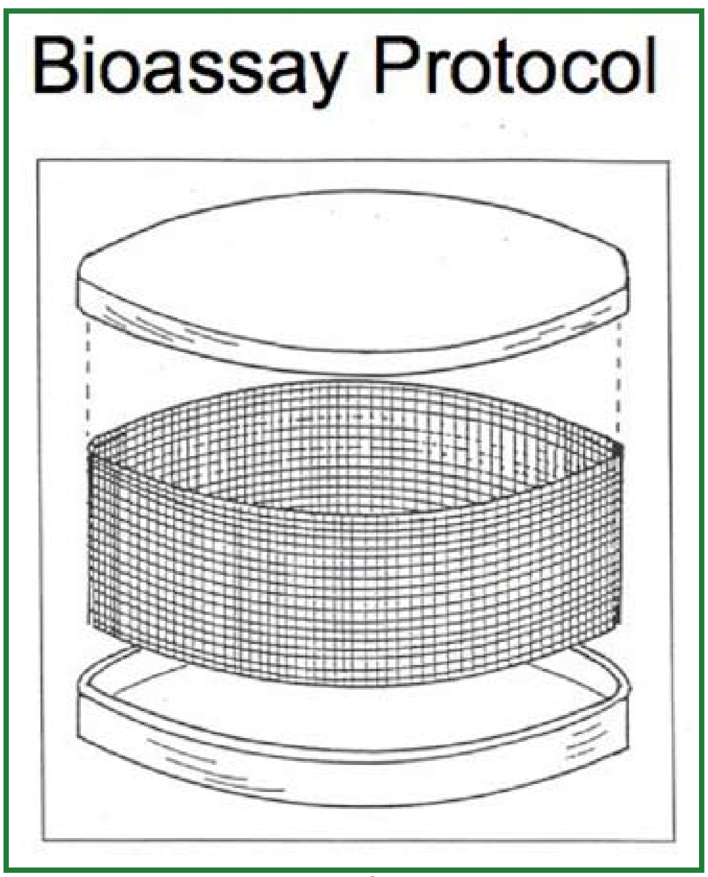
Section II
Pollinating Bee Pesticide Safety Trials 2008-2009

Pollinator Laboratory Bioassays

In 2008 and 2009, we conducted tests designed to determine the residue hazard of a variety of products, as listed in the tables. The products were tested at the maximum label rate if registered or at the maximum rate that that the registrants suggested for the use of their product for insect or mite control on alfalfa seed.

Tests were conducted with pesticides applied with a R&D CO_2 pressurized sprayer at a rate of 26 gallons per acre using a hand-held boom applied to 0.01-acre plots of first- or second-growth alfalfa. Field-weathered residual test exposures were replicated 4 times with 4 foliage samples per treatment. Samples of approximately 400 cm of foliage taken from the upper 15 cm of plants and clipped to 1-inch lengths were placed into plastic Petri dishes (15 cm diameter), the tops and bottoms of which were separated by a wire screen (6.7 meshes/cm, 45 cm long and 5 cm wide).

In our 2008 bioassays, alfalfa leafcutting bees were collected and chilled at 35° F to facilitate handling. Residual test exposures were replicated 4 times by caging 20 bees with each of four foliage samples per treatment. Bees in cages were fed syrup (91:1 ratio) in a wad of cotton (5 x 5 cm) and held at 75° F for 24-hour mortality counts.



Above: Leafcutting bee.
Below: Alkali bee.

Dr. Dan Mayer had concluded that materials or rates of materials that cause less than 25% mortality with 2-hour residues can probably be applied during early morning with little or no hazard to bees and those that cause less than 25% mortality with 8-hour residues can probably be applied during late evening with little or no hazard to bees.

Mortalities of Alfalfa Leafcutting Bee Exposed to Pesticides in Test Plots - 2008	
Treatment	**Residues at 1 Hr**
acetamiprid (Assail)	53.0%*
clothianidin (Belay)	95.2
flonicamid (Beleaf)	12.3
fenpyroximate (Fujimite)	10.2
paraffinic oil (JMS Stylet Oil)	8.2
metaflumizone	1.1
etoxazole (Zeal)	11.0

*Percent corrected for control mortality after 24 hours' exposure.

Based on our studies in 2008 we concluded that caution should be used when applying acetamiprid and that we would not pursue registration of Belay during the bloom period.

Our 2009 bioassay studies, utilizing both leafcutting and alkali bees and summarized in the table below, confirmed that caution should be used when applying acetamiprid. We will pursue registration of indoxacarb for Lygus and caterpillar control and chlorantraniliprole for caterpillar and weevil control via 24 C Special Local Need in 2010.

Mortalities of Alfalfa Leafcutting Bee and Alkali Bee Exposed to Pesticides in Test Plots - 2009		
Treatment	**Leafcutting Bee**	**Alkali Bee**
acetamiprid (Assail)	48%*	32%**
indoxacarb	8	4
chlorantraniliprole	20	12

*Percent corrected for control mortality after 24 hours' exposure.
**Percent corrected for control mortality after 8 hours' exposure.

Bee Bed Population Monitoring: Bee and Blister Beetle

We contracted out and constructed a hydraulic soil core device that connects to a backhoe and is powered by the hydraulics that would typically be used for a packer plate. In fall 2009 we collected representative cores from 11 of the 13 active bee beds in the Touchet-Gardena growing district. These samples are presently being sorted by project technical assistant Amber Vinchese, who is working toward a Master's Degree on this project. Additionally, 64 pitfall traps were placed in a seed field near an active bee bed in spring 2009. These pitfall traps were monitored weekly from April 23 through May 21, 2009. Blister beetles were present in April and their population abundance increased through May until they exceeded 1 beetle caught per trap after May 14.

Above: Operating soil corer.
Below: Soil cores are removed and boxed for study.
Top right: Holes and larvae adjacent to corer hole.
At right: Larvae in and out of soil.

Insecticide Efficacy for Blister Beetle Control

We had initially set the objective to test insecticide efficacies against blister beetle in 2009, since azinphos-methyl is the only registered pesticide for control of predatory beetles on bee beds. In the end, the alfalfa seed growers were mostly unconcerned about blister beetles, hypothesizing that pyrethroids applied pre-bloom for Lygus bug control were reducing blister beetle populations. Therefore these studies were not conducted.

Section III
Insecticide Efficacy Trial Candidate Compound Summary

Lygus populations as measured in our spray trials in 2008 were substantially lower than those measured in 2007. In 2007 Lygus reached outbreak population levels and there were areas in which complete control failures occurred. Lygus populations as measured in our spray trials in 2009 were generally even lower than they were in 2008. The reduced population abundance of Lygus in 2008 and 2009 made control efforts easier and more successful. However, spring weather conditions in south-central Washington State in 2008 and 2009 were cool and relatively wet. This created weather conditions perfect for aphid outbreaks. Populations of cowpea aphid *Aphis craccivora* peaked at our Othello, WA test site at over 500 aphids per five 180º sweep net samples during the extended pre-bloom period in early July. When temperatures finally (and consistently) warmed in late July the aphid populations dropped dramatically.

Individual Insecticide Summaries

Assail 70 WP (acetamiprid) is a chloronicotinyl insecticide registered by United Phosphorus. It is registered on alfalfa seed in Washington State under a 24C Special Local Need registration. In the pre- and post-bloom applications it was effective at controlling Lygus adults, nymphs, and cowpea aphids. The product is considered safe for bees when it is applied in an evening application. Morning applications have proven to be unsafe for both alkali and leafcutting bees. Use the product cautiously at bloom.

Belay 2.13 SC (clothianidin) is a chloronicotinyl insecticide manufactured by Valent Chemical Co. It is not registered for use on alfalfa seed. It was effective in controlling Lygus nymphs and adults and moderately effective at controlling cowpea aphids. It was extremely toxic to leafcutting bees in our 1 hr bioassays in 2008 and it is unlikely that we will pursue a registration for this product.

Beleaf 50 SG (flonicamid) is an A-type potassium channel active insecticide that prevents aphids and bugs from using their piercing-sucking mouth parts. Beleaf is registered on alfalfa seed in Washington State under a 24C Special Local Need registration. This product has proven effective at controlling aphids and Lygus adults and nymphs. In our pollinator insecticide bioassay studies Beleaf has proven to be safe to both alkali and leafcutting bees following both evening and morning applications. Early applications appear to be providing substantial residual control of Lygus populations extending into the bloom period. This product has now become an industry standard.

Alverde (metaflumizone) is a semicarbazone. It is being developed by by BASF Corp and is not registered for use on alfalfa seed. It was relatively inconsistent in the level of control it provided on Lygus and cowpea aphid populations. In our first study with it on leafcutting bees early indications are that it could be considered safe. We will conduct additional research with this compound.

Rimon 0.83 EC (novaluron) is an insect growth regulating insecticide that is only effective on Lygus nymphs. It is registered on alfalfa produced for seed in Washington under a 24 C Special Local Need registration. We have not observed direct contact toxicity with this product on leafcutting or alkali bees. However, there have been concerns from some producers about reduced leafcutting bee return from fields treated at bloom with Rimon. We have not seen this directly. We have not seen a reduction in alkali bee abundance near fields that have been treated with Rimon.

Section IV
Predatory Mite Safety 2009

We are evaluating the impact of specific candidate pesticide chemistries on non-target beneficial arthropods. Starting in early November we began Potter Tower precision exposure studies of selected pesticides on the beneficial predatory mite *Galendromus occidentalis*. This species of predatory mite is the most important spider mite predator in alfalfa seed fields. As of December 17, 2009 we have determined that exposure of predatory mites to field dosage of the candidtate chlorantraiprole (Altacor), etoxazole (Zeal), spirotetramat (Movento), and spiromesafin (Envidor) were not toxic. We plan to complete testing of a greater number of chemistries over the winter.

Predatory mite **Galendromus occidentalis** ***(lower left, adult with egg) and twospotted spider mite.***

Section V
Newly-Planted Alfalfa Tolerance to Flumioxazin 2008

Alfalfa, var. 'Hybriforce 400' (Dairyland Company) was planted on August 15, September 5, and September 26, 2007 in order to establish three distinct growth stages of alfalfa entering the winter. This trial was a repeat of the previous year's trial to establish the tolerance of fall-planted alfalfa to flumioxazin (Chateau) applied in February (dormant stage). The soil was a Warden sandy loam soil with 1.0% O.M. located at the WSU-Prosser IAREC. Alfalfa was seeded with a drill at 25 lbs seed/acre and sprinkler-irrigated with hand lines.

Henbit

Flumioxazin was applied at 0.125 and 0.25 lb ai/a with 0.5 lb ai/a paraquat (Gramoxone) to dormant alfalfa February 19, 2008. A treatment of 0.5 lb ai/a of paraquat alone was also made. Herbicides were applied with a bicycle sprayer in a spray volume of 25 gpa and included COC at 1% (v/v) spray solution. Treatments were replicated 4 times in a split plot design with alfalfa planting date as main plots and herbicide treatments as split plots. Main plots were 10 by 100 feet and split plots were 10 by 30 feet. Alfalfa was harvested May 21, July 9, and August 18, and September 30, 2008 with a sickle bar mower. The hay yield was determined after oven drying at 60° C. Herbicide treatments were repeated after the second cutting and were applied July 15, 2008 prior to alfalfa regrowth.

In mid-November, alfalfa height averaged 19.6, 4.6, and 2.5 cm and root length averaged 28.2, 10.9, and 6.4 cm for the early, middle, and late planting dates, respectively (see table on next page). All herbicide treatments controlled flixweed and downy brome in the first cutting. Henbit was controlled best with flumioxazin plus paraquat compared to paraquat alone, which did not consistently control larger henbit plants. Flumioxazin plus paraquat injured the two later plantings of alfalfa the most (about 8 to 11%) in early April whereas the early planting date was injured less than 5%. Paraquat alone also injured alfalfa, but less than the combination of flumioxazin plus paraquat. Alfalfa stand counts on March 12, 2008 (3 WAT with herbicides) in herbicide treated plots were equal to or greater than stand counts in nontreated checks for the early- and

Flixweed

late-planted alfalfa. However, alfalfa stand counts averaged 15 to 28% lower in all three herbicide treatments compared to the nontreated checks for the September 5 planting date.

Alfalfa hay yield of the first cutting decreased with later planting dates, as indicated in the table. Alfalfa from the first cutting averaged 2.9, 1.9, and 1.7 ton dry/acre from the early, mid, and late planting dates, respectively. Alfalfa planting date did not affect the hay yield of the second cutting, which averaged 1.5 ton dry/acre. There was no effect of herbicide treatment on hay yield in the first two cuttings. Herbicide treatments were repeated in July after the second cutting and flumioxazin treatments reduced the hay yield of the third cutting by 17.5%, compared to nontreated checks which averaged 2 ton dry/acre. Paraquat applied alone tended to reduce hay yield of the third cutting (average 1.8 ton dry/acre), but it was not significantly different than nontreated checks. Hay yield of the fourth cutting was not affected by herbicide treatments, but late-planted alfalfa yielded 17% greater than early-planted alfalfa.

Flumioxazin at the proposed label rate of 0.125 lb ai/a reduced alfalfa hay yields 17% in the third cutting following two sequential applications in February and July, but not in the other three cuttings. Based on these results and results from last year's trial we would anticipate that flumioxazin applied in February to an alfalfa seed field planted in August or early September would likely have little or no negative impact on alfalfa seed yield the following summer.

			Alfalfa Hay Yield			
	Nov. 13, 2007		1st cutting	2nd cutting	3rd cutting	4th cutting
	Height (cm)	Root length (cm)	May 21	July 9	Aug. 18	Sept. 30
Planting date			ton dry hay/acre			
August 15	19.6	28.2	2.9	1.6	1.9	1.30
September 5	4.6	10.9	1.9	1.5	1.8	1.45
September 26	2.5	6.4	1.7	1.6	1.7	1.53
Lsd (005)			0.56	n.s.	n.s.	0.12
Herbicide (lb ai/a)[1]						
Flumioxazin[2] (0.125)			2.2	1.5	1.65	1.4
Flumioxazin (0.25)			2.0	1.5	1.66	1.4
Paraquat (0.5)			2.2	1.5	1.82	1.5
Nontreated			2.4	1.6	2.0	1.5
Lsd (0.05)			n.s.	n.s.	0.25	n.s.

[1]Herbicide treatments were applied February 19, 2008 and reapplied July 15, 2008 after the second cutting prior to alfalfa regrowth.
[2]All flumioxazin treatments included paraquat at 0.5 lb ai/a and COC at 1% (v/v) spray solution.

Section VI
Alfalfa Seed Yield with Flumioxazin Large-Scale Field Trial 2008

Alfalfa tolerance to flumioxazin applied to dormant alfalfa was tested on a grower field near Touchet, Washington, USA. A four-year-old commercial alfalfa seed field grown under sprinkler irrigation was selected and treated by the grower. The soil was a Sagemore silt loam, pH 7, with 1.75% O.M. One half of the field was treated with simazine plus pendimethalin (2 pts + 4 pts/acre) and the other half treated with flumioxazin at 0.125 lb ai/a plus pendimethalin at 2 pts/acre February 28, 2008. Normal production practices were followed throughout the growing season and the seed crop was harvested with a combine equipped with a GPS yield monitoring system. The simazine-treated alfalfa produced 1228 lb/acre seed versus 1134 lb/acre produced by the alfalfa treated with flumioxazin. Treatments were not replicated. Weed control was excellent and similar among the two herbicide treatments with the exception of wild oats, which were only present in the flumioxazin-treated area.

Section VII

Fall-Applied Postemergence Broadleaf Herbicide Trial On Newly Planted Alfalfa 2008

Alfalfa, var. 'Hybriforce 400' (Dairyland Company), was planted on Sept. 10, 2007. The soil was Warden loam with 1.4% O.M. located at the WSU-Prosser IAREC. Alfalfa was drill-seeded at 25 lbs seed/acre and sprinkler-irrigated with hand lines.

Herbicides were applied October 12, 2007 to 5-inch alfalfa with a bicycle sprayer in a spray volume of 20 GPA. All treatments included R-11 nonionic surfactant at 0.25% (v/v) spray solution except for one treatment containing Buctril. Common lambsquarters, common mallow, and mustards ranged from 3 to 6 inches tall, prickly lettuce from 4 to 8 inches tall, and volunteer canola was 8 to 10 inches tall. Treatments were replicated 3 times in a randomized complete block design with plots measuring 7.5 by 25 feet. Weed control and alfalfa injury was rated at various times after application and alfalfa hay was harvested May 21, 2008 with a sickle bar mower from a 28-inch swath by 25 feet in the center of each plot. A subsample of hay was weighed, oven-dried at 60° C, and weighed again to determine percent moisture. Hay yields were adjusted to dry ton/acre.

Alfalfa injury from this relatively high rate of 2,4DB (2 lb ae/a) was less than 10% and similar among the dimethylamine and acid formulations (see table below). Combining bromoxynil (Buctril) with the dimethlyamine formulation of 2,4DB increased the alfalfa injury in the early fall, but the injury was short-lived and by November was similar to 2,4DB applied alone. Fluroxypyr (Starane) injured alfalfa excessively at the 0.1875 and 0.25 lb ae/a rates and when combined with 2,4DB at a lower rate of 0.125 lb ae/a. Alfalfa injury from fluroxypyr increased in the spring, greatly reducing the stand. Asulam (Asulox) injured alfalfa less than 5% at all evaluation dates.

Alfalfa yield was greatest and similar (2.3 to 3.5 ton dry wt./acre) among all 2,4DB alone treatments, 2,4DB plus bromoxynil, and asulam treatments. Alfalfa yield was greatly reduced in all treatments containing fluroxypyr compared to the nontreated weedy check.

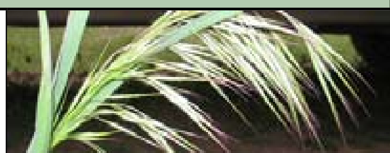
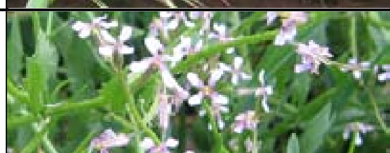
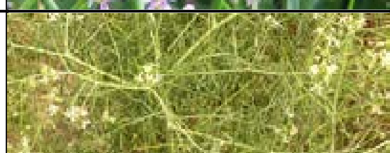
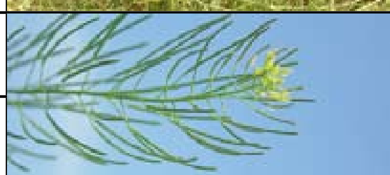
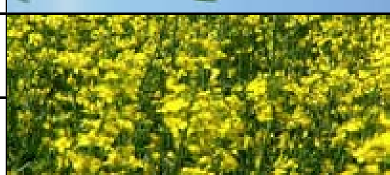
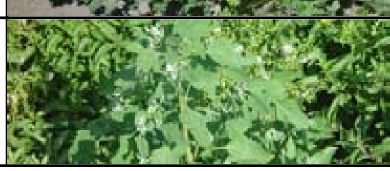
The table on the next page presents weed control results. Both 2,4DB formulations and 2,4DB plus Buctril controlled the mustard species and prickly lettuce well. Asulam controlled downy brome, purple mustard, prickly lettuce, and volunteer canola well. Fluroxypyr controlled tumble mustard and prickly lettuce well and partially suppressed common mallow.

Injury and Hay Yield of Newly Seeded Alfalfa Following Fall Applications of Herbicides

		Alfalfa Injury 10/19/07	Alfalfa Injury 10/26/07	Alfalfa Injury 11/13/07	Alfalfa Injury 3/28/08	Alfalfa Injury 4/29/08	Hay Yield 5/21/08
Treatment	**Rate**	%	%	%	%	%	T dry/a
2,4DB dimethylamine + R-11	2 lb ae/a + 0.25 % v/v	9 e	6 c	8 c	3 c	2 c	2.3 ab
2,4DB acid + R-11	2 lb ae/a + 0.25 % v/v	5 f	4 c	7 c	5 c	5 c	2.9 ab
2,4DB dimethylamine + Buctril	2 lb ae/a + 0.35 ai/a	23 d	15 b	9 c	5 c	3 c	3.5 a
Fluroxypyr (Starane) + R-11	0.19 lb ae/a + 0.25 % v/v	35 c	30 a	35 b	94 ab	88 b	0.2 c
Fluroxypyr (Starane) + R-11	0.25 lb ae/a + 0.25 % v/v	43 b	32 a	62 a	96 a	97 a	0.1 c
Asulam (Asulox) + R-11 (NIS0	3.34 lb ae/a + 0.25 % v/v	0 g	0 c	1 c	3 c	4 c	3.3 a
Fluroxypyr (Starane) + 2,4DB dimethylamine + R-11	0.13 lb ae/a + 1.5 lb ai/a + 0.25 % v/v	52 a	30 a	43 b	90 b	83 b	1.1 bc
Nontreated check		0 g	0 c	0 c	0 c	0 c	3.1 a
	LSD (P=.05)	3.29	6.28	9.49	5.91	7.79	1.97

Herbicide treatments were applied October 12, 2007.
Means within a column followed by same letter do not significantly differ (P=.05, LSD).

% Control of Selected Weeds with Seven Postemergence Fall-Applied Herbicide Treatments Near Prosser, WA in 2007-2008

Weed/Date		2,4DB dimethylamine + R-11	2,4DB acid + R-11	2,4DB dimethylamine + Buctril	Fluroxypyr (Starane) + R-11	Fluroxypyr (Starane) + R-11	Asulam (Asulox) + R-11 (NIS0	Fluroxypyr (Starane) + 2,4DB dimethylamine + R-11	Nontreated check	LSD (P=.05)
		(rates in same order as table on previous page)								
Downy Brome 3/28/08		0 b	0 b	0 b	0 b	0 b	100 a	0 b	0 b	0.00
Purple Mustard 4/29/08		98 a	97 a	92 a	45 b	48 b	99 a	88 a	0 c	34.17
Tumble Mustard 3/28/08		100 a	100 a	100 a	100 a	100 a	53 b	100 a	0 c	4.73
Flixweed 3/28/08		100 a	100 a	100 a	71 b	80 ab	70 b	99 a	0 c	21.21
Flixweed 4/29/08		99 a	99 a	99 a	65 b	77 ab	78 ab	98 a	0 c	26.44
Canola 11/13/07		94 ab	90 ab	97 a	76 c	86 bc	88 ab	97 ab	0 d	10.81
Canola 4/29/08		100 a	100 a	100 a	75 b	67 b	100 a	100 a	0 c	10.46
Prickly Lettuce 11/13/07		97 ab	100 a	94 b	98 ab	100 a	89 c	100 a	0 d	4.64
Prickly Lettuce 3/28/08		100 a	100 a	100 a	100 a	100 a	98 a	100 a	0 b	1.79
Mallow 10/16/07		8 d	13 cd	18 c	80 b	86 a	0 e	90 a	0 e	5.84
Common Lambsquarters 10/26/07		87 a	90 a	89 a	38 c	53 b	10 d	78 a	0 d	13.40

Herbicide treatments were applied October 12, 2007.
Means within a column followed by same letter do not significantly differ (P=.05, LSD).

Section VIII

Spring-Applied Postemergence Broadleaf Herbicide Trial On Newly Planted Alfalfa 2008

Alfalfa, var. 'Hybriforce 400' (Dairyland Company) was planted on Sept. 10, 2007 in a Warden loam soil with 1.4% O.M. located at the WSU-Prosser IAREC. Alfalfa was drill-seeded at 25 lbs seed/acre and sprinkler irrigated with hand lines.

Herbicides were applied March 21, 2008 to 3- to 5-inch tall alfalfa with a bicycle sprayer in a spray volume of 20 GPA. Most treatments included R-11 nonionic surfactant at 0.25% (v/v) spray solution except for one treatment containing bromoxynil (Buctril), in which no adjuvant was added, and another treatment of bentazon (Basagran), in which crop oil concentrate (COC) was added at 1% (v/v) spray solution. Volunteer canola was 6 to 12 inches tall at the time of herbicide application and was not uniformly present in all plots. Treatments were replicated 3 times in a randomized complete block design with plots measuring 7.5 by 25 feet. Alfalfa injury was rated at various times after application and alfalfa hay was harvested May 21, 2008 with a sickle bar mower from a 28-inch swath by 25 feet in the center of each plot. A subsample of hay was weighed, oven-dried at 60° C, and weighed again to determine percent moisture. Hay yields were adjusted to dry ton/acre.

Alfalfa injury tended to be slightly greater with the dimethylamine formulation of 2,4DB than with the acid formulation of 2,4DB when testing the relatively high rate of 2,4DB (2 lb ae/a), but was always less than 10% with both formulations. Combining bromoxynil (Buctril) with the dimethlyamine formulation of 2,4DB increased the alfalfa injury for several weeks after application. Fluroxypyr (Starane) at 0.1875 and 0.25 lb ae/a, MCPB (Thistrol) at 1 lb ae/a, and pyrasulfotole (Huskie) at 13.5 fl oz/a injured alfalfa excessively. Asulam (Asulox) at 3.3 lb ai/a and bentazon (Basagran) at 1 lb ai/a only slightly injured alfalfa (< 6%) at all evaluation dates.

Alfalfa yield was greatest and similar (3.3 to 3.6 ton dry wt./acre) among asulam, bentazon, 2,DB acid, and nontreated control treatments. Alfalfa yield was reduced 27 to 30% in 2,4DB dimethylamine alone and tank mixed with bromoxynil treatments compared to nontreated controls. Alfalfa yield was greatly reduced in all treatments containing fluroxypyr, MCPB, and pyrasulfotole compared to the nontreated control.

Volunteer canola population was variable and no treatment totally controlled volunteer canola. Asulam, MCPB, and pyrasulfatole tended to control volunteer canola more consistently than other treatments. Among the treatments tested, only Asulam controlled downy brome.

Injury and Hay Yield of Newly Seeded Alfalfa Following Fall Applications of Herbicides

		Alfalfa Injury 3/28/08	Alfalfa Injury 4/29/08	Alfalfa Injury 5/21/08	Hay Yield 5/21/08	Canola Control 4/29/08	Brome Control 5/21/08
Treatment	**Rate**	%	%	%	T dry/a	%	%
2,4DB dimethylamine + R-11	2 lb ae/a + 0.25 % v/v	8 c	7 d	2 c	2.8 b	70 bcd	0 b
2,4DB acid + R-11	2 lb ae/a + 0.25 % v/v	1 e	2 de	0 c	3.6 a	65 cd	0 b
2,4DB dimethylamine + Buctril	2 lb ae/a + 0.35 ai/a	28 b	15 c	5 c	2.5 b	--	0 b
Fluroxypyr (Starane) + R-11	0.19 lb ae/a + 0.25 % v/v	41 a	78 b	48 b	0.8 c	8e	0 b
Fluroxypyr (Starane) + R-11	0.25 lb ae/a + 0.25 % v/v	43 a	86 a	60 a	0.8 c	70 bcd	0 b
Asulam (Asulox) + R-11 (NIS0	3.34 lb ae/a + 0.25 % v/v	3 de	0 e	0 c	3.5 a	80 abc	100 a
Bentazon (Basagran) + COC	1 lb ai/a + 1 % v/v	5 cde	2 de	2 c	3.3 a	55 d	0 b
MCPB (Thistrol) + R-11	1 lb ae/a + 0.25 % v/v	33 b	74 b	59 a	0.8 c	90 a	0 b
Pyrasulfotole + bromoxynil (Huskie) + R-11 + UAN32	13.5 fl oz/a + 0.25 % v/v + 2 % v/v	7 cd	92 a	50 ab	1.0 c	88 ab	0 b
Nontreated check		0 e	0 e	0 c	3.6 a	0 e	0 b
	LSD (P=.05)	5.22	6.62	10.28	0.38	18.41	0.00

Means within a column followed by same letter do not significantly differ (P=.05, LSD).

Section IX Crop Tolerance to Pendimethalin Applied After First Cutting 2008

Following the first cutting of alfalfa hay in May 2008, the Prowl H2O formulation of pendimethalin was applied alone at 4 and 8 pt/a or at 4 pt/a in combination with either imazamox (Raptor), Buterac200 (2,4DB), Select (clethodim), or Asulox XP (asulam) to determine alfalfa tolerance to each herbicide treatment. Each treatment was replicated three times in a randomized complete block design. Alfalfa hay yield of the second cutting was determined on July 9, 2008 by cutting a 40 inch by 20 foot swath in the center of each plot with a sickle bar mower. A subsample of fresh hay was weighed, dried, and reweighed to determine the percent moisture and hay yields were converted to tons dry weight per acre. The main weeds present in nontreated checks were pigweed, lambsquarters, prickly lettuce, and purple mustard.

There were no significant differences in alfalfa injury or height among treatments compared to nontreated checks. Hay yield tended to be least in nontreated checks compared to all herbicide treatments. Weed populations were sparse and all treatments controlled the main weeds present greater than 95%.

Section X 2,4DB Formulations Applied in Fall on New Planting 2008

Alfalfa tolerance and volunteer canola control with 2,4DB acid formulation and 2,4DB alkanolamine formulation (Buterac 200) were compared in a field trial at WSU-IAREC near Prosser, Washington, USA. Alfalfa, var. 'Hybriforce 400' was planted on Sept. 10, 2007. The soil was a Warden loam soil with 1.4% O.M. Alfalfa was seeded with a drill at 25 lbs seed/acre and sprinkler-irrigated with hand lines. The field was mowed at a height of 4 inches in early October to reduce height of volunteer canola.

Herbicides were applied October 23, 2007 to 5-inch tall alfalfa with a bicycle sprayer in a spray volume of 20 GPA. Both herbicide formulations were applied at a high rate of 2 lb ae/a to evaluate alfalfa tolerance. Both herbicides were tested with and without R-11 nonionic surfactant at 0.25% (v/v) spray solution. Volunteer canola was 6 to 10 inches tall at the time of herbicide application. Treatments were replicated 3 times in a randomized complete block design with plots measuring 7.5 by 25 feet. Alfalfa injury was rated at various times after application and alfalfa hay was harvested May 21, 2008 with a sickle bar mower from a 28 inch swath by 25 feet in the center of each plot. A subsample of hay was weighed, oven dried at 60° C, and weighed again to determine percent moisture. Hay yields were adjusted to dry ton/acre.

Alfalfa injury at 3 and 21 DAT was less than 10% and not significantly different among treatments. Alfalfa injury in late February was greater on alfalfa treated with the 2,4DB dimethlylamine formulation plus R-11 surfactant than without surfactant. Canola control in November was similar among all 2,4DB treatments, ranging from 83 to 87% control. Canola control in December increased compared to ratings in November and was similar among all treatments, but tended to be least with the 2,4DB dimethylamine formulation with no R-11 surfactant. Hay yields from the first cutting were not significantly different among treatments and averaged 3 ton dry wt./acre.

Section XI Spring-Applied Postemergence Herbicide on Established Alfalfa

Alfalfa tolerance to ten herbicide treatments was tested on a Warden silt loam soil at the WSU-Roza unit near Prosser, Washington, USA. Alfalfa var. 'Perfect' was seeded in May of 2006. Chateau (flumioxazin) and Spartan (sulfentrazone) were applied to dormant alfalfa with Gramoxone (paraquat) on February 27, 2008. A treatment of paraquat alone was included for comparison. The remaining treatments were applied March 25, 2007, to alfalfa 2 to 4 inches tall. Herbicides were applied with a backpack sprayer delivering 20 GPA. Plots were 5 feet by 20 feet and treatments replicated three times in a randomized complete block design. Alfalfa injury was visually rated four times and hay yield determined May 29, 2008. Hay was harvested from a 28-inch by 20 foot swath from the center of each plot. Hay was weighed, and air dried; yields were calculated as dry tons/acre.

Dormant applications of Chateau and Spartan with Gramoxone did not injure alfalfa. Yields were equal to alfalfa treated with Gramoxone alone, which averaged 2.45 tons dry wt/acre. Early postemergence applications of Resource (flumiclorac) and Blizzard (fluthiacet-methyl) injured alfalfa initially, but by late April no injury was evident. Hay yields were equal to nontreated checks, averaging 2.5 tons dry wt/acre.

Early postemergence applications of Raptor (imazamox), Harmony GT (thifensulfuron) and Firstrate (chloransulam) injured alfalfa less than 4% and yields were equal to the nontreated checks. Early postemergence application of Python (flumetsulam) injured alfalfa 11 to 15% and tended to reduce hay yields slightly. Sandea (halosulfuron) injured alfalfa and injury increased with time from early to late April. Sandea reduced hay yield of the first cutting by 45%.

Section XII

Preemergence Control Of Catchweed Bedstraw 2009

The response of catchweed bedstraw to eight herbicides labeled in alfalfa was tested in growth chamber trials. Pendimethalin (Prowl H2O), metribuzin (Sencor), diuron (Karmex), flumioxazin (Chateau), terbacil (Sinbar), Hexazinone (Velpar), and norflurazon (Zorial) were each tested at two rates. Twenty-five catchweed bedstraw seed were planted in 10 cm diameter containers filled with a sandy soil (87% sand/12% silt/1% clay) containing 0.63% O.M. with pH 7.2. Soil was brought to field capacity. Herbicides were applied with a single nozzle bench sprayer delivering 25 GPA. At 24 h after herbicide application, containers were watered 0.63 cm with a mist attachment on a hose to incorporate and activate herbicides. Treatments were replicated 5 times and the entire trial repeated once. Bedstraw control was evaluated at 2, 4, and 6 weeks after planting by counting emerged, live seedlings.

All herbicide treatments with the exception of Prowl at 1.9 and 3.8 lb ai/a, and Sencor at 0.38 lb ai/a controlled catchweed bedstraw. Prowl had no effect on catchweed bedstraw germination or emergence. Sencor applied at 0.75 lb ai/a controlled catchweed bedstraw more consistently than the lower rate tested. Catchweed bedstraw control should be achievable in alfalfa seed production with currently labeled preemergence herbicides if applied prior to emergence of bedstraw and not leached out of the shallow zone of weed seed germination.

Treatment	Rate lb ai/a	Trial 1	Trial 2
		Catchweed Bedstraw Live Seedlings/Pot	
Prowl H2O (pendimethalin)	1.9	11.2	8.6
	3.8	10.6	8.6
Sencor (metribuzin)	0.38	3.2	0.8
	0.75	0.8	0.2
Karmex (diuron)	1	0	0.2
	2	0	0.2
Chateau (flumioxazin)	0.063	0	0
	0.13	0	0
Sinbar (terbacil)	0.5	0.4	0
	1.0	0.2	0
Velpar (hexazinone)	0.75	0.2	0
	1.5	0.4	0.4
Zorial (norflurazon)	0.75	0	0
	1.5	0	0
Princep (simazine)	0.8	0	0
	1.6	0	0
Nontreated Check		11.8	8.4
LSD 0.05		2.0	2.6

Section XIII
Alfalfa Setback Trial 2009

This trial was located on a 38-acre alfalfa seed (Pioneer 54V09) field under furrow irrigation near Moses Lake, Washington, USA. The field was planted in the fall of 2007 in 30-inch rows. Dan Roseburg, the grower, applied all treatments with his own large-scale field equipment. The preemergence (dormant) treatments and the setback treatments were applied with a 60-foot boom sprayer.

Dormant applications of either ethalfluralin (Sonalan) (1.9 lb ai/a) plus glyphosate or flumioxazin (Chateau) (0.125 lb ai/a) plus glyphosate were applied March 3, 2009. A rainfall (0.34 inches) occurred later in the evening. Three areas of the field received the Chateau treatment and two areas of the field received the Sonalan treatment.

Setback treatments were applied April 24, 2009 when alfalfa was 9 inches tall. Carfentrazone (Aim) (1.9 EW) was applied at 2 fl oz/a (0.03 lb ai/a) and paraquat (Gramoxone) at 3 pt/a (0.75 lb ai/a) in 30 GPA water. The grower did not add any surfactant to either treatment. On the west half of the field, the setback strips (60 ft wide) were sprayed north to south, perpendicular to the dormant treatments and the alfalfa rows. On the east half of the field, the setback treatments (60 ft wide) were applied parallel to the alfalfa rows and within the two dormant treatments. About 4 acres were treated with each setback treatment.

Both dormant treatments tended to allow many prickly lettuce seedlings to germinate in the bottom of the furrows where there were greater amounts of dead alfalfa residues. There were also some lambsquarters and kochia and a little Russian thistle that escaped both dormant treatments. On May 6, 2009, the Aim setback treatment controlled prickly lettuce in furrows about 85% and lambsquarters and kochia about 75-80%. Gramoxone setback treatment controlled these same weeds about 99% on May 6, 2009. As the table shows, alfalfa growth was set back and desiccated more fully (aver. 85%) with the Gramoxone treatment than with the Aim treatment (aver. 50%). See also photos at right.

May 6, 2009 - 12 Days Post-Treatment		
Setback Treatment	Alfalfa Height	% Desiccation
None	14-18 in.	none
Aim	10-13 in.	50%
Gramoxone	9-13 in.	85%

June 1, 2009 - 6.5 Weeks Post-Treatment			
Setback Treatment	Height	% Bloom	Row Closure
None	25-30 in.	25%	closed
Aim	23-28 in.	15%	75% closed
Gramoxone	19-20 in.	1-2%	open

Alfalfa height, percent bloom, and row closure in early June were all reduced most by Gramoxone treatment compared to Aim treatment. This was contrary to results in 2008, where Aim set back the alfalfa more completely than Gramoxone. The difference in results could be due to the lack of using an adjuvant with the Aim treatments.

The grower applied 2,4DB plus Buctril as a directed application to kill existing annual broadleaf weeds and Canada thistle about May 30 to the entire field. On June 1, 2009 alfalfa height, percent bloom, and row closure were recorded. Bees had not been put on the field yet.

The grower harvested alfalfa seed the first week of September 2009 using a combine equipped with a yield monitor. Due to software problems, the grower was unable to retrieve seed yield data for the various herbicide and setback treatments within the field. The grower will attempt to obtain the data from the yield monitor manufacturer.

Twelve days after setback treatment. Above: Carfentrazone (Aim). Below: Paraquat (Gramoxone).

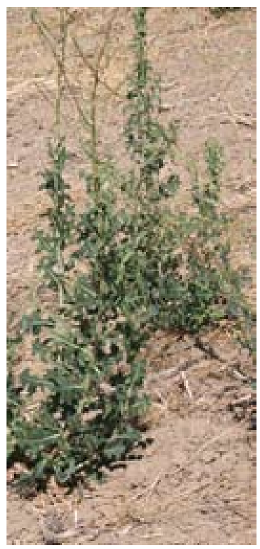
Section XIV
Herbicide Trial In Established Alfalfa Seed Field 2009

Seventeen herbicide treatments were tested in a 2-year old alfalfa seed field near Touchet, Washington, USA. The soil was a Sagemore silt loam and the alfalfa variety was FG-43M120 (Forage Genetics). The entire trial was tilled March 5, 2009 and eight herbicide treatments were applied March 6, 2009 to bare soil prior to crop or weed emergence. The field was sprinkler-irrigated following PRE herbicide treatments. Postemergence (POST) treatments were applied April 17, 2009 when alfalfa was 5 to 9 inches tall.

Herbicides were applied with a backpack sprayer equipped with four 8002 XR flan fan nozzles spaced 20 inches apart and calibrated to deliver 20 GPA. Plots measured 6.7 by 30 feet. Treatments were replicated three times in a randomized complete block design. Weed control and alfalfa injury were rated on five dates from April 7 to June 15, 2009. Alfalfa was 32 inches tall and shaded out most weeds on the June 15, 2009 rating date. Alfalfa seed was harvested August 20, 2009 by cutting a 10-foot-long section from the middle row of each plot. Foliage was dried and passed through a belt thresher twice. Seed was cleaned and weighed to calculate yield. Seed yield was not obtained from some plots due to equipment tracks from grower operations. Percent germination of alfalfa seed collected from five selected POST applied herbicide treatments was determined by placing 200 seeds from each plot in Petri dishes held two weeks at 20° C and counting the number of germinated seed.

Weeds were not distributed uniformly in all plots, making weed control ratings difficult. The main weeds present were prickly lettuce, mayweed chamomile, and wild oats. In April, prickly lettuce and mayweed control were excellent with Chateau, Spartan, Asulox plus Sencor, and indaziflam applied PRE (see first table following). By mid June, all PRE treatments except Gramoxone alone were nearly free of prickly lettuce. Firstrate, Asulox plus 2,4-DB, Asulox plus Buctril, Asulox plus Basagran, and Asulox plus Raptor applied POST all controlled prickly lettuce 98% or more in late April. Asulox alone and saflufenacil tended to be slower-acting on prickly lettuce than other PRE or POST herbicides, but eventually controlled prickly lettuce well. Pyroxasulfone only partially controlled prickly lettuce. Harmony and Raptor applied alone only partially controlled prickly lettuce in mid-June indicating that herbicide resistant biotypes (to ALS inhibitor herbicides) of prickly lettuce were likely present in the population.

Wild oat.



Prickly lettuce.

Mayweed chamomile.

Mayweed chamomile initial control April 27 was excellent with Chateau, Spartan, Asulox plus Sencor, and indaziflam applied PRE. Pyroxasulfone, saflufenacil, and Asulox did not consistently control mayweed chamomile when applied PRE. All POST treatments except flumiclorac controlled mayweed chamomile greater than 89%. Asulox plus Basagran and Asulox plus 2,4-DB controlled mayweed 99% or more. All treatments controlled wild oats well except indaziflam and Harmony.

Alfalfa was not significantly injured by any PRE herbicide treatments, as shown in the second table following. Harmony applied POST injured alfalfa the greatest, averaging 70% in late April and causing stunted and chlorotic growth, which eventually recovered. Asulox plus 2,4-DB applied POST caused some epinastic, twisted growth of alfalfa for several weeks following treatment, typical of injury with 2,4-DB applied alone. POST applied Firstrate and Resource caused some temporary injury to alfalfa for several weeks after application. Other herbicide treatments applied POST did not injure alfalfa appreciably. Alfalfa seed yield was extremely variable, ranging from 769 to 1357 lb/acre, but was not significantly different among herbicide treatments. Percent alfalfa seed germination averaged 81% and did not differ among five POST applied treatments tested; Firstrate, Raptor, Asulox, Asulox+Raptor, and Gramoxone (control).

Weed Control Following PRE (March 6, 2009) and POST (April 17, 2009) Applied Herbicide Treatments in Alfalfa Seed Near Touchet, WA

Herbicide Treatment	Rate (lb ai/a)	Timing	Prickly Lettuce 4/7/09	Prickly Lettuce 4/27/09	Prickly Lettuce 6/15/09	Mayweed 4/27/09	Mayweed 6/15/09	Wild Oat 6/15/09
			% Control					
Flumioxazin (Chateau) Paraquat (Gramoxone) COC	0.125 0.5 1 %	PRE PRE	100	100	100	100	--	97
Sulfentrazone (Spartan) Paraquat (Gramoxone) COC	0.19 0.5 1 %	PRE PRE	100	98	100	98	--	100
Asulam (Asulox) Paraquat (Gramoxone) COC	0.75 0.5 1 %	PRE PRE	0	90	100	52	50	98
Asulam (Asulox) Paraquat (Gramoxone) COC	1.5 0.5 1%	PRE PRE	0	22	97	22	88	93
Asulam (Asulox) Metribuzin (Sencor) Paraquat (Gramoxone) COC	1.5 0.75 0.5 1%	PRE PRE PRE	100	100	100	98	--	100
Pyroxasulfone (KIH-485) Paraquat (Gramoxone) COC	0.138 0.5 1%	PRE PRE	50	43	99	63	--	100
Saflufenacil (BAS800) Paraquat (Gramoxone) COC	0.033 0.5 1%	PRE PRE	73	89	98	67	30	99
Indaziflam Paraquat (Gramoxone) NIS	5 oz 0.5 0.25%	PRE PRE	100	100	100	100	--	67
Paraquat (Gramoxone) NIS Chloransulam (Firstrate)	0.5 0.25% 0.021	PRE POST	--	98	100	96	--	95
Paraquat (Gramoxone) NIS Flumiclorac (Resource)	0.5 0.25% 0.04	PRE POST	--	85	100	33	43	98
Paraquat (Gramoxone) NIS Thifensulfuron (Harmony)	0.5 0.25% 0.016	PRE POST	--	92	67	93	--	0
Paraquat (Gramoxone) NIS Imazamox (Raptor)	0.5 0.25% 0.039	PRE POST	--	83	67	90	--	98
Paraquat (Gramoxone) NIS Asulam (Asulox)	0.5 0.25% 1.5	PRE POST	--	89	98	89	--	98
Paraquat (Gramoxone) NIS Asulam (Asulox) 2,4DB (Buterac 200)	0.5 0.25% 1.5 1	PRE POST POST	--	99	99	99	--	98
Paraquat (Gramoxone) NIS Asulam (Asulox) Bromoxynil (Buctril)	0.5 0.25% 1.5 0.35	PRE POST POST	--	99	100	97	--	99
Paraquat (Gramoxone) NIS Asulam (Asulox) Bentazon (Basagran)	0.5 0.25% 1.5 1	PRE POST POST	--	100	100	100	--	100
Paraquat (Gramoxone) NIS Asulam (Asulox) Imazamox (Raptor)	0.5 0.25% 1.5 0.039	PRE POST POST	--	99	100	93	--	100
Paraquat (Gramoxone) NIS	0.5 0.25%	PRE	0	0	0	0	--	0
LSD (0.05)			10.7	27.6	32.6	38.4	N.S.	23.2

All POST treatments included nonionic surfactant (NIS) at 0.25% (v/v) spray solution, except treatment 16, which included crop oil concentrate at 1% (v/v) spray solution.

Alfalfa Injury and Alfalfa Seed Yield Following PRE (March 6, 2009) and POST (April 17, 2009) Applied Herbicide Treatments in Alfalfa Seed Near Touchet, WA
Numbers in Parentheses Following Seed Yield Are % Germination of Seed

Herbicide Treatment	Rate (lb ai/a)	Timing	Alfalfa Injury % 4/7/09	Alfalfa Injury % 4/27/09	Alfalfa Injury % 5/4/09	Alfalfa Injury % 5/19/09	Alfalfa Injury % 6/15/09	Seed Yield (lb/A) 6/15/09
Flumioxazin (Chateau) Paraquat (Gramoxone) COC	0.125 0.5 1 %	PRE PRE	0	0	1	0	0	971
Sulfentrazone (Spartan) Paraquat (Gramoxone) COC	0.19 0.5 1 %	PRE PRE	0	0	1	0	0	769
Asulam (Asulox) Paraquat (Gramoxone) COC	0.75 0.5 1 %	PRE PRE	3	0	0	2	0	789
Asulam (Asulox) Paraquat (Gramoxone) COC	1.5 0.5 1%	PRE PRE	3	0	0	0	0	1130
Asulam (Asulox) Metribuzin (Sencor) Paraquat (Gramoxone) COC	1.5 0.75 0.5 1%	PRE PRE PRE	0	0	2	0	0	928
Pyroxasulfone (KIH-485) Paraquat (Gramoxone) COC	0.138 0.5 1%	PRE PRE	0	0	0	0	0	1357
Saflufenacil (BAS800) Paraquat (Gramoxone) COC	0.033 0.5 1%	PRE PRE	0	1	0	0	0	1146
Indaziflam Paraquat (Gramoxone) NIS	5 oz 0.5 0.25%	PRE PRE	0	1	1	0	0	1154
Paraquat (Gramoxone) NIS Chloransulam (Firstrate)	0.5 0.25% 0.021	PRE POST	--	18	6	0	0	816 (77%)
Paraquat (Gramoxone) NIS Flumiclorac (Resource)	0.5 0.25% 0.04	PRE POST	--	22	3	0	0	1112
Paraquat (Gramoxone) NIS Thifensulfuron (Harmony)	0.5 0.25% 0.016	PRE POST	--	70	52	20	9	967
Paraquat (Gramoxone) NIS Imazamox (Raptor)	0.5 0.25% 0.039	PRE POST	--	7	0	0	0	1010 (83%)
Paraquat (Gramoxone) NIS Asulam (Asulox)	0.5 0.25% 1.5	PRE POST	--	2	0	0	0	1285 (80%)
Paraquat (Gramoxone) NIS Asulam (Asulox) 2,4DB (Buterac 200)	0.5 0.25% 1.5 1	PRE POST POST	--	27	18	3	0	1067
Paraquat (Gramoxone) NIS Asulam (Asulox) Bromoxynil (Buctril)	0.5 0.25% 1.5 0.35	PRE POST POST	--	9	4	1	0	1201
Paraquat (Gramoxone) NIS Asulam (Asulox) Bentazon (Basagran)	0.5 0.25% 1.5 1	PRE POST POST	--	20	1	0	0	995
Paraquat (Gramoxone) NIS Asulam (Asulox) Imazamox (Raptor)	0.5 0.25% 1.5 0.039	PRE POST POST	--	12	0	0	0	1136 (79%)
Paraquat (Gramoxone) NIS	0.5 0.25%	PRE	0	0	0	0	--	789 (84%)
LSD (0.05)			N.S.	5.4	3.6	3.0	0.5	N.S.

All POST treatments included nonionic surfactant (NIS) at 0.25% (v/v) spray solution, except treatment 16, which included crop oil concentrate at 1% (v/v) spray solution.

Section XV
Alfalfa Dessicant Trial 2009

Four herbicides, carfentrazone (Aim), paraquat (Gramoxone), pyraflufen-ethyl (Vida), and saflufenacil (Kixor), were applied on August 13, 2009 to seed alfalfa that was fully matured with seed pods in a field near Touchet, Washington, USA. The site was a 2-year-old commercial field, the variety FG-43M120 (Forage Genetics), and the soil a Sagemore silt loam. Herbicides were applied with a two-person backpack sprayer equipped with three flat fan nozzles delivering 20 GPA. The sprayer was built to allow application by two persons holding opposite ends of the boom while holding the boom 16 inches over the alfalfa canopy. Paraquat treatments included nonionic surfactant at 0.25% (v/v) spray solution, whereas all other treatments included methylated seed oil (MSO) and ammonium sulfate (AMS) at 1% and 2.5% (v/v) spray solution, respectively. Treatments were replicated three times in a randomized complete block design. Plots were 7.5 by 25 feet long.

Percent alfalfa desiccation was rated August 20, 2009 and alfalfa seed was harvested the same day by cutting a 10-foot-long section of the middle row of each plot with a sickle. A longer period of time between herbicide application to desiccation rating and harvest was not possible due to the grower moving his harvest date up to August 21. Plants were air dried on tarps for five weeks, harvested foliage was passed twice through a belt thresher, and the collected seed was cleaned and weighed. Germination tests were performed on 200 seeds from each plot in Petri dishes held two weeks at 20° C.

Results are presented in the table on the following page. Paraquat completely desiccated the alfalfa at 1 week after treatment (WAT). Saflufenacil at 0.022 lb ai/a and carfentrazone at 0.016 or 0.032 lb ai/a both provided 87 to 88% desiccation of alfalfa at 1 WAT. Pyraflufen-ethyl applied at 2 or 3 fl oz/acre did not completely desiccate the crop at 1 WAT, averaging only 16 and 22% desiccation. Alfalfa seed yield and germination did not differ statistically among desiccation treatments.

Photos at right, from top:
Untreated control,
paraquat (Gramoxone) treatment,
saflufenacil (BAS800) treatment,
and pyraflufen-ethyl (Vida) treatment,
all at one week after treatment.

Dessication, Seed Yield, and Germination 1 WAT					
Treatment	Rate	Unit	8/20/2009 Desiccation %	8/20/2009 Seed Yield lb/A	12/2/09 Germination %
Carfentrazone (Aim EW)[1]	0.016	lb ai/a	87 b	1151	88
Carfentrazone (Aim EW)[1]	0.032	lb ai/a	88 b	1128	81
Paraquat (Gramoxone)[2]	0.75	lb ai/a	100 a	1167	86
Saflufenacil (BAS800)[1]	0.022	lb ai/a	87 b	1198	83
Pyraflufen-ethyl (Vida)[1]	2	fl oz/a	16 d	1187	85
Pyraflufen-ethyl (Vida)[1]	3	fl oz/a	22 c	1059	86
Nontreated			0 e	1003	89
	LSD (P=.05)		5.6	N.S.	N.S.

[1] Included methylated seed oil (MSO) and ammonium sulfate (AMS) at 1% and 2.5% (v/v) spray solution, respectively.
[2] Included nonionic surfactant at 0.25% (v/v) spray solution.

Section XVI
Alfalfa Terbacil (Sinbar)/Metribuzin (Sencor) Trial 2009

Terbacil (Sinbar) is now marketed by Tessenderlo Kerley, Inc. instead of DuPont. The company requested that a small trial be conducted on established forage alfalfa to provide additional data and experience with terbacil. A trial was conducted on Warden silt loam soil at the WSU-Prosser research station. Terbacil (Sinbar) and metribuzin (Sencor) at were applied to alfalfa at 0.5 lb ai/a tank-mixed with paraquat (Gramoxone) at 0.375 lb ai/a and nonionic surfactant at 0.25% (v/v).

Herbicides were applied March 3, 2009 in a spray volume of 20 GPA and treatments were replicated four times in a randomized complete block design. Plots were 6.2 ft by 25 ft. Green leaves were present at the time of herbicide application, but alfalfa was only 1 inch tall. Shepherd's purse (up to 4 inches tall), henbit (1 to 2 inches tall), and flixweed (2 to 4 inches tall) were present at the time of the herbicide application. Alfalfa was harvested on May 18, 2009 using a sickle bar mower that cut a 4.66 ft by 25 ft swath from the center of each plot. Hay fresh weight was recorded.

Both terbacil and metribuzin controlled shepherd's purse greater than 98% and henbit and downy brome 100% at 31 days after treatment (DAT). Lesser amounts of flixweed were also controlled 100% by both herbicides. Both herbicides slightly injured early growth of alfalfa 15% at 17 DAT. By 31 DAT, no injury was evident on the alfalfa. Alfalfa yielded similar among all treatments, averaging 14.8 ton fresh hay/acre.

Response of Alfalfa and Winter Annual Weeds to Herbicides Applied March 3, 2009

Treatment	Rate	Alfalfa			Shepherd's Purse		Henbit		Downy Brome	
		Injury 3/20/09	Injury 4/3/09	Yield 5/18/09	Control 3/20/09	Control 4/6/09	Control 3/20/09	Control 4/6/09	Control 3/20/09	Control 4/6/09
	Lb. ai/a	%	%	Fr. wt. ton./a	%	%	%	%	%	%
Terbacil + Paraquat	0.5 + 0.38	15 a	0	15.1 a	75 a	99 a	78 a	100	100 a	100
Metribuzin + Paraquat	0.5 + 0.38	15 a	0	14.3 a	79 a	99 a	79 a	100	99 a	100
Nontreated		0	0	15.0 a	0	0	0	0	0	0

Means within a column followed by the same letter are not significantly different according to Fisher's protected least significant different test at P = 0.05.

Section XVII

Alfalfa Line Source Irrigation Trial

As part of a line source deficit irrigation project on forage alfalfa, the efficacy of three herbicide treatments was evaluated across five irrigation levels ranging from 100% ET replacement to severe water deficit. Hexazinone (Velpar) plus paraquat (Gramoxone Inteon), flumioxazin (Chateau) plus paraquat, and paraquat alone were applied February 19, 2009 to an established 3-year-old stand of alfalfa, var. 'Perfect.' Herbicides were applied with a bicycle sprayer delivering 25 GPA. Weed control by species was evaluated during the spring and summer among irrigation and herbicide treatments.

Very little or no injury was observed with all three treatments in March, 2009. Velpar plus Gramoxone completely controlled all winter annual broadleaf weeds across all irrigation levels prior to the first cutting of alfalfa in late May, as shown by the table at right. Chateau plus Gramoxone controlled winter annual broadleaf weeds well, but there were occasional escapes across all irrigation treatments. Gramoxone alone resulted in the greatest number of winter annual broadleaf weeds, averaging 15 to 20 plants per plot in mid-May except for the high deficit irrigation treatment, which averaged only 4 plants per plot. Differences in winter annual weed incidence among irrigation levels during the early spring period was not expected due to the herbicides being applied well in advance of implementation of the irrigation regimes.

Herbicide	Rate (lb ai/a)	Irrigation Level[1]	Winter Annual Weed Counts[2]	Grass Counts
Velpar + Gramoxone	0.75 + 0.5	1	0	0
		2	0	0.2
		3	0	1.3
		4	0	5.0
		5	0	3.3
Chateau + Gramoxone	0.125 + 0.5	1	0	0
		2	0.7	1.5
		3	0.3	1.3
		4	1.5	3.2
		5	1.3	3.8
Gramoxone	0.5	1	4.0	0
		2	20.0	0.8
		3	14.8	2.8
		4	19.2	4.8
		5	14.8	5.7

[1] 1=dry, deficit, to 5=100% ET replacement.
[2] Taken May 15, 2009, these included shepherd's purse, tumble mustard, and tall hedge mustard.
[3] Taken September 17, 2009, these included green foxtail and barnyardgrass.

The second and third cuttings of alfalfa were virtually weed-free among all irrigation levels and herbicide treatments except a low density of summer annual grass weeds in the last cutting. Neither Velpar nor Chateau controlled grass weeds well in the final cutting compared to Gramoxone alone, which has no soil residual activity. Grass weed counts increased as irrigation level increased. No grass weeds were present in the high deficit irrigation treatment in September, indicating the soil was too dry to promote germination of the grass seed or grass seedlings that germinated were unable to survive under the low soil moisture conditions.

Weed seed longevity was also studied in this trial. Nylon weed seed packets containing one hundred weed seeds each were buried 1.5 cm deep March 17, 2009 in six replications of the high, low, and medium irrigation treatments to determine the influence of irrigation treatment on the longevity of the weed seed in the soil. Seed of three weed species, Western salsify, common lambsquarters, and prickly lettuce were included. Seed packets were recovered after six months on September 17, 2009.

Western salsify intact seed recovery was very low indicating the seed is very short-lived and either germinates or decays within a 6-month period. An average of 4 intact salsify seed were recovered from deficit irrigated plots (dry treatment) and they germinated 75%, as the table below indicates. The number of prickly lettuce and common lambsquarters intact seed recovered decreased as irrigation level increased, indicating that greater soil moisture accelerated either decay or germination of these two species in the field. Eighty-four percent of common lambsquarters and 92% of prickly lettuce seed were recovered intact from high deficit (dry) irrigated plots. Both prickly lettuce and common lambsquarters intact seed recovered germinated relatively well, ranging from 76 to 94% germination.

Species	Irrigation Level	Intact Seed Recovered (out of 100)	Germination (%)
Western Salsify	Dry (low)	4	75
	Medium	0	--
	Wet (high)	0	--
Prickly Lettuce	Dry (low)	92	89
	Medium	73	93
	Wet (high)	59	94
Common Lambs-quarters	Dry (low)	84	82
	Medium	72	76
	Wet (high)	67	78

Section XVIII

Alternatives to Burning Crop Residues in Alfalfa Grown for Seed: Economic/Pest Management Impacts and Interactions between Selected Burning Alternatives and Precision Crop Spacing

Background

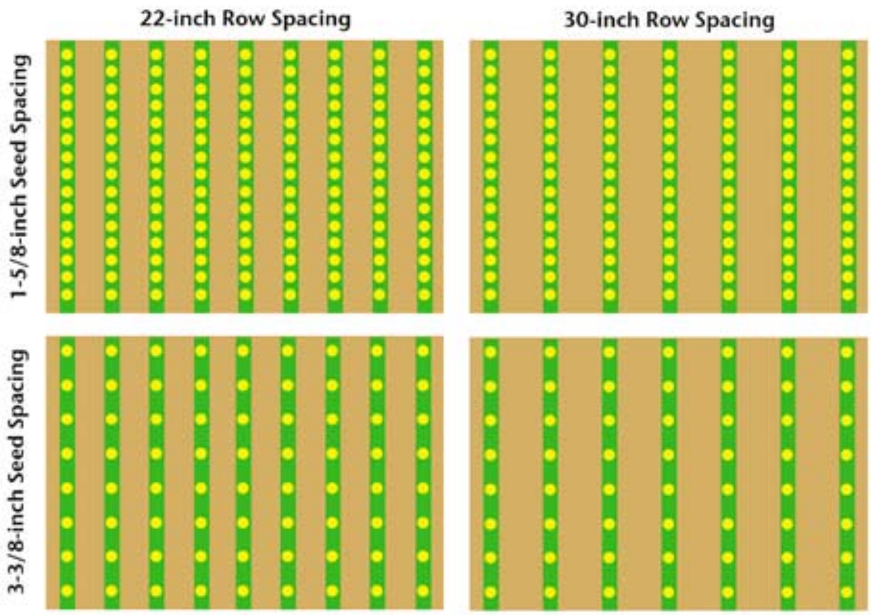
Alfalfa seed producers in Walla Walla County, Washington State, USA, burn fields in late winter to decrease insect, weed, and disease pests and to eliminate crop residues. Burning has been attractive because it provides effective pest control at minimal cost while removing crop residues. In a two-year study funded by the Washington State Department of Ecology Agricultural Burning Practices and Research Task Force 2005-2007, WSU and USDA-ARS scientists evaluated five experimental alternatives along with traditional stubble burning and an untreated control. The results from these studies suggested that further research into two practical alternatives to burning—residue tillage and harvest/removal of residue—was warranted.

The foundational research conducted 2005-2007 also indicated that one way to reduce smoke emissions from field burning would be to decrease the plant density, thereby decreasing straw stubble in the field. However, we knew that decreasing plant density could also have some important effects like decreasing the alfalfa stands' ability to compete against weeds, changing the fields' susceptibility to white mold, and impacting the population abundance of pest and beneficial insects.

WSU and USDA-ARS scientists approached the Agricultural Burning Practices Research Task Force again in May of 2007 with a proposal to evaluate the costs and benefits of selected alternatives to burning alfalfa seed crop residues and those alternatives' interactions with variations in planting density. This report covers results from July 2007 to September 2009.

Plot Establishment

On July, 31, 2007, utilizing a precision planter provided by project partner Forage Genetics International (pictured at left), we planted pelleted seed in a series of test plots within a commercial alfalfa seed farm near Touchet, Washington, USA. Plots were established on two different row spacings as illustrated on the following page and at two seeding densities, for a total of four treatments.



The schematic above (not to scale) illustrates our two row spacings (22 and 30 inches) and two seeding densities (1-5/8 and 3-3/8 inches within the row). A total of 16 replicate plots of 30 to 33 feet wide by 490 or 720 feet were planted in each row spacing/seeding density combination. The photos at right show the difference between 22-inch (top) and 30-inch rows.

Establishment Year Activities and Results

The plots we established with our July 31, 2007 plantings were farmed commercially by our grower collaborators Mark and Tim Wagoner throughout the following year. We took readings on stand establishment in September 2007. Weed density, white mold incidence, and insect populations were assessed at intervals in the spring of 2008; no significant differences were present among the various plant spacing regimes during this establishment year. Finally, yield was assessed when the plots were harvested in late August 2008; yield was significantly greater in the plots with 30-inch row spacing at 1-5/8-inch seeding density.

Weed Densities within Various Plant Spacings, Year 1

Row Spacing	Seeds in Row	Plants per Acre	Prickly Lettuce Incidence[1]	Salsify Incidence
22"	1-5/8"	117,000	1.6±0.50	1.70±0.70
22"	3-3/8"	80,000	1.8±0.40	1.80±0.58
30"	1-5/8"	71,000	1.7±0.48	1.90±0.68
30"	3-3/8"	48,000	1.7±0.48	1.90±0.57

1/ Weed incidence ± standard deviation rated on a 1-3 scale where 1=<0.5 plant/m^2; and 3=1 plant per m^2

Yield Variations among the Plant Spacings, Year 1

Row Spacing	Seeds in Row	Plants per Acre	Seed Yield lbs/Acre[1]
22"	1-5/8"	117,000	571±36
22"	3-3/8"	80,000	565±54
30"	1-5/8"	71,000	899±44**
30"	3-3/8"	48,000	696±53

1/ Seed yield in pounds per acre ± standard error in August 2008

Photos at Right: Alfalfa planted with 3-3/8" plant spacing (left) and 1-5/8" plant spacing

Second Year Activities and Results

Stubble & Emissions

The second year of our trial gave us the opportunity to work with the stubble (crop residue) remaining in the field after the harvest of the crop from our establishment year. One of our objectives was to quantify the stubble remaining in the test plots to see the variation in stubble yield among the seed/row spacings, toward an understanding of the potential emissions resulting from the various planting densities. Fields were mowed and stubble mass calculated for the various planting densities. We then referred to the 2004 report *Quantifying Post-harvest Emissions from Bluegrass Seed Production Field Burning,* sponsored by the Department of Ecology, in which authors Johnston and Golob determined that when a burn was conducted at an 87% efficiency on stubble left in a "low load" grass seed field, the smoke emitted from 1800 lbs. of stubble resulted in 2,881 lbs of carbon dioxide (CO_2) , 291 lbs. of carbon monoxide (CO), 18 lbs. of methane (CH_4), 73 lbs. of particulate matter less than 10 microns in diameter (PM_{10}), and 58 lbs. of particulate matter less than 2.5 microns in diameter ($PM_{2.5}$). Using these values we extrapolated the smoke quantities emitted for our test plots as shown in the table.

At right, from top: January 2009 stubble mowing; stubble removed from a test plot; quantifying stubble and calculating mass. Below: Field burning viewed from distance.

Potential Emissions from Various Plant Spacings

Spacing	22x1-5/8	22x3-3/8	30x1-5/8	30x3-3/8
Residue/Acre	0.73 tons	0.54 tons	0.61 tons	0.58 tons
CO_2 lbs	2337	1729	1953	1857
CO lbs	309	228	258	245
CH_4 lbs	29	22	24	23
$PM_{2.5}$ lbs	42	31	35	45
PM_{10} lbs	53	39	44	42

Second Year Activities and Results, cont.

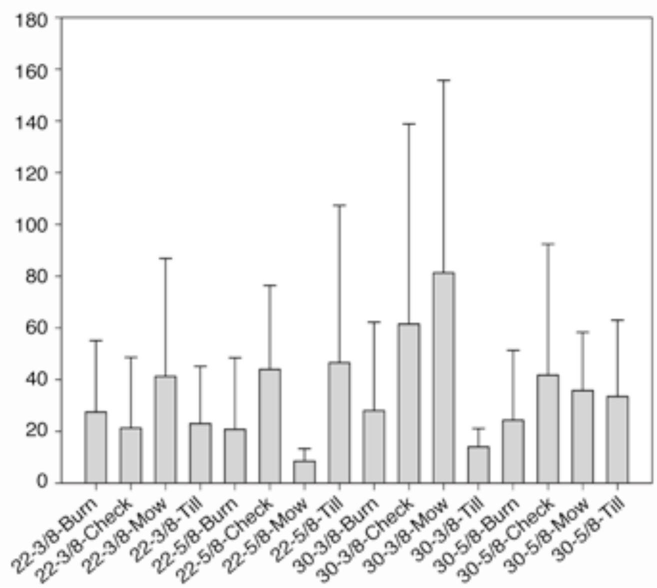
Stem Rot Disease Survival

Materials and Methods: The top 0.5 inches of soil was collected from a 3.3-square-foot section in the center of each alfalfa treatment plot on March 4, 2009. There were four replicated plots of each treatment in the field (treatments detailed in the figure at right). The soil was air dried and rolled to a fine dust using a rolling pin, then sifted to obtain the sclerotia that were present in the soil. The total number of sclerotia of *Sclerotinia sclerotiorum*, the causal agent of alfalfa stem rot, that were recovered from the soil within each of the replicated plots were counted. The average number of sclerotia was determined for each treatment. A Fisher's Protected Least Significant Difference test was used to assess whether significant differences were observed among the treatments.

Results: Due to the high degree of variance among the treatments in the number of sclerotia collected per replicated plot, there were no significant differences ($P \leq 0.05$) observed among the treatments in the number of sclerotia recovered from the soil (as shown in the figure above right). However, trends associated with plant spacing and stubble treatment were observed when treatments were arranged from the greatest to the least number of sclerotia recovered from the soil, as illustrated in the tables at right

Recommendations: Given that the 22" row spacing with a 3-3/8" seed spacing had the lowest average number of sclerotia recovered from soil among the spacing treatments and that burning had the lowest average number of sclerotia recovered from soil among the stubble removal treatments, it may be that the combination of this spacing and stubble removal treatment could reduce the number of sclerotia recovered from an alfalfa seed field. However, the differences among the various combinations of spacings and stubble treatments were not significant ($P \leq 0.05$), therefore more research needs to be conducted to determine whether a combination of burning and manipulation of row and seed spacings could produce any significant reduction in the number of sclerotia that overwinter in an alfalfa seed field.

Mean Number of Sclerotia, Year 2



Key to Above Figure: 22 or 30 = 22 or 30 inch between-row spacing; 3/8 or 5/8 = 3 3/8 or 1 5/8 inch within-row seed spacing; Check = nothing done to stubble following harvest; Burn = stubble was burned; Mow = stubble was mowed; and Till = stubble was tilled.

Impact of Spacing on the Average Number of Sclerotia Recovered from 3.3 ft² of Aoil

Between-Row Spacing	In-Row Seed Spacing	Avg. No. Sclerotia
30"	3 3/8"	45.0
30"	1 5/8"	33.8
22"	1 5/8"	29.9
22"	3 3/8"	28.3

Impact of Stubble Management Treatment on the Average Number of Sclerotia Recovered from 3.3 ft² of Soil

Stubble Treatment	Avg. No. Sclerotia
Check	42.1
Mow	39.1
Till	29.3
Burn	24.9

At Right: White mold, **Sclerotinia sclerotiorum,** *on alfalfa.*

Second Year Activities and Results, cont.

Impact on Arthropod Populations

Materials and Methods: Insect populations were monitored by various methods as alfalfa broke dormancy in April 2009. Pitfall traps were utilized to monitor ground-dwelling arthropods, yellow sticky card traps were utilized to monitor flies, and sweep net samples were taken to monitor both flies and Lygus. Samples were taken from each possible combination of treatments with four replications in a randomized block design. Pitfall and yellow sticky card traps were assessed weekly during this period and five sweep net samples were taken on 9 April and 16 April. Beneficial and pest arthropods were quantified and the plots were subsequently treated with Lorsban (May 27) and Beleaf (June 11).

Results: Arthropod counts ± standard error are presented in the adjacent tables. There were no significant differences in insect abundance among the various row spacings and seeding in row densities with the exception of Lygus abundance in the burn and till treatments. However, the absolute numbers of Lygus adults present were so low as to be biologically irrelevant.

Recommendations: Results in this first year of the three-year study were inconclusive with respect to treatment interaction impacts on arthropod abundance. Year-to-year fluctuation in population counts of various arthropods makes the planned follow-up field studies in the 2010 and 2011 seasons appropriate.

Above: Technicians prepare to deploy sweep net and pitfall traps in test plots.
At Left: Emptying sweep net contents into collection bag.

Carabid Beetles Captured/Week in Pitfall Traps

Treatment	4/2/09	4/9/09	4/16/09	4/23/09
Burn	1.00±0.22	1.78±0.62	0.81±0.26	1.30±0.52
Control	1.12±0.30	2.07±0.50	1.14±0.42	2.50±0.78
Mow	1.53±0.35	1.81±0.38	1.19±0.40	1.93±0.52
Till	1.37±0.34	2.12±0.34	0.47±0.21	1.17±0.30

Spiders Captured/Week in Pitfall Traps

Treatment	4/2/09	4/9/09	4/16/09	4/23/09
Burn	0.44±0.16	0.44±0.16	0.71±0.22	1.50±0.34
Control	0.31±0.12	0.31±0.12	1.31±0.24	0.70±0.26
Mow	0.87±0.33	0.87±0.37	0.94±0.25	1.43±0.43
Till	0.87±0.24	0.87±0.24	1.31±0.36	1.00±0.27

Flies Captured/Week on Yellow Sticky Traps

Treatment	4/2/09	4/9/09	4/16/09
Burn	2.31±0.44	15.81±1.35	28.18±2.85
Control	2.13±0.27	17.44±1.52	25.31±3.17
Mow	2.46±0.51	12.31±1.30	25.93±2.45
Till	2.67±0.50	14.62±1.46	29.87±2.26

Flies Captured/5 Sweeps with Sweep Net

Treatment	4/9/09	4/16/09
Burn	0.25±0.14	1.06±0.08
Control	0.44±0.18	0.81±0.26
Mow	0.37±0.12	0.56±0.18
Till	0.50±0.26	1.00±0.26

Lygus Adults Captured/5 Sweeps with Net

Treatment	4/9/09	4/16/09
Burn	0.06±0.06*	0.12±0.08*
Control	0.31±0.17	0.31±0.12
Mow	0.18±0.10	0.25±0.11
Till	0.60±0.06	0.06±0.06*

*Lygus populations are significantly (p<0.05) lower than populations in the control plots.

Above: Deploying pitfall trap.

Impact on Weed Seed Germination

Materials and Methods: Weed seed was collected in the late summer of 2008 from mayweed chamomile (also known as dog fennel) *(Anthemis cotula)*, prickly lettuce *(Lactuca serriola),* and Western salsify *(Tragopogon dubious)* in an alfalfa seed field near Touchet, Washington, USA. Seed was stored in the lab at 20° C. One hundred seeds from each weed type were placed in 8 by 8 cm stainless steel mesh packets and placed either on the soil surface or buried 2.5 cm deep January 20, 2009 in an alfalfa seed field near Touchet. Surface packets were covered lightly with a small amount of alfalfa residue. Plots were burned on February 18, 2009 and seed packets were recovered, seeds were removed, and germination was tested in Petri dishes at 15° C in the dark on March 5, 2009. Germinated seedlings were counted and removed every 2 to 4 days for three weeks.

Wire mesh packets containing weed seeds for our weed viability study (after stubble burn).

Results: Germination of mayweed chamomile from seed that had been stored in the lab at 20° C was only 25%, which indicated some induced dormancy had occurred. Mayweed seed that was buried at 2.5 cm in the field germinated 69%, regardless of field burning treatment. Mayweed seed placed on the soil surface germinated 49% and burning reduced germination to zero.

Prickly lettuce and salsify germinated 90% or more in all treatments except where seed was placed on the soil surface and subjected to burning. Field burning reduced prickly lettuce seed germination to 1.3% and salsify to 5%.

Burning nearly destroyed all seed from these three species when seed was placed on the soil surface, but had no effect on seed buried 2.5 cm deep. The three species tested normally disseminate by wind and typically would be distributed near the soil surface in late summer and autumn.

Recommendation: Burning of alfalfa residues is an effective means to destroy many weed seeds that remain on the soil surface. This information should be taken into account as part of an integrated pest management program.

Effects of Field Burning on the Germination of Three Weed Species from Seed Packets Placed on the Soil Surface and Buried 2.5 cm in an Alfalfa Seed Field Near Touchet, Washington in 2009

Seed Placement Burn Treatment	Percent Germination		
	Mayweed	Prickly Lettuce	Salsify
Lab Control	25.0	98.8	99.3
Surface Placement			
Nonburned	49.0 a	90.0 a	97.3 a
Burned	0 b	1.3 b	5.0 b
Buried (2.5 cm)			
Nonburned	68.8 a	94.3 a	96.3 a
Burned	68.5 a	95.0 a	99.5 a

Second Year Activities and Results, cont.

Impact on Weed Incidence

Materials and Methods: After the mowing, tilling, burning, and control treatments were implemented within each of the various row spacing/plant spacing combinations on February 18, 2009, herbicide treatments were superimposed on each. A 2.4 x 3-meter section within each trial plot was covered with a tarp on March 6, 2009, and the grower subsequently applied spring herbicide treatments of simazine, pendimethalin, and paraquat. The tarped areas created a non-herbicide-treated control within each of the residue management/spacing treatments.

Weeds were counted by species May 19, 2009 in a 1-m^2 section of both the herbicide treated and non-treated (tarped) areas in each plot.

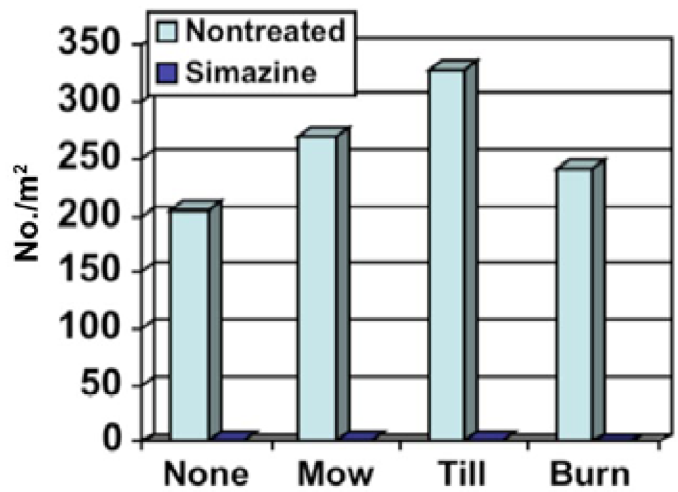
Results: Western salsify and prickly lettuce were the two most prevalent weeds in the trial. In non-herbicide-treated tarped areas, prickly lettuce density ranged from 204 to 329 plants/m^2 and was not significantly affected by the four residue management treatments, but tended to be greatest in the tilled treatments (see top right figure). Simazine controlled prickly lettuce well over all residue management treatments.

Prickly lettuce

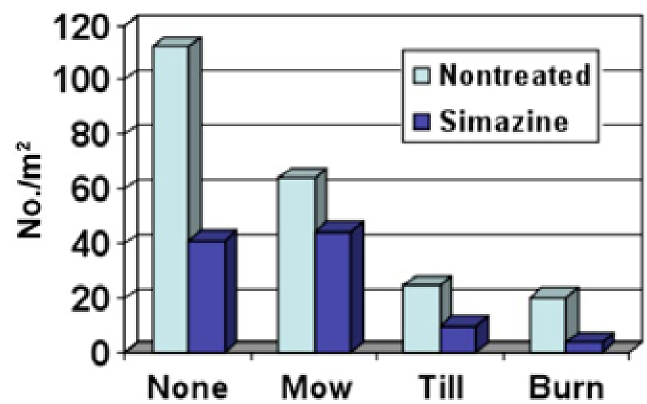
Western salsify density was lowest in the burn and till treatments (without herbicide) and was further reduced by simazine treatment, although control was never complete (see middle figure at right). Burning followed by simazine treatment reduced salsify density to 3.8 plants/m^2. In mowed and no-residue-removal treatments (without tillage or burning) and no simazine, salsify density ranged from 64 to 112 plants/m^2.

Western salsify, a biennial weed, is most prevalent in perennial crops were tillage is infrequent or absent. These results demonstrate the impact of soil disturbance and field burning on the incidence of Western salsify. Western salsify can germinate in late fall, late winter, and early spring. Disturbance of the soil in early spring greatly reduced the incidence of salsify. Burning also destroyed many seeds on the soil surface and possibly some small seedlings. Later-spring-germinating seedlings were controlled to a great extent by the pre-emergence herbicide treatment in early March.

Prickly Lettuce Counts in Alfalfa Seed May 19, 2009 Following Various Residue Management Treatments



Salsify Counts in Alfalfa Seed May 19, 2009 Following Various Residue Management Treatments



Recommendations: An integrated weed management program in alfalfa grown for seed should consider the life cycle of key weeds, including the fact that Western salsify can germinate in late fall, late winter, and early spring and seems to be deterred by soil disturbance and burning.

Western salsify

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