2012 Progress Report to the BC Cranberry Marketing Commission

Reduced-risk Fireworm Management and New Herbicides for Cranberries in BC

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Objective 1: Assess the interaction of chemigation timings with the efficacy of reduced-risk insecticides for fireworm control.

Methods: Two experiments were conducted on cranberry beds infested with second generation fireworm larvae. A single sprinkler (LF 2400) was connected to a pump and supply tank and used to generate different treatment timings. The head was moved to a different spot for each treatment. Due to the large area required for each treatment, plots were not replicated. In the third experiment, a grower bed was chosen that had a fireworm problem due to different sprinkler coverage within the bed. Areas within the bed were systematically monitored for fireworm damage and those results related to sprinkler head psi, number of heads covering an area, and irrigation rate.

Results:
Chemigation Comparison. Only one site had sufficient fireworm post-treatment to monitor. There was no difference in efficacy between Intrepid and Delegate for different chemigation situations (short vs. long injection times) (Table 1). All treatment timings worked and there was no difference between insecticides.

Irrigation Uniformity vs. Whole Bed Efficacy with Chemigation. Spot evaluations of fireworm damage were made within beds which had different psi and sprinkler head coverage within the bed (Figures 1 and 2). Percent infested fruit decreased linearly with increase in the sprinkler irrigation rate at each collection site (from>15% at <0.03 in/hr to 0% at 0.12 in/hr (Figure 1). On collection sites with only 20 psi and receiving water from only 1 sprinkler, there were >20 bbl/ac lost to fireworm compared to <0.5 bbl/ac crop loss on sites with 40 psi receiving water from 2 sprinklers (Figure 2).

Table 1. Single Sprinkler Mock Chemigation Test for BHFW Control. Arm file BHFW Chemigation 1 2012			
Treatment	Total Alive Blackheaded Fireworm Larvae #/5 Sweeps		
	8/27/2012	8/31/2012	Total
Control	6.8	2.5	9.3
Delegate 6 oz/ac 1 minute charge; 2 minutes injection; 13 minutes washoff	0	0	0
Delegate 6 oz/ac 5 minute charge; 10 minutes injection + washoff	0	0	0
Intrepid 16 oz/ac 1 minute charge; 2 minutes injection; 13 minutes washoff	0.3	0	0.3
Intrepid 16 oz/ac 5 minute charge; 10 minutes injection + washoff	0.3	0	0.3
LSD (P=.05)	2.5	1.19	2.61
Treatment Prob(F)	0.0002	0.0019	0.0001

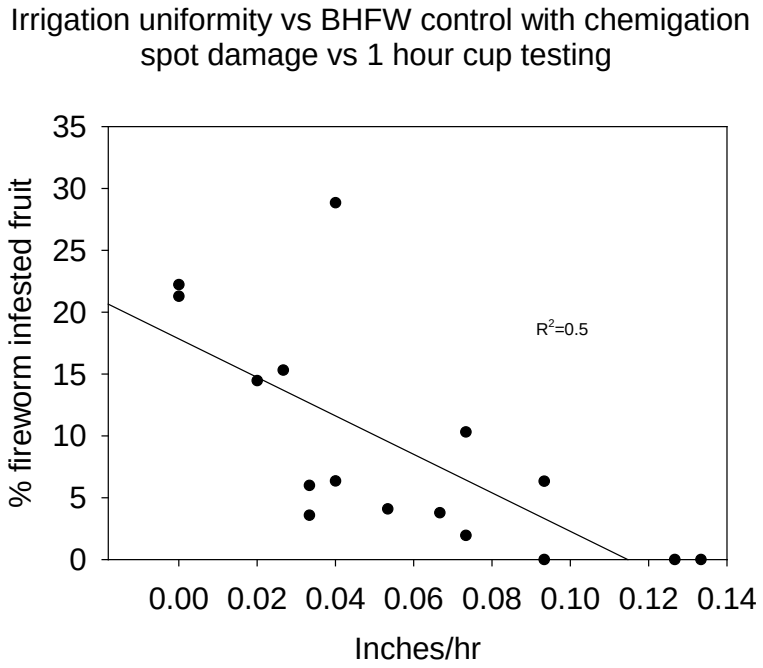


Figure 1. Fireworm infestation as function of sprinkler coverage within a bed.

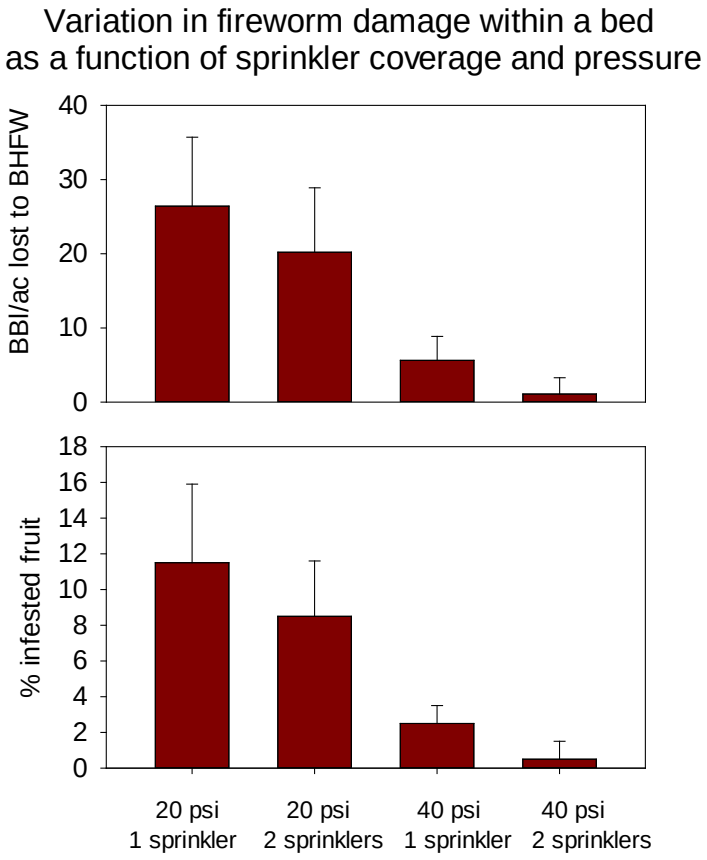


Figure 2. Fireworm infestation and crop lost to fireworm as function of sprinkler coverage and pressure within a bed.

Objective 2: Assess whole farm implications of a reduced-risk insect control program

Methods. Efficacy trials of reduced risk insecticides for first and second generation fireworm were conducted across replicated small plots within farm beds. Treatment were applied using spray volumes to mimic chemigation. Efficacy was monitoring with post-treatment sweeping for larvae. Additional work was conducted across whole beds or whole farms. Three programs were compared – organic beds (Multiple application of Entrust by hand), reduced risk beds (various combination of Altacor and Intrepid), convention beds (Diazinon and Lorsban). Treatments were pair using adjacent farms or beds. Data were collected by post-treatment sweeping, fruit damage assessment and trap counts.

Results:

First Generation: In research trials during first generation on small replicated plots, there was no difference in efficacy between different timings of Altacor and Intrepid (1st larvae notice vs. peak larvae) (Tables 2 & 3). Both Altacor and Intrepid performed equally. In whole bed chemigation trials Intrepid and Altacor were better than Lorsban or Delegate (Tables 4 & 5).

Second Generation Ovicides: The efficacy of insecticides targeting newly laid eggs was assessed on two farms. Treatments were applied at first significant moth flight recorded in pheromone traps on the beds. Efficacy was based on sweeping during peak larvae hatch. Altacor, HGW 86 and Intrepid all had ovicidal properties and prevented egg hatch (Tables 5 & 6). Treatments provided efficacy 4 to 6 weeks post treatment. There was no statistical differences between insecticide treatments, but Altacor was lowest larvae counts for both sweeping times on both farms.

Season-Long Fireworm Trap Counts as a Function of Insecticide Program. Season-long trap counts were monitored across farms in Long Beach. Data across conventional, reduced risk and organic beds were averaged. Results suggest no differences between reduced risk conventional programs, but higher overall numbers in organic beds (Figure 3). Discrete comparisons were also made between beds within a farm that had different management tactics. On Farm 1, Altacor applied during the first significant moth count resulted in lower moth counts than larvicide timings of Altacor or Intrepid (Figure 4). This held until mid–August. On Farm 2, the opposite trend occurred. A mid-July Altacor treatment provided season-long suppression of fireworm moths. Overall, these data suggest that reduced risk insecticides are comparable to conventional, but the ideal timings for season-long suppression of egg-hatch with minimal applications have yet to be worked out. Beds were also monitored for beneficial insect populations (spider and wasps) while sweeping for fireworm. There were no significant trends noted between treatments.

Table 2. Effect of Larvicide Timing on Control of First Generation Fireworm in Long Beach WA 2012
(ARM file BHFW 1 2012)

	Blackheaded Fireworm Larvae /10 Sweeps				
	# Dead	# Alive	# Dead	#Alive	Total Alive
Treatment	5/17/2012		5/26/2012		5/17 + 5/26
Control	0	26.3	0	6.75	33.3
Altacor 4 oz/ac 5/10/12 1st larvae	20.7	0.3	0.083	0.083	0.3
Altacor 4 oz/ac 5/14/12 Peak larvae	37.3	0	2.25	0	0
Intrepid 16 oz/ac 5/14/12 Peak Larvae	30	0	1.083	0.167	0
LSD (P=.05)	17.7	12.6	3.0	1.3	14.8
Treatment Prob(F)	0.009	0.005	0.3	0.0001	0.003

Table 3. Comparison of Larvicides and Larvicide Timing for Control of First Generation Fireworm in Whole Farm Beds in Long Beach WA 2012 (ARM file)BHFW Farms Beckerle 2012)

	Blackheaded Fireworm Larvae /10 Sweeps *				
	# Dead	# Alive	# Dead	#Alive	Total Alive
Treatment	5/18/2012		5/25/2012		5/18 + 5/25
Lorsban 3 pt/ac 5/15/12	1.25±0.7	7.5±2.6	0	5.25±0.7	12.75±3.1
Intrepid (Peak Larvae) 16 oz/ac 5/14/12	4.25±0.6	0	0.5±0.5	0	0
Altacor 4 oz/ac 5/10/12 (1st larvae)	3±1.9	0.25±0.2	0	0	0.25±0.2
Altacor 4 oz/ac 5/14/12 (peak larvae)	5.75±1.2	0	0.5±0.3	0	0
*mean±standard error					

Table 4. Comparison of Larvicides for Control of First Generation Fireworm in Whole Farm Beds in Long Beach WA 2012 (ARM file BHFW Farms Johnson 2012)

	Blackheaded Fireworm # /10 Sweeps *	
	Dead	Alive
Treatment - applied 5/12/12	5/17/2012	5/17/2012
Lorsban 2.4 pt/ac	3.75±1.4	2±1.0
Intrepid 16 oz/ac	6.5±1.5	0
Altacor 4 oz/ac	4±1.0	0
Delegate 6 oz/ac	4.75±1.1	1.75±0.5
*mean±standard error		

Table 5. Comparison of Ovicidal Properties of Reduced Risk Insecticides for Control of Second Generation Fireworm at Farm 1 in Long Beach WA 2012 (ARM file BHFW 2 2012 Charlie's)

	Blackheaded Fireworm Larvae (# Alive/Sweeps)								
	Small	Medium	Large	Total	Small	Medium	Large	Total	Total
Treatment	7/23/2012				8/3/2012				7/23+/8/3
Control	0.3	5.3	1.7	7.3	0.3	1	2	3.3	10.7
Altacor 4 oz/ac 6/11	0	0.3	0.3	0.7	0	0.7	0.7	1.3	2
HGW 86 10.1 oz/ac 6/11/12	0	1.3	0.3	1.7	0	0.7	0.3	1.0	2.7
Intrepid 16 oz/ac 6/11/12	0.3	2.3	1	3.7	0	1.3	2.3	3.7	7.3
LSD (P=.05)	0.9	3.4	1.6	5.3	0.6	3.4	3.9	6.4	7.3
Treatment Prob(F)	0.6	0.05	0.2	0.08	0.4	0.9	0.5	0.6	0.07
Treatments applied 6/11/12 110 gpa at first significant moth flight recorded in pheromone traps									

Table 6. Comparison of Ovicidal Properties of Reduced Risk Insecticides for Control Of Second Generation Fireworm at Farm 2 in Long Beach WA 2012 (ARM file BHFW 2 2012 2012 Normadin)									
	Blackhead Fireworm Larvae # /5 Sweeps								
	Small	Medium	Large	Total	Small	Medium	Large	Total	Total
Treatment	7/16/2012				7/23/2012				7/16+7/23
Control	33.5	8	4.5	46	7.5	30	5.5	44	90.0
Altacor 4 oz/ac 6/29/12	2	0	0	2	0	0	0	0.3	2.3
HGW 86 10.1 oz/ac 6/29/12	7.3	0.3	0	7.5	3.3	1.8	1.5	8.3	15.8
Intrepid 16 oz/ac 6/29/12	3.8	0.3	0	4	1	0.5	0.3	2.5	6.5
LSD (P=.05)	24.3	6.8	5.6	31.6	7.6	28.3	5.0	38.3	68.6
Treatment Prob(F)	0.05	0.06	0.2	0.03	0.2	0.1	0.1	0.05	0.05
Treatments applied 6/29/12 110 gpa at first significant moth flight recorded in pheromone traps									

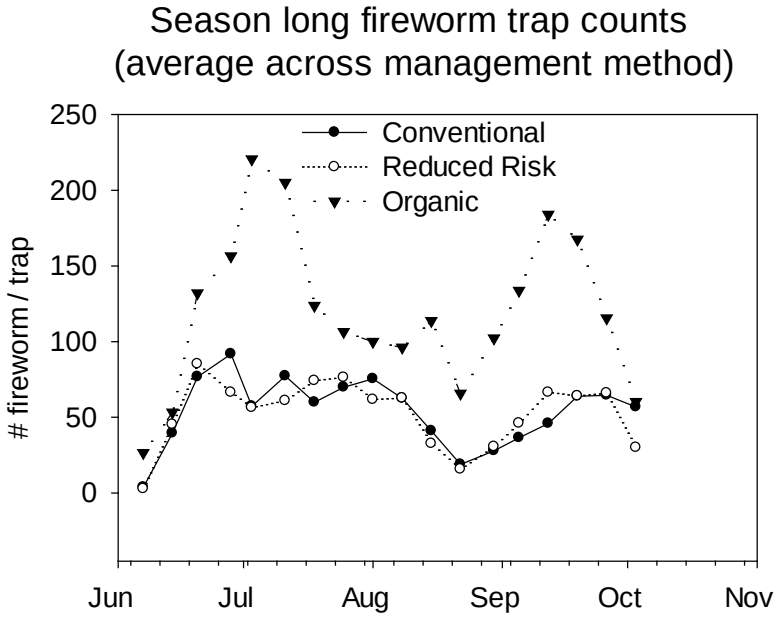
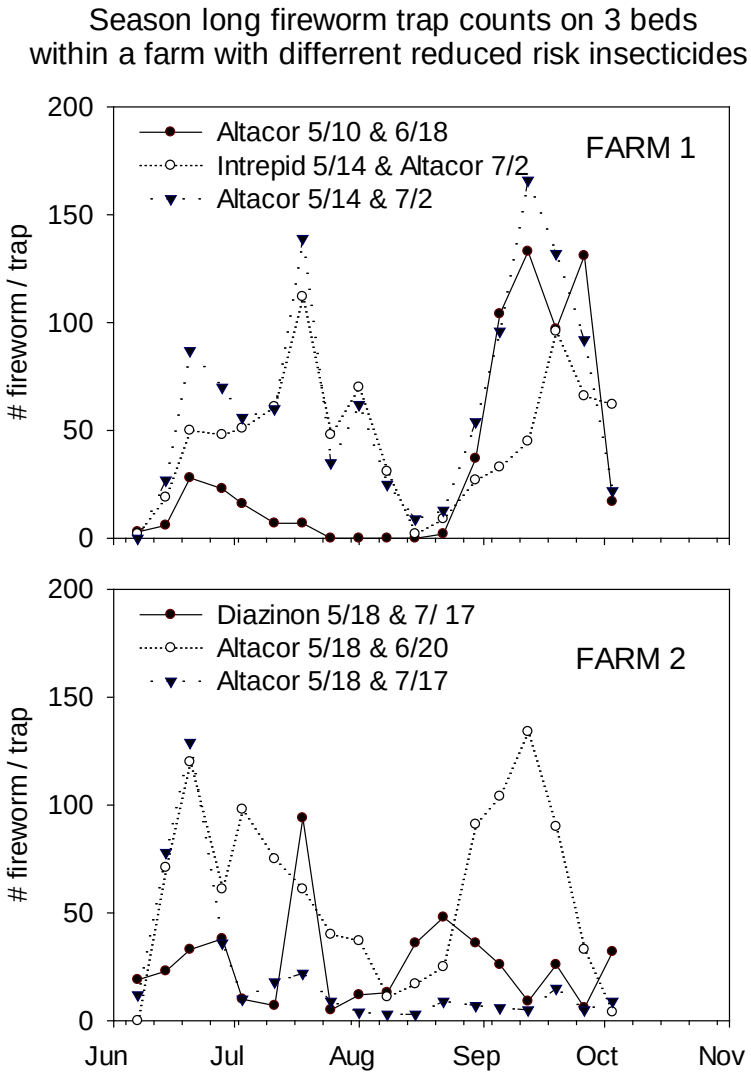


Figure 3. Mean blackheaded fireworm counts per trap in 2012 as a function of insecticide program (N=8 beds for conventional and reduced risk treatments, 4 beds for organic).

Figure 4. Blackheaded fireworm counts per trap in 2012 as a function of an insecticide program within individual beds on a farm.



Objective 3: Assess if carbaryl has blossom or fruit thinning effects in cranberries.

Methods: A five-year old Grygleski bed was sprayed with carbaryl at full bloom, fruit set and 10 days after fruit set (3 replicated 6' by 6' plots). Fruit set was measured in early August by counting the number of fruit and pedicels per upright on 27 random upright per plot.

Results: A carbaryl spray during full bloom reduced fruit set compared to post-set sprays, but not compared to the control (Table 8). There were post-set timing effects on fruit set. There were no treatment effects on yield. Concern about the use of carbaryl for tipworm control after fruit set appears to be unwarranted.

Table 8. Effect of timing of carbaryl during bloom and fruit set on fruit set and yield of Grygleski cranberries in 2012. Arm file carbaryl 1 2012

Treatment	% Fruit set	Yield (bbl/ac)
Carbaryl 2.5 lbs/ac 6/11 - full bloom	38	187
Carbaryl 2.5 lbs/ac 7/2 - fruit set	47	167
Carbaryl 2.5 lbs/ac 7/12 10 days post-fruit set	47	158
Control	44	175
LSD (P=.05)	7	83
Treatment Prob(F)	0.05	0.8

Objective 4 – Evaluate indaziflam herbicides for cranberry weeds control

Methods**:** Eleven replicated trials were conducted in Long Beach WA in 2012 on young or established cranberry beds. Treatments included comparisons with standard and other new herbicides, plus untreated control. Plot sizes ranged from 3'by 6' to 6' by 6'. Spray volume was 30 GPA, unless otherwise specified. Plots were rated for percent control or coverage for specific weeds on the trial sites several times during the growing season. The genus and species of common weed names used in this report are provided in the last table. Crop yield and phytotoxicity data were collected on plots that had cranberry vines. Crop destruction of treated fruit was done on all treatment sites.

Results:
Weed control - grasses. Across all rates and timings, indaziflam provided excellent season-long control of annual bluegrass, barnyard grass, velvet grass, fescue, sweet vernal, bent grass, and reed canary grass (Tables 9b, 10, 12, 13b, 13c, 14). Control was superior to Casoron at the 2 or 4 lb ai/ac rate. There was no control of salt grass (Table 13c).

Weed control - annual broadleaves. Indaziflam provided excellent season-long control of Marsh St John's Wort, pearly wort, fireweed, cleavers and cudweed (Tables 9a, 9b, 10, 11, 12, 13e, 14, 15)

Weed Control – biennial and perennial broadleaves. Indaziflam provided no or poor control of silverleaf, yellowweed, horsetail, buttercup, false dandelion, false lily of the valley, sour dock and silverleaf (Tables 9a, 10b, 11, 13a, 13d, 13f, 14, 16, 19). It provided good control of the legumes lotus and white clover (Tables 9b, 13a). More research is required to discern the difference between seedling control and established plant control of these two legumes. Similarly there may be some suppression of sour dock, but this was likely for seedlings, not established plants.

Weed control – rushes and sedges. There was no control of established perennial rushes (slender rush and spike rush), but the annual rush, toad rush, was controlled season-long at the lowest rate of indaziflam. Pointed broom sedge was not controlled (Tables 9b, 11, 13c, 16).

Weed control – seedling trees. Willows coming up from seed were controlled with indaziflam, but alder was not controlled. This data set is weak and more trials targeting these important cranberry weeds are needed (Table 9b).

Crop safety- Across all sites or bloom density, rates and timings used in these trials, there was no effect of indaziflam on cranberry vines (phytotoxicity rating) or yield (crop rating or picked bbl/ac) (Tables 9b, 13f, 15, 16). This included a carry-over effect on yield in 2012 from vines treated in 2010 (Table 17). A slight discoloration of new growth was observed on one site at one observation (Table 19). This may or may not have been an outlier. Because of crop destruct concerns, trials on crop safety were limited and need to be repeated.

Horsetail Wiping with Roundup. There was no difference in surfactant treatments on the burndown of horsetail with Roundup (Table 20). Both LI700 and Syltac had similar results. No comparisons were made to Roundup alone. Neither treatment appeared to be a superlative treatment for horsetail suppression.

Summary**:** With the timings done in these experiments, indaziflam provided excellent season-long control of a range of important cranberry weeds and appeared to have no negative impact on growth or yield. This was observed at rates well above label. This is in contrast to earlier studies done in 2010 and 2011, when applications were made after the start of new growth in cranberries and crop damage resulted.

Based on these data, indaziflam fits an important niche in cranberry herbicides and could become a very important tool for providing season-long control of many important weed species. Additional research with indaziflam with focus on collecting more crop safety data, efficacy at lower rates, and use on new and young plantings is planned.

Table 9a. Comparison of Liquid Casoron and Indaziflam for Weed Control and Crop Safety in Cranberries (Arm file indaz cas comp 2 2012)

	Horsetail							Fireweed
	Farm 1	Farm 2	Farm 3	Farm 4	Farm 1	Farm 2	Farm 3	Farm 1
	6/15/12	6/22/12	6/22/12	6/25/12	8/8/12	8/9/12	8/13/12	8/13/12
Treatment	% Coverage	% Control			% Coverage			
Control	53	0	0	2	58	30	53	7
Casoron SC 2 lb ai/a	0	85	15	97	37	22	20	0
Indaziflam 6.5 oz/a	13	10	76	47	77	33	23	0
LSD (P=.01)	38	42	50	57	112	35	88	6
Treatment Prob(F)	0.006	0.001	0.005	0.	0.3	0.3	0.3	0.01

	Yellowweed					Sour Dock		
	Farm 1	Farm 2	Farm 3	Farm 1	Farm 2	Farm 1	Farm 1	Farm 2
	6/15/12	6/22/12	6/22/12	8/8/12	8/9/12	6/15/12	8/13/12	8/8/12
Treatment	% Coverage	% Control		% Coverage				% Coverage
Control	40	0	0	52	53	80	12	83
Casoron SC 2 lb ai/a	25	36	37	50	60	47	15	90
Indaziflam 6.5 oz/a	18	12	7	47	53	25	0	58
LSD (P=.01)	42	49	73	95	66	124	62	86
Treatment Prob(F)	0.2	0.06	0.1	0.9	0.9	0.2	0.5	0.3

Treatments were applied 3/30/12 or 4/2/12 on four different grower beds.

Table 9b. Comparison of Liquid Casoron and Indaziflam for Weed Control and Crop Safety in Cranberries (Arm file indaz phyto 1 2012)

	Lotus			St John's Wort			Slender Rush	Pearly Wort
	Farm 1	Farm 1	Farm 2	Farm 1	Farm 2	Farm 1	Farm 1	Farm 1
	6/22/12	8/8/12	8/8/12	6/22/12	8/13/12	8/8/12	6/22/12	8/13/12
Treatment	% Control	% Coverage		% Control	% Coverage			
Control	0	48	53	0	12	20	0	40
Casoron SC 2 lb ai/a	40	9	7	7	20	18	35	11
Indaziflam 6.5 oz/a	100	4	2	99	3	1	27	0
LSD (P=.01)	113	61	78	11	37	31	98	785
Treatment Prob(F)	0.03	0.05	0.07	0.0001	0.2	0.08	0.3	0.2

	Fescue	Annual Bluegrass		Velvet Grass Seedlings	Cleavers	Pointed Broom Sedge		
	Farm 1	Farm 1	Farm 2	Farm 3	Farm 1	Farm 1	Farm 2	Farm 3
	6/25/12	6/25/12	6/25/12	8/23/12	8/8012	6/14/12	6/22/12	8/23/12
Treatment	% Control			% Coverage	% Control			% Coverage
Control	0	0	0	80	0	0	0	58
Casoron SC 2 lb ai/a	58	67	55	72	17	100	17	63
Indaziflam 6.5 oz/a	100	100	90	0	83	87	93	8
LSD (P=.01)	64	13	8	93	67	50	58	56
Treatment Prob(F)	0.004	0.0001	0.0001	0.03	0.009	0.001	0.003	0.01

	Willow	Crop Phytotoxicity Rating 1=none, 5=severe		Yield (bbl/ac)	
	Farm 3				
	8/24/12	Farm 1	Farm 2	Farm 3	
Treatment	# Plants/ 36 ft^2	6/25/12	8/22/12		
Control	5	1	1	21	
Casoron SC 2 lb ai/a	2	2	1	44	
Indaziflam 6.5 oz/a	0	1	1	64	
LSD (P=.01)	8	1	0	43	
Treatment Prob(F)	0.3	0.004	1	0.1	

Table 10. Annual Bluegrass and St. John's Wort Weed Control in Alleyways between Cranberry Varieties Trial (ARM File pre emergent 2 2012)					
Treatment	Annual Bluegrass			St John's Wort	
	6/20/12	8/10/12	9/28/12	8/10/12	9/28/12
	% Coverage				
Indaziflam 5 oz/a	0	1	4	0	0
Indaziflam 10 oz/a	0	0	2	0	0
Casoron SC 1 lb ai/a	2	15	46	3	8
Casoron SC 2 lb ai/a	4	19	61	2	8
Casoron SC 3 lb ai/a	5	13	72	3	8
Casoron SC 4 lb ai/a	4	19	37	4	14
Control	24	74	100	4	16
LSD (P=.05)	10	23	21	2	6
Treatment Prob(F)	0.0004	0.0001	0.0001	0.0004	0.0001

Table 11. Comparisons of Casoron Formulations with Indaziflam for Cranberry Weed Control (ARM File Liquid Casoron 1 2012)							
Treatment	Horsetail		St John's Wort				Toad Rush
	4/3/12	8/9/12	6/15/12		8/8/12		6/15/12
	% Coverage		% Control		% Coverage		% Control
Control	78	93	0	0	87	87	0
Casoron SC 2 lb ai/a Nov 16	18	13	63	0	55	50	0
Casoron SC 2 lb ai/a March 21	0	4	100	0	23	22	0
Casoron SC 2 lb ai/a Nov 16 + Mar 21	0	3	95	65	58	8	50
Casoron 4G 2 lb ai/a March 21	15	10	98	80	40	29	100
Indaziflam 5 oz/a	90	80	90	95			100
LSD (P=.05)	25	13	54	25	57	43	74
Treatment Prob(F)	0.001	0.001	0.02	0.001	0.2	0.02	0.03

Table 12. Carryover Effect of Indaziflam on Control of Annual Bluegrass and Cudweed. (ARM File New herbicide indaz 1 2011)

	Annual Bluegrass		Cudweed	
	% Coverage			
Treatment	9/1/2011	8/13/2012	6/25/2012	8/13/2012
Control	60	22	27	28
indaziflam 3/14/11 @ 5 oz ai/a 30 gpa	2	23	2	20
indaziflam 3/14/11 @5 oz ai/a 400 gpa	2	11	1	4
indaziflam 11/8/11 @5 oz ai/a 30 gpa	62	13	4	0
indaziflam 11/8/11 @5 oz ai/a 400 gpa	57	12	1	2
LSD (P=.05)	35	22	22	19
Treatment F	9	1	3	5
Treatment Prob(F)	0.005	0.6	0.1	0.04

Table 13a. Comparison of Indaziflam Rate and Timing to Liquid Casoron for Weed Control in Cranberries (ARM File Preemergent 1 2012)

	Lotus			White Clover		Buttercup	False Dandelion	
	% Cover			% Control	% Coverage	% Coverage	% Control	% Coverage
	4/12/12	4/30/12	8/9/12	4/27/12	8/8/12	4/12/12	4/27/12	8/8/12
Treatment	Farm 1	Farm 2	Farm 1	Farm 3	Farm 3	Farm 2	Farm 3	Farm 3
Control	65	77	82	0	33	32	0	27
Indaziflam 5 oz/ac Feb + March	0	0	5	67	0	1	0	31
Indaziflam 6.5 oz/ac Mar	11	2	10	67	7	17	0	35
Casoron SC 2 lbs ai/ac	39	43	83	0	22	9	50	18
LSD (P=.05)	40	46	29	88	18	20	0	42
Treatment Prob(F)	0.02	0.02	0.0008	0.2	0.01	0.05	1	0.8

Table 13b. Comparison of Indaziflam Rate and Timing to Liquid Casoron for Weed Control in Cranberries (ARM File Preemergent 1 2012)								
	Reed Canary Grass	6 Weeks Fescue	Barnyard Grass				Sweet Vernal Grass	Willow Seedlings
	Farm 1	Farm 1	Farm 1	Farm 2	Farm 3	Farm 4	Farm 3	Farm 4
	% Control		% Coverage					#/Plot
Treatment	4/26/12	4/26/12	7/31/12	7/31/12	8/9/12	8/8/12	8/8/12	8/24/12
Control	0	0	78	15	63	83	77	17
Indaziflam 5 oz/ac Feb + March	42	100	3	0	0	2	0	2
Indaziflam 6.5 oz/ac Mar	87	100	5	0	0	10	0	7
Casoron SC 2 lbs ai/ac	32	33	20	3	17	18	67	16
LSD (P=.05)	81	58	15	13	44	25	32	12
Treatment Prob(F)	0.2	0.01	0.0001	0.08	0.04	0.001	0.001	0.06

Table 13c. Comparison of Indaziflam Rate and Timing to Liquid Casoron for Weed Control in Cranberries (ARM File Preemergent 1 2012)

	Bentgrass	Annual Bluegrass	Salt Grass		Toad Rush			Spike Rush
	% Control		% Coverage		% Control			% Coverage
	Farm 1	Farm 2	Farm 3	Farm 4	Farm 5	Farm 6	Farm 7	Farm 7
Treatment	4/26/12	4/27/12	8/8/12	8/8/12	4/27/12	4/26/12	8/9/12	7/31/12
Control	0	0	50	38	0	0	0	13
Indaziflam 5 oz/ac Feb + March	100	100	29	60	100	100	100	5
Indaziflam 6.5 oz/ac Mar	95	92	48	30	100	100	100	12
Casoron SC 2 lbs ai/ac	1	50	49	33	58	17	57	2
LSD (P=.05)	10	48	40	59	52	29	40	15
Treatment Prob(F)	0.0001	0.007	0.7	0.6	0.009	0.0002	0.003	0.3

Table 13d. Comparison of Indaziflam Rate and Timing to Liquid Casoron for Weed Control in Cranberries (ARM File Preemergent 1 2012)

	Horsetail					Sour Dock		
	% Control		% Cover			% Control		% Coverage
	Farm 1	Farm 2	Farm 2	Farm 3	Farm 1	Farm 1	Farm 2	Farm 1
Treatment	4/26/12		8/8/12			4/27/12	4/26/12	8/8/12
Control	0	0	55	57	67	0	0	80
Indaziflam 5 oz/ac Feb + March	52	0	58	13	35	82	50	8
Indaziflam 6.5 oz/ac Mar	0	0	65	12	40	33	93	10
Casoron SC 2 lbs ai/ac	67	52	38	1	47	85	33	63
LSD (P=.05)	63	45	39	12	79	63	54	32
Treatment Prob(F)	0.08	0.07	0.4	0.0001	0.8	0.04	0.03	0.003

Table 13e. Comparison of Indaziflam Rate and Timing to Liquid Casoron for Weed Control in Cranberries (ARM File Preemergent 1 2012)

	% Coverage Western St John's Wort							
	Farm 1	Farm 2	Farm 3	Farm 4	Farm 1	Farm 2	Farm 3	Farm 4
Treatment	7/31/12				8/9/12			
Control	52	67	52	98	67	70	83	100
Indaziflam 5 oz/ac Feb + March	0	0	27	3	0	0	10	3
Indaziflam 6.5 oz/ac Mar	0	5	10	7	0	5	25	4
Casoron SC 2 lbs ai/ac	5	18	67	43	25	22	90	32
LSD (P=.05)	39	30	46	12	50	36	25	7
Treatment Prob(F)	0.05	0.006	0.08	0.0001	0.05	0.01	0.0004	0.0001

Table 13f. Comparison of Indaziflam Rate and Timing to Liquid Casoron for Weed Control in Cranberries (ARM File Preemergent 1 2012)

	% Coverage Yellowweed					Crop phytotoxicity rating 1=none, 5=severe	Estimated crop 1=0 bbl/ac, 5= 200 bbl/ac
	Farm 1	Farm 1	Farm 2	Farm 2	Farm 3		
Treatment	4/30/12	8/9/12	7/31/12	8/9/12	8/8/12	8/8/12	8/8/12
Control	13	10	13	30	13	1	1.2
Indaziflam 5 oz/ac Feb + March	26	92	4	2	10	1	1.8
Indaziflam 6.5 oz/ac Mar	37	77	4	5	2	1	1.3
Casoron SC 2 lbs ai/ac	28	4	20	18	8	1	1.3
LSD (P=.05)	62	34	31	32	14	0	1
Treatment Prob(F)	0.8	0.001	0.5	0.3	0.3	1	0.1

Table 14 Efficacy comparison between indaziflam and Casoron formulations (Arm file Indaz Cas compare 1 2012)								
	Horsetail		Western St. John's Wort		Toad rush	Mixed Grass Seedlings	Barnyard Grass	Velvet Grass
	4/11/12	6/12/12	6/12/12	6/12/12	8/8/12	6/12/12	8/8/12	8/8/12
Treatment	% Cover	% Control						
Control	53	0	0	0	0	0	0	0
Casoron SC 2 lb ai/ac	0	88	60	93	25	88	9	23
Casoron 4G 2 lbs ai/ac	0	96	96	83	0	96	33	30
Indaziflam 6.5 oz/ac (320gpa)	23	68	100	100	96	100	93	81
LSD (P=.05)	29	20	47	28	52	18	70	66
Treatment Prob(F)	0.01	0.0001	0.006	0.0001	0.01	0.0001	0.06	0.1

Table 15. Crop Safety Study of a High Rate of Indaziflam as a Function of Time of Application. (ARM file indaz phyto 1 2012)							
	St John's Wort	Fescue	Crop Phytotoxicity Rating 1= None, 5=Severe			Yield (bbl/ac)	
	% Coverage						
	8/13/2012		6/23/12		8/13/12		
Treatment	Grygleski		Stevens	Grygleski		Stevens	Grygleski
Control	7	18	1	1	1	4	5
Indaziflam 10 oz/ac 2/20/12	2	0	1	1	1	3	5
Indaziflam 10 oz/ac 3/20/12	4	1	1	1	1	4	5
Indaziflam 10 oz/ac 4/6/12	2	0	1	1	1	3	4
LSD (P=.05)	6	15	0	0	0	1	1
Treatment Prob(F)	0.2	0.02	1	1	1	0.4	0.2

Table 16. False Lily of the Valley Control with Indaziflam (ARM File Lily 1 2012)			
	False Lily-Of-The-Valley		Yield
	% Control	% Stalks in Bloom	Bbl/Ac
Treatment	6/14/2012		9/11/2012
Control	0	33	16
Indaziflam 5 oz/ac	10	43	12
Indaziflam 10 oz/ac	0	57	19
Indaziflam 20 oz/ac	43	68	7
Mat 28 1 0z/ac	28	70	0
LSD (P=.05)	54	96	16
Treatment Prob(F)	0.3	0.9	0.2

Table 17. Crop Safety Study of Indaziflam on Cranberry – Carryover Effect (Arm file new herbicide indaz 5 2011).				
	crop phytotoxicity rating 1=none, 5=severe		yield (bbl/ac)	
Teatment	9/2/2011	8/13/2012	2011	2012
Control	1	1	135	67
indaziflam 5 oz/ac 3/14/12	1	1	115	97
LSD (P=.05)	0	0	81	70
Treatment Prob(F)	1	1	0.4	0.2

Table 18. Sour Dock Control with Combination of Stinger and Indaziflam. (ARM file Sourgrass 2 2012)							
	% Coverage Sour Dock					Ease Of Sour Dock Pulling 1=Hard, 5= Easy	Cranberry Phytotoxicity Rating 1=None, 5= Severe
	4/26/12	6/14/12	8/7/12	6/15/12	8/8/12	6/14/12	
Treatment	Farm 1			Farm 2		Farm 1	
Control	100	100	63	17	70	4	1
Stinger 8 o/ac + indaziflam 5 oz/ac 3/8/12	52	20	42	10	17	2	1
Stinger 8 oz/ac 1/10/12 + 3/8/12 + indaziflam 5 oz/ac 3/8/12	75	23	60	1	10	1	1
Stinger 8 oz/ac 1/10/12 + Casoron SC 2 lb ai/ac 3/8/12	57	25	28	2	23	1	1
LSD (P=.05)	49	14	34	6	47	1	0
Treatment Prob(F)	0.2	0.0001	0.1	0.003	0.07	0.004	1

Table 19. Silverleaf Control with Indaziflam. (ARM File Silverleaf 1 2012)			
	Silverleaf		Cranberry Phytotoxicity Rating
	% Control	% Coverage	
Treatment	6/14/12	8/8/12	6/14/12
Curio 1 oz/ac	82	55	1
Indaziflam 6.5 oz/ac	17	15	2
Quinclorac 8 oz/ac	8	8	1
Control	0	47	1
LSD (P=.05)	7	46	1
Treatment Prob(F)	0.0001	0.1	0.003

Table 20. Effect of surfactant on the efficacy of wiping horsetail with Roundup. Arm file horsetail wiping 1 2012	
Treatment	Horsetail burndown rating 1= none, 5= severe 8/24/12
Control	1
Roundup 10% + 5% LI700 7/18/12	2.3
Roundup 10% + 1% Syltac 7/18/12	2
LSD (P=.05)	0.76
Treatment Prob(F)	0.0178

Table 21. Common and latin names of weeds listed in Table 9 to 20.			
Common name	Latin name	Common name	Latin name
Annual Blueggrass	*Poa annua*	Point Broom Sedge	*Carex scoparia*
Barnyard grass	*Echinochloa crus-galli*	Reed Canary Grass	*Phalaris arundinacea*
Bent grass	*Agrostis spp.*	Salt Grass	*Distichlis stricta*
Bog St. Jon's Wort	*Hypericum*	Silverleaf	*Potentilla pacifica*
Buttercup	*Ranunculus repens*	Six-weeks Fescue	*Vulpia myuros*
Cleavers	*Galium aparine*	Slender Rush	*Juncus tenuis*
Cudweed	*Gnaphalium uliginosum*	Sour Dock	*Acetosella vulgaris*
False dandelion	*Hypochaeris radicata*	Spike rush	*Eleocharis palustris*
False Lily-of-the Valley	*Maianthemum dilatatum*	St John's Wort	*Hypericum spp.*
Fescue	*Festuca spp.*	Sweet Vernal grass	*Anthoxanthum odoratum*
Fireweed	*Epilobium angustifolium*	Toad rush	*Juncus bufonius*
Horsetail	*Equisetum arvense*	Velvet grass	*Holcus lanatus*
Lotus	*Lotus corniculatus*	White clover	*Trifolium repens*
Marsh St. John's Wort	*Hypericum virginicum*	Willow	*Salix lucid*
Pearly Wort	*Sagina procumbens*	Yellow Weed	*Lysimachia terrestris*