

Research report to the
Oregon Processed Vegetable Commission
2008

Title: *Weed management in sweet corn and other rotational crops*

1. *Maximizing weed control with HPPD herbicides topramezone and tembotrione*
2. *Tillage and rotation effects on weed seed predation*
3. *Puncturevine*

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SUMMARY

- σ Both Impact and Laudis are effective grass killers. The weed control spectrum of these herbicides was enhanced by the addition of atrazine. Both are weak on purslane.
- σ The data from the Stayton I experiment with Coho sweet corn suggest that corn yield may have been reduced by as much as 14% by tankmixing and applying Impact and Laudis with either Outlook or Dual Magnum herbicides at V 5-6.
- σ Low rates of atrazine likely improve the efficacy of HPPD inhibit herbicides, but may not reduce competition enough to improve yield, even (especially) at extremely weedy sites.
- σ Accent Q is less likely to cause injury to corn than Accent (without a safener).
- σ The new PPO herbicide from BASF (Kixor) caused significant injury to corn when applied PRE and injury was not consistent among the 40 varieties tested.
- σ Two years of testing indicate that the risk of Impact carryover is low, but that 2X rates of Impact may reduce table beet yield, growth of fall planted mustard, and influence snap bean grade 9 months after application.
- σ Seed predation in several grower fields followed carabid beetle activity during the summer.
- σ Wild proso millet emergence declined with increasing activity-density in research farm plots.
- σ A few puncturevine seeds survived 196 F for 1 hour.

PROJECTS

1. *Maximizing weed control with HPPD herbicides topramezone and tembotrione*

1.1 *Grass control in sweet corn with HPPD herbicides.* Two experiments were located near Stayton, Oregon in 2008 to evaluate the efficacy of HPPD inhibitor herbicides in sweet corn. Both sites were strip-tilled. The variety Coho was planted on May 26 in Exp I and Kokanee on May 30 in Exp II. Barnyardgrass was the predominate weed in Exp. I and wild proso millet was abundant in Exp. II. PRE herbicides in Exp I were applied 1 day after planting and incorporated with approximately ½" irrigation and rainfall within 3 days. POST herbicides were applied at V2-4 and V4-6 (depending on site) with a backpack sprayer delivering 20 GPA at 20 to 30 PSI (depending on environment). Plots were 10 feet wide by 30 feet long with 4 rows of corn per plot. Treatments were replicated 4 times in a RCB design.

Results

Stayton I (barnyardgrass site). Weed emergence appeared to be delayed by the small grain/common vetch cover crop residues that remained between and in rows after strip-tillage. Slugs were abundant and bait was applied twice by the grower to reduce damage to the corn. PRE herbicides BAS 800 and 781 caused significant injury to the corn. Weed control with the HPPD herbicide treatments was good to exceptional if atrazine was included in the tankmix (Table 1 and 2). Purslane control was particularly poor if Laudis and Impact were applied without atrazine.

Sweet corn yield was average to low at this site considering the vigor of this variety (Table 2). Weed density was moderate and did not significantly reduce corn yield in the untreated check. However, the data suggest that corn yield may have been compromised by tankmixing and applying HPPD herbicides with either Outlook or Dual Magnum herbicides at V 5-6 (Figure 1). Contrast analysis indicated that sweet corn yield declined by 14% when Impact or Laudis were applied at V5-6 rather than V3-4 ($F=16.6$, $P=0.0001$). A 7% decrease in yield occurred when Dual Magnum was tankmixed with the HPPD herbicides rather than Outlook ($F=3.9$, $P=0.06$). Similar results were noted in 2007 but the effect was attributed to early season weed competition that occurred before Impact and Laudis were applied at V4-5. However, in this experiment, weed density was insufficient to reduce crop yield (check yield did not differ from other treatments), thus indicating that the herbicides themselves were impacting the crop directly and reducing yield when applied at V5-6.

Stayton II (wild proso millet site). The variety at this site was Kokanee and wild proso millet and lambsquarters were the most common weeds. No differences were noted in weed control among the 8 treatments. Impact and Laudis tankmixed with either Dual Magnum or Outlook and atrazine gave exceptional control of wild proso millet and lambsquarters whether applied at v 3-4 or v 4-5. Tankmixes with Dual Magnum caused more injury to the crop (leaf necrosis) than tankmixes with Outlook, but this did not affect crop height. Sweet corn yield in HPPD treatments averaged only 8.5 t/A. Weed competition in the check plots reduced yield by 20%. There was no difference in yield between treatments that were applied at V2-3 rather than V4-5.

Table 1 cont'd

Herbicide	Timing	Date	Rate	Obs	6 WAP (6-July)		8 WAP (25-July)		Obs	Weed control 8 WAP (25-July)			
					Phyto	Stunting	Phyto	Stunting		Barnyard-grass	Purslane	Composite rating	
					<i>0-10</i>	<i>%</i>	<i>0-10</i>	<i>%</i>		<i>-----%-----</i>			
13	Accent+isoxadifen COC UAN 28%	v5-6	6-Jul	0.016 1.00 2.50	4	-	-	0	8	4	90	55	84
14	Accent+isoxadifen Aim COC UAN 28%	v5-6	6-Jul	0.016 0.016 1.00 2.50	4	-	-	1.0	12	3	93	100	94
15	Impact Outlook Atrazine MSO UAN	v3-4	21-Jun	0.016 0.84 0.5 1.00 2.50	4	0	0	0	10	4	99	100	98
16	Impact Outlook Atrazine MSO UAN	v5-6	6-Jul	0.016 0.84 0.5 1.00 2.50	4	-	-	1.5	14	4	90	100	93
17	Impact Dual Magnum Atrazine MSO UAN	v3-4	21-Jun	0.016 1.43 0.5 1.00 2.50	4	0	0	0.3	0	4	95	100	95
18	Impact Dual Magnum Atrazine MSO UAN	v5-6	6-Jul	0.016 1.43 0.5 1.00 2.50	4	-	-	1.3	10	4	97	100	97
19	Laudis Outlook Atrazine MSO UAN	v3-4	21-Jun	0.082 0.84 0.5 1.00 2.50	4	0	0	0.3	0	4	98	100	99
20	Laudis Outlook Atrazine MSO UAN	v5-6	6-Jul	0.082 0.84 0.5 1.00 2.50	4	-	-	0.5	5	4	99	100	98

Table 1 cont'd

	Herbicide	Timing	Date	Rate	Obs	6 WAP (6-July)		8 WAP (25-July)		Obs	Weed control 8 WAP (25-July)		
						Phyto	Stunting	Phyto	Stunting		Barnyard-grass	Purslane	Composite rating
						<i>lbs ai/A</i>		<i>0-10</i>	<i>%</i>		<i>0-10</i>	<i>%</i>	-----%-----
21	Laudis Dual Magnum Atrazine MSO UAN	v3-4	21-Jun	0.082 1.43 0.5 1.00 2.50	4	0	4	0.3	4	4	96	100	97
22	Laudis Dual Magnum Atrazine MSO UAN	v5-6	6-Jul	0.082 1.43 0.5 1.00 2.50	4	-	-	1.5	15	4	97	100	95
	FPLSD (0.05)					ns	6	0.8	10		16	26	12

Table 2 cont'd

	Herbicide	Timing	Date	Rate	Obs	Weed control at harvest				Corn harvest		
						Barnyard-grass	Purslane	Crabgrass	Composite rating	Ear no.	Yield	Avg. ear wt.
				<i>lbs ai/A</i>	-----%-----				<i>No/A</i>	<i>t/A</i>	<i>lbs</i>	
13	Accent+isoxadifen COC UAN 28%	v5-6	6-Jul	0.016 1.00 2.50	4	98	94	100	95	23100	8.7	0.8
14	Accent+isoxadifen Aim COC UAN 28%	v5-6	6-Jul	0.016 0.016 1.00 2.50	3	99	100	100	99	22100	8.0	0.7
15	Impact Outlook Atrazine MSO UAN	v3-4	21-Jun	0.016 0.84 0.5 1.00 2.50	4	98	100	100	99	25900	10.0	0.8
16	Impact Outlook Atrazine MSO UAN	v5-6	6-Jul	0.016 0.84 0.5 1.00 2.50	4	98	100	100	98	23300	9.1	0.8
17	Impact Dual Magnum Atrazine MSO UAN	v3-4	21-Jun	0.016 1.43 0.5 1.00 2.50	4	100	100	100	100	21300	8.6	0.8
18	Impact Dual Magnum Atrazine MSO UAN	v5-6	6-Jul	0.016 1.43 0.5 1.00 2.50	4	97	100	100	97	19800	7.9	0.8
19	Laudis Outlook Atrazine MSO UAN	v3-4	21-Jun	0.082 0.84 0.5 1.00 2.50	4	98	100	100	98	26100	10.3	0.8

Table 2 cont'd

Herbicide	Timing	Date	Rate	Obs	Weed control at harvest				Corn harvest			
					Barnyard-grass	Purslane	Crabgrass	Composite rating	Ear no.	Yield	Avg. ear wt.	
				-----%-----				No/A	t/A	lbs		
20	Laudis Outlook Atrazine MSO UAN	v5-6	6-Jul	0.082 0.84 0.5 1.00 2.50	4	100	100	100	100	21100	8.3	0.8
21	Laudis Dual Magnum Atrazine MSO UAN	v3-4	21-Jun	0.082 1.43 0.5 1.00 2.50	4	98	100	100	97	27000	10.3	0.8
22	Laudis Dual Magnum Atrazine MSO UAN	v5-6	6-Jul	0.082 1.43 0.5 1.00 2.50	4	99	100	100	99	21500	8.1	0.8
FPLSD (0.05)						4	12	16	15	4300	1.4	0.1

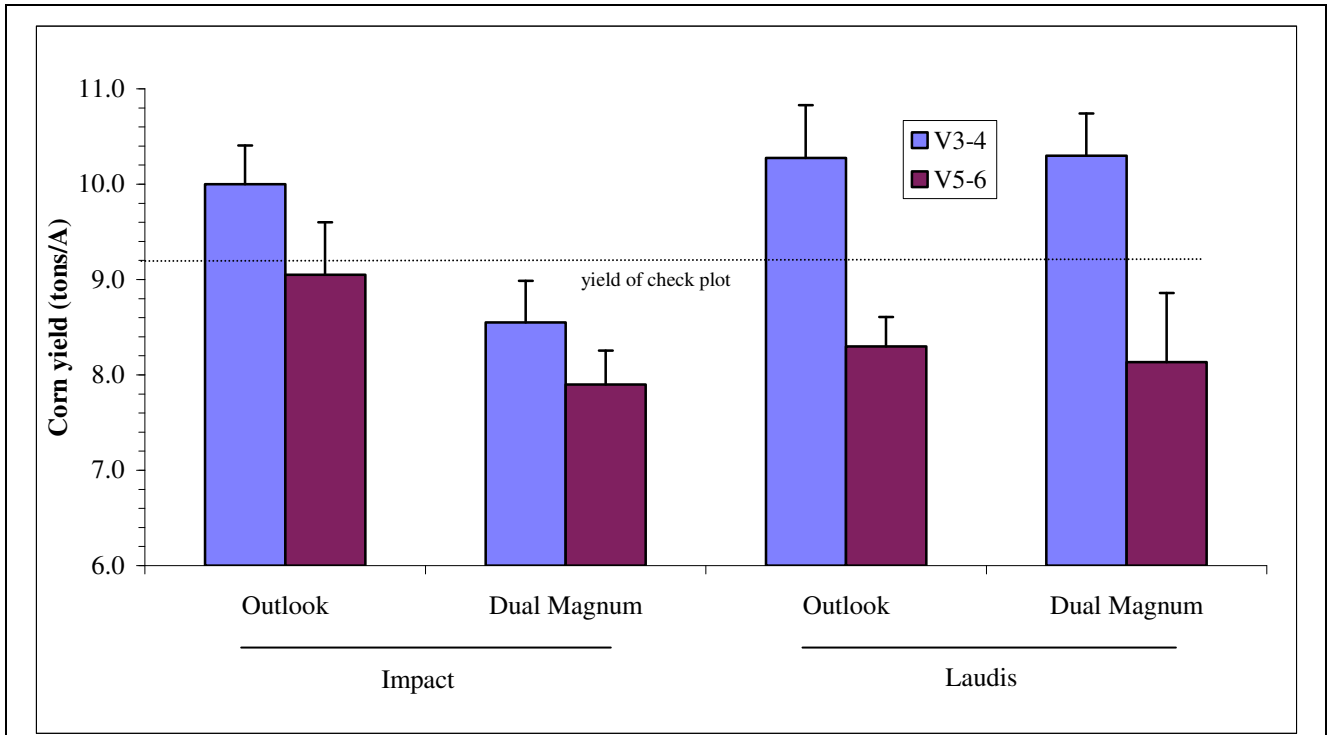


Figure 1. Effect of HPPD herbicide timing and tank mix partner on Coho sweet corn yield (+SE), Stayton I, 2008.

Table 3. Herbicide application data for Stayton I.

Date	Tuesday, May 27, 2008	Saturday, June 21, 2008	Sunday, July 6, 2008
Crop stage	Var. Coho planted May-26	V 3-4	V 5-6, 14-18 inches tall
Weed density and growth stage	-	-	(see Figure 2 below)
Application timing	PRE	V3-4 treatments	V5-6 treatments
Start/end time	11-11:30 A	2-2:30PM	7-9 AM
Air temp/soil temp (2")/surface	72/67/72	84/85/86	61/60/61
Rel humidity	60%	80%	80%
Wind direction/velocity	0-2 SW	0-2 SW	5-10 N, with direction of rows
Cloud cover	100	100	100
Soil moisture	Wet	Very dry	Very dry in block 1, very wet in blocks 2-4
Plant moisture	-	Dry	Dry
Sprayer/PSI	BP 25 PSI	BP 30 PSI	BP 20 PSI
Mix size	2100/4 plots	2100/4 plots	2100/4 plots
Gallons H2O/acre	20	20	20
Nozzle type	5-XR8003	5-XR8003	5-XR8003
Nozzle spacing and height	20/24	20/24	20" above weeds, which were up to a foot tall, 6-8 inches above corn canopy to mitigate spray drift
Soil incorporation	Irrigation	-	-



Figure 2. Exp I at V5-6 application timing, July 6, 2008.

Table 4. Sweet corn tolerance and weed control, early to mid-season, Stayton II, 2008.

	Herbicide	Timing	Rate	Obs	Early to midseason crop ratings				Weed control 7 WAP (25-July)		
					5 WAP (6-July)		7 WAP (25-July)		Wild proso millet	Common lambs-quarters	Composite rating
					Phyto	Stunting	Phyto	Stunting			
					<i>lbs ai/A</i>	<i>0-10</i>	<i>%</i>	<i>0-10</i>	<i>%</i>	<i>%</i>	
1	Check		0	4	0	0	0	8	0	0	0
2	Impact	V2-3	0.0164	4	0	4	0	9	92	100	93
	Outlook		0.84								
	Atrazine		0.5								
	MSO		1								
	UAN		2.5								
3	Impact	V4-5	0.016	4	-	-	1.0	15	95	96	94
	Outlook		0.84								
	Atrazine		0.5								
	MSO		1								
	UAN		2.5								
4	Impact	V2-3	0.016	4	0	6	0.3	5	95	100	96
	Dual Magnum		1.43								
	Atrazine		0.5								
	MSO		1								
	UAN		2.5								
5	Impact	V4-5	0.016	4	-	-	1.5	16	92	98	93
	Dual Magnum		1.43								
	Atrazine		0.5								
	MSO		1								
	UAN		2.5								
6	Laudis	V2-3	0.082	4	0	0	0	0	95	99	94
	Outlook		0.84375								
	Atrazine		0.5								
	MSO		1								
	UAN		2.5								
7	Laudis	V4-5	0.082	4	-	-	0.5	5	93	100	94
	Outlook		0.84375								
	Atrazine		0.5								
	MSO		1								
	UAN		2.5								
8	Laudis	V2-3	0.082	4	0	0	0.3	6	95	100	94
	Dual Magnum		1.43								
	Atrazine		0.5								
	MSO		1								
	UAN		2.5								
9	Laudis	v4-5	0.082	4	-	-	1.5	8	91	100	94
	Dual Magnum		1.43								
	Atrazine		0.5								
	MSO		1								
	UAN		2.5								
	FPLSD				ns	ns	0.6	ns	8	3	6

Table 5. Effect of HPPD inhibitor herbicides on sweet corn yield and weed control at harvest Stayton II, 2008.

	Herbicide	Timing	Rate	Obs	Weed control at harvest			Corn yield		
					Wild proso millet	Common lambsquarters	Composite rating	Ears	Fresh wt.	Avg. ear wt.
			<i>lbs ai/A</i>	<i>----- % -----</i>			<i>no./A</i>	<i>tons/A</i>	<i>lbs</i>	
1	Check		0	4	0	0	0	18300	6.7	0.71
2	Impact	V2-3	0.016	4	96	100	94	22900	8.7	0.77
	Outlook		0.84							
	Atrazine		0.5							
	MSO		1							
	UAN		2.5							
3	Impact	V4-5	0.016	4	93	97	90	22000	7.7	0.70
	Outlook		0.84							
	Atrazine		0.5							
	MSO		1							
	UAN		2.5							
4	Impact	V2-3	0.016	4	93	100	93	22000	8.7	0.80
	Dual Magnum		1.43							
	Atrazine		0.5							
	MSO		1							
	UAN		2.5							
5	Impact	V4-5	0.016	4	98	99	96	22900	8.3	0.72
	Dual Magnum		1.43							
	Atrazine		0.5							
	MSO		1							
	UAN		2.5							
6	Laudis	V2-3	0.082	4	94	100	94	22400	8.6	0.77
	Outlook		0.84							
	Atrazine		0.5							
	MSO		1							
	UAN		2.5							
7	Laudis	V4-5	0.082	4	95	100	95	21600	8.4	0.78
	Outlook		0.84							
	Atrazine		0.5							
	MSO		1							
	UAN		2.5							
8	Laudis	V2-3	0.082	4	96	100	95	22900	8.7	0.76
	Dual Magnum		1.43							
	Atrazine		0.5							
	MSO		1							
	UAN		2.5							
9	Laudis	v4-6	0.082	4	96	100	96	21800	8.6	0.79
	Dual Magnum		1.43							
	Atrazine		0.5							
	MSO		1							
	UAN		2.5							
FPLSD (0.05)					8	3	3	ns	ns	ns

Table 6. Herbicide application data for Stayton II.

Date	Saturday, June 21, 2008	Sunday, July 6, 2008
Crop stage	V2-3 (var. Kokanee planted May 30)	V 4-5, 14-18 inches tall
Weed density and growth stage	-	(see Figure 3 below)
Herbicide/treatment	2,4,6,8	3,5,7,9
Application timing	EPOST	LPOST
Start/end time	11:30-12 PM	6-7 AM
Air temp/soil temp (2")/surface	82/82/84	61/60/61
Rel humidity	80%	80%
Wind direction/velocity	0-2 SW	5-10 N, with direction of rows
Cloud cover	90	100
Soil moisture	Dry, sandy	Very dry, will irrigate within 2 days
Plant moisture	Dry	Dry
Sprayer/PSI	BP 30 PSI	BP 20 PSI
Mix size	2100/4 plots	2100/4 plots
Gallons H2O/acre	20	20
Nozzle type	6-XR 8003	6-XR 8003
Nozzle spacing and height	20/24	20/24

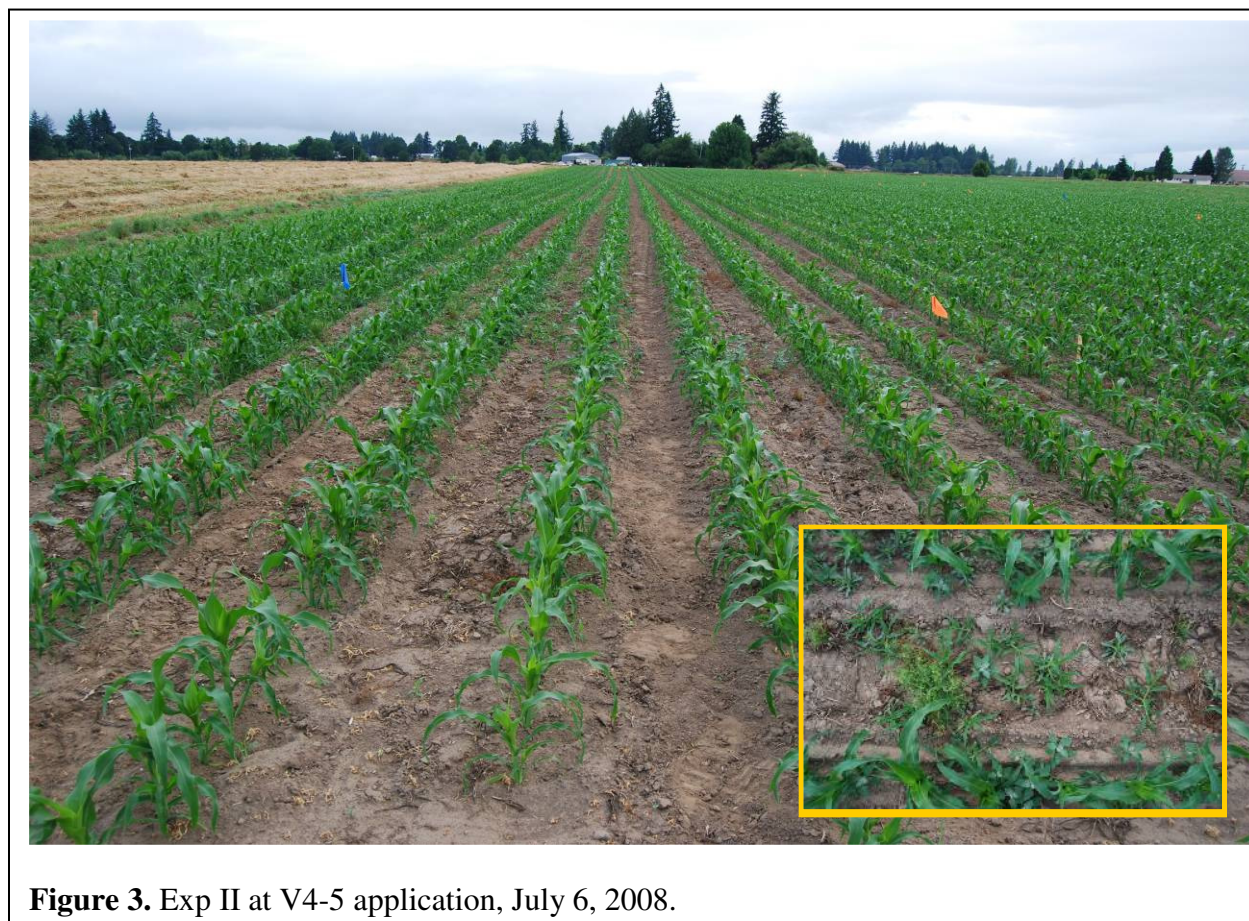


Figure 3. Exp II at V4-5 application, July 6, 2008.

1.2. Atrazine effects on Laudis efficacy in sweet corn.

Atrazine is typically recommended as a tank mix with HPPD inhibitor herbicides to broaden the weed control spectrum. Atrazine acts as a synergist and enhances HPPD activity. However, this practice conflicts with the objective of reducing or eliminating atrazine use in sweet corn production. Additionally, complete weed control in sweet corn is seldom needed, unless growers want to avoid recharge of the weed seed bank. Sweet corn is a very competitive crop, and it may be possible to avoid atrazine applications altogether when using HPPD inhibitor herbicides, yet maintain expected sweet corn yield. The objective of this experiment was to determine the effect of atrazine rate on Laudis weed control efficacy when applied to sweet corn varieties with very different competitive abilities.

Methods. Two varieties of sweet corn were planted on May 14, 2008 at 26,000 seeds/A. Quickie had a harvest maturity of 75 days and Var. 128 had a maturity of 110 days. There was a large difference in height and leaf area index (LAI) between the two varieties. A weed free check-plot was maintained by applying Outlook and atrazine after planting, and removing escapes by hand during the season. Laudis was applied at 1 oz/A, 1/3 the rate that is labeled for weed control in corn. Treatments with Laudis were applied POST on June 23 when corn was at V4-5 and was 12-16 inches tall, depending on variety. Leaf area index and corn height was determined when the corn was at 50% silking.

Results and Discussion. As mentioned above, the two corn varieties had very different growth characteristics. Var. 128 was very competitive and again suppressed weeds better than Quickie. The addition of atrazine improved weed control most when applied to plots with the variety Quickie (Fig. 4). Var. 128 was very competitive with approximately 90% control when Laudis was applied without atrazine, compared to only 50 to 60% control when the same treatment was applied to Quickie (Figure 4). Yield did not increase with improved weed control, however.

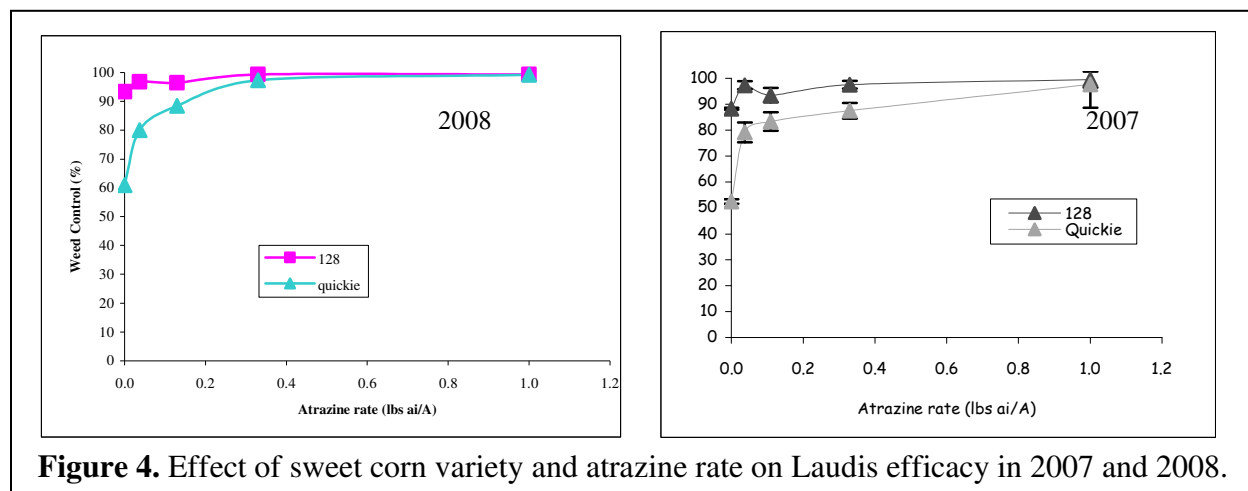


Figure 4. Effect of sweet corn variety and atrazine rate on Laudis efficacy in 2007 and 2008.

1.3. Sweet Corn Varietal Tolerance to Accent, Status, and Kixor Herbicides

We have cooperated with Dr. Chris Boerboom of the University of Wisconsin for the last 5 years as he has screened sweet corn varieties for crop tolerance to a number of new herbicides. This information has been used to inform breeders so they can avoid susceptible gene combinations that predispose sweet corn to damage to certain herbicides, and to inform growers of the varieties that are most susceptible to herbicide injury.

Methods. Planting rows were made with a John Deere Max emerge planter on May 23, 2008. Row spacing was 30 inches and fertilizer (450 lbs/A 12-29-10) was banded next to the rows. Sweet corn was planted on May 28 with push-type belt planters set to 1.5 inches deep. Plots were 20 ft long with one row (or variety of corn) per plot, and 15 feet separating each block of varieties (treatment) (see Figure 1). Outlook and atrazine herbicides were applied broadcast over the plots 1 day after planting, and then the plots irrigated with ½” water.

Injury ratings were made at 7, 14, and 28 DAT by comparing herbicide treated plots with the same variety in the untreated block. Ear quality was evaluated by stripping 10 ears in each plot and looking for irregular cob shape or tip fill. The data were analyzed as a strip-plot with main effects of variety and Accent treatment. However, because the plots of this study were not randomized in space, and represent only one of four replications located across the US, the outcomes in the table below should be viewed as preliminary data. A final report from all locations will be forthcoming.

Results of this study will be summarized across the four sites. Data from the one replication located in Corvallis indicated that there very little if any improvement in crop safety to Accent when the safener isoxadifen was added, and no increase in crop injury when Laudis was tankmixed with Accent (Table 7 and 8). Merit eventually died in all treatments that had been treated with Accent, whether tankmixed with isoxadifen or not. Kixor significantly injured corn when applied preemergence, and there appeared to be differences among varieties, but this injury may have been caused more by the emergence phenology of the variety coupled with rainy weather more than the intrinsic susceptibility of the cultivars. An example of the data published to inform growers on best use of these herbicides is presented in the table below (Table 9) and will be updated this winter.

Table 7. ANOVA For effect of variety (averaged across herbicide treatment of Accent, isoxadifen, and Laudis) and treatment (averaged across variety).

	Injury ratings								
	7 DAT			14 DAT			28 DAT		
	F	P	LSD	F	P	LSD	F	P	LSD
Variety	10.6	<0.0001	9.7	10.2	<0.0001	10.4	86	<0.0001	4.7
Treatment	4.9	0.0093	2.7	2.8	0.06	2.9	1	0.3	1.3

Table 8. Effect of Accent, isoxadifen, and Laudis on sweet corn growth. Each cell is the average response of 40 sweet corn varieties.

Variety	Accent (1.09 oz/A)			Accent (1.09 oz/A) + Isoxadifen (0.41 oz/A)			Accent (1.09 oz/A) + Isoxadifen (0.41 oz/A) +Laudis (4 fl oz/A)		
	DAT			DAT			DAT		
	7	14	28	7	14	28	7	14	28
Means	7.4	6.8	3.6	4.0	4.0	3.1	3.4	3.5	2.5
Std error	2.1	2.3	2.6	1.8	2.1	2.5	1.8	1.7	2.3

Table 9. Example of the data published that summarizes experiments at 4 sites across the US.

T = Tolerant		Low risk of injury or limited symptoms					
I = Intermediate		Occasional, noticeable injury possible; avoid risky conditions (weather extremes, overlaps)					
S = Sensitive		Noticeable injury possible; use herbicide at your own risk; use special precautions					
HS = Highly Sensitive		Severe injury likely, herbicide use is not recommended					
Hybrid	Company	Accent	Callisto	Hybrid	Company	Accent	Callisto
Accord	Mesa Maize	I	I	Double Up	Rogers	I	T
Alexis	Crookham	T	I	Dynamo	Harris Moran	S	HS
Ambrosia	Crookham	T	T	Early Gold	Harris Moran	I	I
Applause	Crookham	T	I	Eliminator	Crookham	S	I
Argent	Crookham	S	HS	Empire	Snowy River	I	I
Basin R	Seminis	S	S	Enterprise	Snowy River	T	T
Bliss	Snowy River	T	T	Equinox	Crookham	T	T
Bodacious	Crookham	I	I	Everest	Snowy River	I	T
Bojangles	Crookham	I	S	Fleet	Crookham	S	T
Bold	Rogers	S	I	Frosty	Crookham	T	T
Bon Appetit TSW	Mesa Maize	T	T	Gateway	Rogers	S	T
Bon Jour TSW	Mesa Maize	I	T	GH 2042	Rogers	S	S
Breeders Choice	Mesa Maize	T	T	GH 2171	Rogers	I	T
Brocade TSW	Mesa Maize	I	T	GH 2669	Rogers	S	I
BSS 3495	Rogers	T	T	GH 4927	Rogers	S	I
Cahill	Rogers	S	I	GH 6014	Rogers	S	I
Cameo	Crookham	I	T	GH 6223	Rogers	S	T
Captivate	Crookham	I	I	GH 6377	Rogers	-	S
Cascade	Crookham	S	T	GH 6462	Rogers	I	T
Cavalry	Harris Moran	S	T	GH 8267	Rogers	S	S
Celestial	Crookham	S	HS	GSS 1303	Rogers	T	I
Challenger	Seminis	T	T	GSS 1477	Rogers	S	S
Charmed	Crookham	I	T	GSS 2008	Rogers	T	T
Chase	Seminis	S	I	GSS 2914	Rogers	S	HS
Chief Ouray	Mesa Maize	S	I	GSS 4165	Rogers	T	T
Cinderella	Crookham	T	I	GSS 5649	Rogers	-	I
CNS710 rust	Crookham	S	T	GSS 6550	Rogers	-	S
Coho	Harris Moran	S	I	GSS 6564	Rogers	I	T
Colombus	Snowy River	S	I	Harvest Gold	Seminis	I	I
Colonial	Rogers	I	T	HM 2390	Harris Moran	T	T
Dasher	Crookham	I	T	HMX 4380BES	Harris Moran	T	T
Delectable	Crookham	I	S	HMX 4383S	Harris Moran	I	I
Devotion	Seminis	S	S	HMX 4387WS	Harris Moran	I	I
DMC 21-84	Del Monte	S	-	HMX 4388S	Harris Moran	S	S
DMC 21-86	Del Monte	S	-	HMX 4394	Harris Moran	I	T
Double Gem	Mesa Maize	S	T	HMX 4396S	Harris Moran	I	

1.4. Carryover Potential of Impact Herbicide, 2007-08

Methods. Experiments were conducted at the OSU Vegetable Farm (Corvallis) to determine carryover potential of Impact herbicide that was applied in July of 2007. The design for the experiment was a strip plot, with herbicide rate and follow-crop as the subplots. Crop main plots were 10 by 70 ft, and Impact rate subplots were 10 by 20 ft (Figure 1). All plots were replicated 3 times. The soil classification at this site was a loam soil (33 % sand, 43 % silt, and 25 % clay) with a pH of 5.8, OM % (LOI) of 1.90, and a CEC of 20.7 meq/100 g of soil. Super sweet Jubilee corn was planted on May 30, 2007 in rows 2.5 ft apart. Outlook herbicide was applied PRE to control weeds, and plots were cultivated when the corn was about 16 inches tall. A few sunflowers were seeded with the corn as an indicator crop. Surviving sunflowers were killed with glyphosate spot treatments just before they produced seeds. Impact herbicide was applied to subplots within the sweet corn planting on July 7, 2007 at 0.016 and 0.032 lbs ai/A, with one of the subplots of each replicate block not receiving any herbicide. The solution that remained after the application was measured to ensure that the intended rate was applied. The two herbicide treatments were applied with a back pack sprayer with a 10 ft boom with 15 GPA of water/A.

The corn was mowed 10 days before predicted commercial harvest on Aug 22 and flailed close to the ground on Aug 24, 2007. On Aug 26, plots were disked 3 times and a Roter and roller applied once to prepare a seedbed. Fertilizer was spread on Aug 28 at 400 lbs/A of 12-29-10, followed again by the Roter and roller at a very slow speed. A weather station recorded rainfall and air temperature at the field site. Field crops were planted with a 7.5 ft wide Nordsten drill with a row spacing of 15 inches. Brassica and beet crops were planted on a 26 inch row spacing with a Gaspardo vacuum seeder, while beans and squash were planted on a 30 inch row spacing with a John Deere max emerge planter. Mint was transplanted on a 1 ft in-row spacing after making 2-60 inch rows with the row clearers set to about 6 inches deep on the John Deere planter. Data for each crop and season were analyzed separately as a RCB design with Block as a class variable and Rate (0, 1, 2) as a continuous variable using PROC GLM of SAS.

Fall planted crops. Crimson clover, perennial ryegrass, forage fescue, processing squash (Golden Delicious), snap beans (OR91G), sugar beets, and Chinese cabbage (Napa) were planted on Aug 30 and 31 2007, 55 days after Impact herbicide was applied to the corn. In 2006, 85 days passed between the Impact application and crop planting. After planting, Pyramin and Dual Magnum were applied to the beets, Dual magnum and Devrinol were applied to Chinese cabbage, and Outlook was applied to the squash and snap beans. Light rain fell but was not enough to incorporate the herbicides, so the plots were irrigated with about 0.5 inches of water. On Oct 29 2007, Nortron, Aim, and MCPA were applied to the ryegrass and fescue to minimize winter weed competition with the crop. Emerged crop seedlings were counted on Oct. 10, 50 days after the crops were seeded, and growth and phytotoxicity rated on Oct 28, 2007. Crops were harvested the following spring and summer as recorded below. Field crops were harvested from 11 ft sq and the Chinese cabbage from 10 ft of the three rows in each plot.

Spring planted crops. Spring plots were disked twice and rototilled three times on May 2 and 3, 2008 to prepare a seedbed. Fertilizer was broadcast at 500 lbs (12-29-10) before the last tillage. Crops of clover, pak choi (leafy brassica, var. Joi Choy), peppermint, perennial ryegrass, snap beans (OR91-G), squash (Golden Delicious), table beets (Detroit dark red) and turf-type tall fescue were planted on May 5 and 6. Herbicides were applied to minimize weed competition

(Table 1) and plots irrigated lightly to incorporate the herbicides. Hand weeding, cultivation, and rototilling were used to keep weeds from reducing crop growth. Ryegrass, clover and peppermint were harvested from 11 ft sq in the center of each plot. Snap beans, beets, and pak choi were harvested from 8.2 ft of row.

Results.

Fall planted crops (2007). Few effects were noted on crop growth (Table 10). Emergence counts in November of 2007 indicated that snap bean and squash emergence may have been reduced by 2007 Impact herbicide application, but visual evaluations indicated no effects on plant color or growth. Sugar beet mean emergence declined with increasing Impact rate, but did not differ statistically among treatments. Unfortunately, the sugar beet crop was entirely destroyed by geese.

Spring planted crops (2008). Cool and wet weather through mid-June reduced emergence of some crops. No significant effects of the 2007 Impact herbicide application were noted on ryegrass, clover, mint or pak choi (Table 11). Two attempts at establishing fescue failed because of poor weed control. Table beet yield was marginally tolerant to Impact at 1.5 oz/A. Snap bean pod grade was greatest with Impact at 1.5 oz/A, indicating a potential delay in maturity at the 2x rate. No effects of Impact were noted on plant color for any of the crops, including squash.

Table 10. Effect of Impact herbicide on fall-planted follow-crops. Herbicides were applied in July 7, 2007 and crops planted on Aug 30-31, 2007.

Planting Season and Crop	Planting date	Impact herbicide rate	Emergence/stand	Phyto	Stunting	Phyto	Stunting	Total above-ground biomass	Dry matter yield
		<i>1=0.75 oz; 2=1.5 oz/A</i>	<i>0-10</i>	<i>%</i>		<i>0-10</i>	<i>%</i>	<i>kg/unit area</i>	<i>kg/unit area</i>
Fall planted crops									
P. ryegrass	30-Aug	0	<i>10-Oct</i>	<i>28-Oct</i>	<i>28-Oct</i>	<i>1-May</i>	<i>1-May</i>	<i>9-Jul</i>	<i>9-Jul</i>
			100	0	0	0	0	3.3	1.74
			95	0	0	0	0	4.1	1.76
			104	0	0	0	0	3.1	1.71
			<i>ns</i>	<i>ns</i>	<i>ns</i>	<i>ns</i>	<i>ns</i>	<i>P=0.07</i>	<i>ns</i>
Tall Fescue	30-Aug	0	<i>28-Oct</i>	<i>28-Oct</i>	<i>1-May</i>	<i>1-May</i>	<i>9-Jul</i>	<i>9-Jul</i>	
			-	0	0	0	0	1.5	0.64
			-	0	0	0	0	1.3	0.60
			-	0	0	0	0	1.6	0.58
			<i>ns</i>	<i>ns</i>	<i>ns</i>	<i>ns</i>	<i>ns</i>	<i>ns</i>	
Clover	30-Aug	0	<i>10-Oct</i>	<i>28-Oct</i>	<i>28-Oct</i>	<i>1-May</i>	<i>1-May</i>	<i>9-Jul</i>	<i>9-Jul</i>
			100	0	0	0	0	2.8	0.97
			81	0	0	0	0	2.7	0.94
			92	0	0	0	0	2.6	0.92
			<i>ns</i>	<i>ns</i>	<i>ns</i>	<i>ns</i>	<i>ns</i>	<i>ns</i>	
Ch. Cabbage <i>Napa cabbage, seed crop</i>	31-Aug	0	<i>10-Oct</i>	<i>28-Oct</i>	<i>28-Oct</i>	<i>29-Apr</i>	<i>29-Apr</i>	<i>30-Apr</i>	
			100	0	0	0	0	22.6	-
			94	0	0	0	7	30.2	-
			113	0	0	0	27	19.6	-
			<i>ns</i>	<i>ns</i>	<i>ns</i>	<i>P=0.005</i>	<i>P=0.07</i>	<i>-</i>	
Sugar beets	30-Aug	0	<i>10-Oct</i>	<i>28-Oct</i>	<i>28-Oct</i>	<i>Crop destroyed by geese</i>			
			100	0	0	-	-	-	-
			84	0	0	-	-	-	-
			86	0	0	-	-	-	-
			<i>ns</i>	<i>ns</i>	<i>ns</i>				
Snap beans	30-Aug	0	<i>10-Oct</i>	<i>28-Oct</i>	<i>28-Oct</i>				
			100	0	0	-	-	-	-
			93	0	0	-	-	-	-
			88	0	0	-	-	-	-
			<i>P=0.05</i>	<i>ns</i>	<i>ns</i>				
Squash	30-Aug	0	<i>10-Oct</i>	<i>28-Oct</i>	<i>28-Oct</i>				
			100	0	0	-	-	-	-
			74	0	0	-	-	-	-
			67	0	0	-	-	-	-
			<i>P=0.003</i>	<i>ns</i>	<i>ns</i>				

Table 11. Effect of Impact herbicide on spring-planted follow-crops. Impact herbicide was applied on July 7, 2007 and crops planted May 5, 2008.

Planting Season and Crop	Planting date	Impact herbicide rate	Emergenc e/ stand	Phyto	Stunting	Phyto	Stunting	Total above-ground biomass/ no. plants harvested	Pod, head, or root yield and grade	
				% of check	0-10	%	0-10			%
Spring planted crops										
Clover	5-May	0 1 2	100 79 79 <i>ns</i>	16-Jun	16-Jun	16-Jun	25-Aug	25-Aug	25-Aug	3.5/ 0.82 ¹ 3.6/ 0.85 3.4/ 0.80 <i>ns/ ns</i>
				0	0	0	0	0		
				6	6	6	2	2		
				<i>ns</i>	<i>ns</i>	<i>ns</i>	<i>ns</i>	<i>ns</i>		
P. ryegrass	5-May	0 1 2	100 107 86 <i>ns</i>	16-Jun	16-Jun	16-Jun	25-Aug	25-Aug	25-Aug	2.8/ 0.62 ¹ 2.6/ 0.63 3.1/ 0.72 <i>ns/ ns</i>
				0	0	3	0	0		
				0	0	6	0	0		
				<i>ns</i>	<i>ns</i>	<i>ns</i>	<i>ns</i>	<i>ns</i>		
Mint	5-May	0 1 2	- - - <i>ns</i>	- - - <i>ns</i>	- - - <i>ns</i>	- - - <i>ns</i>	25-Aug	25-Aug	25-Aug	3.8/ 0.96 ¹ 4.3/ 1.08 4.0/ 1.05 <i>ns/ ns</i>
							0	0	0	
							0	0	0	
							<i>ns</i>	<i>ns</i>	<i>ns</i>	
Ch. cabbage Pak Choi leafy greens	5-May	0 1 2	100 120 160 <i>ns</i>	16-Jun	16-Jun	16-Jun	25-Aug	25-Aug	25-Aug	15.6 ² 15.6 15.0 <i>ns</i>
				0	0	7	-	-		
				10	13	-	-	-		
				<i>ns</i>	<i>ns</i>	<i>ns</i>	<i>ns</i>	<i>ns</i>		
Table beets	5-May	0 1 2	100 153 120 <i>ns</i>	16-Jun	16-Jun	16-Jun	25-Aug	25-Aug	27-Aug	19.6 ³ 17.3 14.0 <i>ns</i>
				0	0	7	0	2		
				7	13	0	3	0		
				<i>ns</i>	<i>ns</i>	<i>ns</i>	<i>ns</i>	<i>ns</i>		
Snap beans	5-May	0 1 2	100 87 86 <i>P=0.07</i>	16-Jun	16-Jun	16-Jun	25-Aug	25-Aug	5-Aug	4.8 4.5 4.1 <i>P=0.09</i>
				0	0	0	-	-		
				0	0	0	-	-		
				<i>ns</i>	<i>ns</i>	<i>ns</i>	<i>P=0.09</i>	<i>P=0.56/ 0.06</i>		
Squash	5-May	0 1 2	100 122 106 <i>ns</i>	16-Jun	16-Jun	16-Jun	25-Aug	25-Aug	22-Oct	No effect noted on potential yield or color of fruit.
				0	0	0	0	0		
				0	0	13	0	4		
				<i>ns</i>	<i>ns</i>	<i>P=0.01</i>	<i>ns</i>	<i>ns</i>		

¹ Fresh wt and dry matter, respectively.

² No. Chinese cabbage heads harvested.

³ No. beet roots harvested/plot.

⁴ % grade 1-3 beets.

⁵ % 1-4 sieve beans.

2.1. Activity Density and Weed Seed Predation Potential of Ground Beetles in Annual Row Crops of the Pacific Northwest (On-farm experiments)

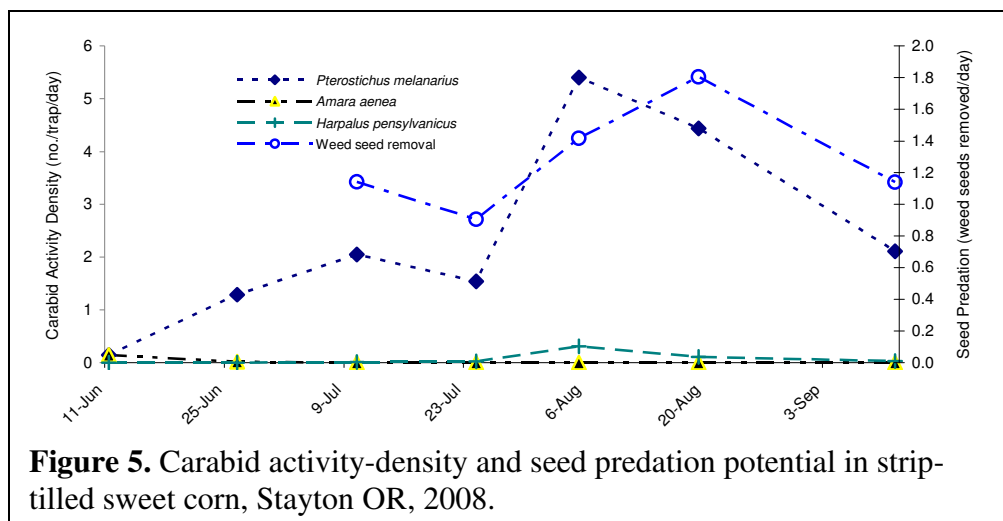
Methods. Ground beetle activity-density was measured in six farm fields of Western Oregon and two fields in the Columbia Basin with pitfall traps placed at six to eight sites in each field from July through September 2008. Pitfall catches were assessed after 14 days. Seed predation potential was measured during expected periods of summer annual weed seed rain by placing weed seed stations next to pitfall traps from June through October. Stations included a plaster-filled 5 cm Petri dish set flush with the soil surface and holding 30 pigweed seeds. The dish was surrounded by 1.2 cm mesh screen to exclude rodents and birds and covered by a rain guard.

Results

In the majority of fields visited this spring in the Willamette Valley, spring breeding species such as *Harpalus affinis* and *Amara spp.* were the most prevalent adult species. However, in one field with a spring pea-summer snap bean rotation, *Pterostichus melanarius* (a fall-breeding species) was the most common species trapped. This field was no-till planted to peas in February and this may be the partial cause of the high number of *P. melanarius*. Spring tillage is reported to be detrimental to fall breeding species such as *P. melanarius* because they are in their larval stage in spring and unable to escape the destructive effects of tillage.

The activity-density of *P. melanarius*, a prevalent carabid species of the Willamette Valley, and a significant weed seed predator, grew in early June and then sharply decreased in late July. *P. melanarius* populations began to rise again in mid-August and early September. This trend was seen in all other fields located in western Oregon and eastern Washington and could have been caused by the die-off of the older cohorts of *P. melanarius*. The greatest carabid activity-density and seed predation was in a corn field that was strip/conservation tilled for last two years (Figure 5). In six out of the eight fields, the activity-density of *Pterostichus melanarius* and weed seed (Powell amaranth) loss followed similar trends.

In eastern Washington potato fields there was more seed predation and carabid beetle populations in the conventional field compared to the organic. This may have been due to the relatively new age of the organic field, and the extreme soil disturbance that occurred during its recent construction.

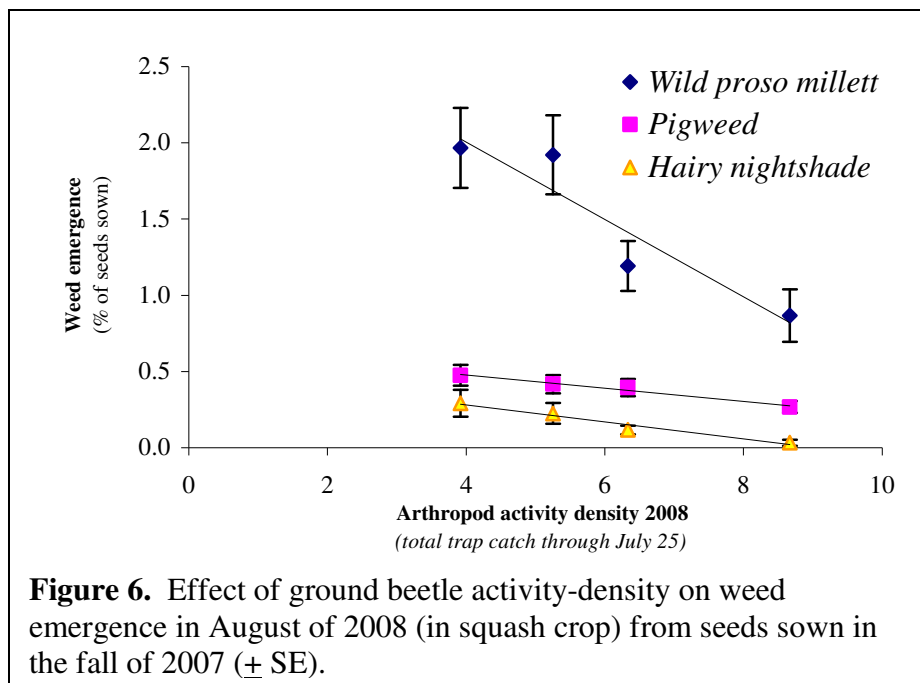


2.2. Effect of Primary Tillage Sequence on Weed Seed Predator Activity-density and Weed Emergence (Corvallis)

A pulse-chase experiment began in the fall of 2006 in a tall fescue-snap bean-squash rotation. 24 plots (sq foot?) were established in 2007. These plots were surrounded by landscape fencing in order to keep beetle activity densities enclosed that were manipulated by treatments. Treatments imposed to plots before snap bean planting in 2007 were strip-tillage vs. conventional planting systems, both with and without insecticide (Mocap) applications. After snap bean harvest, each plot was split in half with landscape fencing and cover crops were direct-drilled or the plots were conventionally tilled and cover crops seeded. Squash was direct-seeded in the spring of 2008. Weed seed rain was simulated by ‘planting’ seeds of wild proso millet, hairy nightshade, and Powell amaranth on the soil surface or by burying them 2.5 cm deep in the fall of 2007. This was to determine the relationship between ground beetle activity-density and weed emergence in 2008. Ground beetle activity-density was measured with pitfall traps throughout the snap bean and squash crops in 2007 and 2008, respectively.

Results

Strip tillage in the spring of 2007 enhanced carabid beetle activity-density in 2008, but only if insecticides were not applied to the plots. There was no effect of fall tillage in 2007 on ground beetle activity-density. Weed emergence in 2008 was lowest in plots that were strip-tilled in the spring of 2007 and that did not receive insecticides, indicating that invertebrate seeds predators may be important in regulating annual weed recruitment. Wild proso millet emergence in 2008 was correlated with ground beetle activity-density (Figure 6). The results of this experiment are unique in that this preliminary data indicate a link between tillage/cultural practices and changes in weed density and carabid beetle activity-density. A second experiment is underway to validate these results.



3. Puncturevine

Although it is weed mostly found in the eastern Washington and Oregon, puncturevine is beginning to make an appearance west of the mountains, most notably at several sites in the Willamette Valley. A major vector of puncturevine seeds is farm equipment. Seeds are moved from site to site or from region to region by equipment, usually embedded in tires. Puncturevine typically establishes first on road sides or field margins where competition is low, then moves concentrically into the field. It takes 3 to 4 years for puncturevine seedbanks to dissipate, even when no new puncturevine seeds are produced. Therefore, speeding the decline in the field margin seedbank is a primary goal. The objective of this experiment was to determine the feasibility of reducing the puncturevine seed bank by heating the soil.

Methods. Dry puncturevine seeds, collected from eastern Washington, were exposed to 194° F in a kiln for 60 minutes. Following heating, the seeds were planted in petri dishes filled with field soil, and germinated on a temperature table at 83°F.

Results. Puncturevine seed survival (based on germination percentage) did not begin to decline until 30 minutes of exposure to 194° F (Figure 7). A small percentage of seeds even produced seedlings after exposure to 194° F for 55 minutes. However, seeds were dry when heat-treated, and may respond differently when imbibed. Further testing will commence this winter with the seeds heated while in soil. Steam treatments may be needed to reduce puncturevine seed survival to acceptable limits in a shorter period of time, but this requires hauling and heating water, and injection technology to distribute the steam.

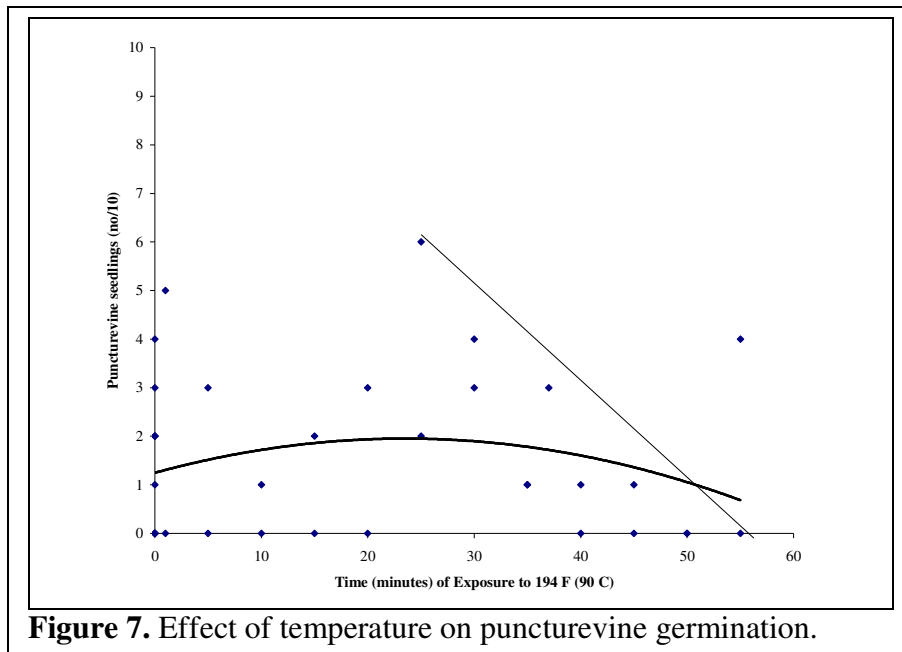


Figure 7. Effect of temperature on puncturevine germination.