

Canadian Agricultural Adaptation Program (CAAP)

Project Reporting Form

The following information is to assist you with CAAP reporting requirements. If you have any questions regarding any of the sections or bullets below contact your CAAP Project Officer.

- As per the Contract Agreement, **Interim reports** require sign-off by the project manager and **Final financial reports** must be signed off by an external accountant and by two executive officers/directors of the applicant, for the full report. See also the Financial Tracking template.
- Each and every Interim Report and the Final Performance Report shall be supported by documents, including invoices, statements, and receipts as the Council may require.
- Changes to estimated project costs, movement between cost elements, project timelines, and partner revenues often occur. CAAP pre-approval is required for material changes that affect initial project objectives, budget and/or extension of the project’s term. Please contact your Project Officer as soon as you become aware of any changes.
- CAAP funding must be acknowledged on all press releases, public announcements and promotional materials related to the project/activity, and with consent of Council. Logos are available from our office at (866) 955-3714 or by email at caap-pcaa@agfoodcouncil.com. Copies of all such materials must be provided to CAAP prior to release to ensure that proper acknowledgement has been expressed.
- **Please note that this is a CONFIDENTIAL REPORT and results are not to be shared outside of funding agencies, as there is patentable information contained within this report.**
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Project Title	Field Proofing the Use of Plant Hormones to Increase Canola, Wheat and Pea Yields – Component 1		
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Project Start Date	February 21, 2012	Project End Date	November 30, 2013
Report Due Date	December 31, 2013	Reporting Period included in report	February 21, 2012 to December 31, 2013

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Final Report Performance story:

With global warming, heat stress-induced flower and fruit loss will become a greater problem in the major canola, wheat and pea growing regions of Canada; therefore, to safeguard future crop yield, agronomic practices need to be identified to increase heat stress tolerance. This project investigated the development of methods to increase pod/seed/fruit retention leading to increased seed yield in canola, pea, and wheat under field conditions by application of potential innovative crop enhancement products. The goals were to determine the optimal concentration of two crop enhancement products for increasing seed yields under field conditions, to understand how these products perform in various ecological area of Western Canada, to understand the mechanism by which increased yield is achieved by these products, and determine if seed quality parameters are affected by product application. Our 2012 and 2013 field season data indicate that our two crop enhancement treatments (4-Cl-IAA and 4-Me-IAA) can be use as a tool to increase seed yield and ameliorate heat stress in pea, canola and wheat crops without compromising seed quality. Additional field trials will be important to confirm these results and to fine-tune the use of these crop enhancement treatments under various ecological regions.

<p>Project Summary/Objectives</p>	<p>This collaborative project investigated the development of methods to increase pod/fruit retention leading to increased seed yield in canola, pea, and wheat under field conditions by application of potential innovative crop enhancement products (plant growth regulators).</p> <p>Deliverables: Chemical(s)/hormones that can be applied to the crop to increase pod/seed head retention leading to increased canola, wheat and pea seed yield in the field. More specifically we will:</p> <ol style="list-style-type: none">1) Fine-tune the optimum hormone or hormone analog concentrations to use under field conditions.2) Understand the hormone response in various ecological areas of Western Canada.3) Further understand the mechanism by which increased yield is achieved (i.e. increased pod/spike number; seeds per pod/spike; increased seed size).4) Understand if hormone treatments affect seed quality parameters including seed size, protein (wheat) and oil (canola) content.
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Methods and Results:

In preparation for the field studies, greenhouse studies were conducted to identify the optimum crop stage for applying the hormone treatments to canola, pea and wheat. Based on the greenhouse study findings, we applied the hormone treatments in the field at the following stages:

Canola – Between BBCH stage 50-52 (Stage 50: Flower buds present, still enclosed by leaves; Stage 52: Flower buds free, level with the youngest leaves)

Wheat – Between BBCH stage 43-45 (Stage 43: most mature tiller on plant is at Mid boot stage: flag leaf sheath just visibly swollen; Stage 45: Late boot stage: flag leaf sheath swollen)

Pea – Between BBCH 50 (When floral buds are observable within stipule leaves, but not beyond the stipule leaves).

- The cultivars used in this study were: for canola, ‘Canterra 1852H’ (Round-up Ready) in 2012, and ‘SY4114’ (Round-up Ready) in 2013 (as the Canterra 1852H was not available for our use in 2013; for pea, ‘Carneval’; for wheat, 5604HR.
- Field studies were conducted in Red Deer, Calgary, Regina and Saskatoon to test four concentrations of 4-Me-IAA and four concentrations of 4-Cl-IAA on their ability to increase seed yield and ameliorate heat stress-induced seed yield losses in canola, wheat and pea crops. Each crop was planted in a randomized complete block design with 4 plot replications in 2012 and 6 plot replications in 2013. Instead of changing the timing of hormone application over the study (to fine-tune optimal stage for hormone application in the field), the same timing and hormone concentration range was used in 2012 and 2013 to test for reproducibility of effects over years. In 2012 and 2013, all four sites were planted for each crop. For seed yield calculations, the final plot size was measured for each plot after plot trimming, and the plant density per plot was estimated by counting the number of plants (pea and canola; and number of spike for wheat) in 1 meter from 5 inner rows per plot. Seed subsamples from the plots of all three crops were collected to estimate seed dockage and 1000 kernel weight (KWT) for each plot. For seed quality analysis, Near Infrared Reflectance spectroscopy (NIR) was used to determine oil seed content for canola seed and for protein content in wheat grains.
- Component analyses: From the field plots, samples were collected to conduct a yield component analysis. In canola this involved sampling five plants per plot, and determining the plant height, number of racemes per plant, and number of pods per plant. In wheat this involved sampling ten plants per plot, and determining the number of spikes per plant, weight per spike, number of seeds per spike, plant height, and plant dry weight. In pea this involved sampling five plants per plot, and determining the plant height, the number of pods per plant, and the number of seeds per plant.
- An ANOVA analysis was performed on seed yield data within each year (2012 and 2013) and location (Calgary, Red Deer, Regina, Saskatoon) using the MIXED procedure of SAS. A covariance model was used to analyze yield with treatments as the main effect and the number of plants per m² (in pea and canola) and number of spikes per m² (in wheat) as covariates. Replicate (4 in 2012 and 6 in 2013) was included as a random effect in the model. Statistical significance was declared at P≤0.05. Mean separation is by the least significant difference test (LSD), where the probability (P) level of significance is given for the respective comparisons.
- An ANOVA analysis was performed on plant component data within each year (2012 and 2013) and location (Calgary, Red Deer, Regina, Saskatoon). Treatment combinations (10) were the main effect and replicate (4 in 2012 and 6 in 2013) was the random effect using the MIXED procedure of SAS. Statistical significance was declared at P≤0.05. Mean separation is by the least significant difference test (LSD), where the probability (P) level of significance is given for the respective comparisons.
- Single degree of freedom contrasts were performed on specific treatment comparisons using the MIXED procedure of SAS.

Saskatoon Canola
Canola Dose-Response
2012 Canola variety: Canterra 1852H (Round-up Ready)
2013 Canola variety: SY4114 (Round-up Ready)

Saskatoon 2012			Saskatoon 2013		
Hormone type	Conc	Yield corrected for dockage (Kg/ha); 2012 Treatment Effect P=0.8766	Yield corrected for dockage (Kg/ha); 2013 Treatment Effect P=0.7018	2013 LSD (P) value for comparison to the control	2013 LSD (P) value for comparison to the surfactant
4Cl-IAA	1*10-4 M	2355	4465	nd	0.2473
	1*10-5 M	2414	3873	nd	nd
	1*10-6 M	2769	4497	nd	0.241
	1*10-7 M	2439	4830	0.2481	0.0932
4Me-IAA	1*10-4 M	2424	4977	0.1749	0.068
	1*10-5 M	2322	4465	nd	0.2472
	1*10-6 M	2499	4394	nd	nd
	1*10-7 M	2694	4140	nd	nd
Control	Control	2494	4037		nd
Surfactant	Surfactant	2661	3648	nd	

Summary: Saskatoon site Canola; Seed yield

- **2012 and 2013 ANOVA Treatment Effect not significant, but a trend in increasing seed yield (36% increase) with application of 4-Me-IAA at 1E-4M was observed in the Canola variety SY4114 (used in 2013) (single-degree of freedom contrast of surfactant control with 4-Me-IAA at 1E-4M, P=0.068).**
- **No plant injury effects observed with hormone treatments at any concentration in 2012 and 2013.**

The maximum day temperature at the Saskatoon site prior to the time of hormone application on the canola plots was greater in 2013 than in 2012 (see below).

Canola Saskatoon site 2012	Temperature Maximum (°C)
June 25	24
June 26	30
June 27	24
June 28	17
June 29	23
June 30	25
July 1	25
Hormone application date	

Canola Saskatoon site 2013	Temperature Maximum (°C)
June 30	25
July 1	29
July 2	30
July 3	25
July 4	26
July 5	25
July 6	18
Hormone application date	

Saskatoon site Canola Component Analyses:

Saskatoon							
Hormone type	Conc	Number of racemes per plant 2012; Treatment Effect P=0.4506	Number of racemes per plant 2013; Treatment Effect P=0.8437	Number of pods per plant 2012; Treatment Effect P=0.5847	Number of pods per plant 2013; Treatment Effect P=0.9152	Plant height (cm) 2012; Treatment Effect P=0.8444	Plant height (cm) 2013; Treatment Effect P=0.9794
4Cl-IAA	1*10-4 M	6.8	4.8	197	123	100.7	99.9
	1*10-5 M	7.0	4.7	198	108	106.4	98.8
	1*10-6 M	6.8	4.7	222	118	101.2	101.4
	1*10-7 M	6.8	4.5	208	120	99.2	99.6
4Me-IAA	1*10-4 M	7.5	4.5	225	128	102.7	100.4
	1*10-5 M	6.8	5.0	183	108	102.2	100.4
	1*10-6 M	7.5	4.7	219	113	103.6	99.9
	1*10-7 M	7.3	4.5	207	117	100.8	100.7
Control	Control	7.3	4.7	204	116	104.7	100.0
Surfactant	Surfactant	6.8	4.8	219	114	105.6	101.4

Saskatoon						
Hormone type	Conc	Seed oil content (%) 2012; Treatment Effect P=0.3232	1000KWt (g) 2012; Treatment Effect P=0.5176	1000KWt (g) 2013; Treatment Effect P=0.0088	2013 LSD (P) value for comparison to the control	2013 LSD (P) value for comparison to the surfactant
4Cl-IAA	1*10-4 M	52.50	3.55	3.56	0.0444	nd
	1*10-5 M	51.62	3.56	3.76	0.1243	0.0009
	1*10-6 M	51.44	3.55	3.62	nd	nd
	1*10-7 M	51.17	3.59	3.58	0.099	nd
4Me-IAA	1*10-4 M	51.96	3.44	3.71	nd	0.0117
	1*10-5 M	49.28	3.58	3.64	nd	0.163
	1*10-6 M	51.86	3.58	3.65	nd	0.1465
	1*10-7 M	50.76	3.58	3.58	0.099	nd
Control	Control	51.03	3.62	3.67		
Surfactant	Surfactant	51.26	3.59	3.56		

Summary: Saskatoon site Canola Component Analyses:

- In 2013, a significant increase in 1000 KWT was observed with application of 4-Cl-IAA at 1E-5M and 4-ME-IAA at 1E-4M compared to the surfactant control.
- In 2012 and 2013, hormone treatment did not significantly affect number of racemes per plant, number of pods per plants, plant height, and seed oil content (2012).

Calgary-Canola

Canola Dose-Response

2012 Canola variety: Canterra 1852H (Round-up Ready)

2013 Canola variety: SY4114 (Round-up Ready)

Hormone type	Conc	Calgary 2012			Calgary 2013		
		Yield corrected for dockage (Kg/ha); 2012 Treatment Effect P=0.6734	2012 LSD (P) value for comparison to the control	2012 LSD (P) value for comparison to the surfactant	Yield corrected for dockage (Kg/ha); 2013 Treatment Effect P=0.7362	2013 LSD (P) value for comparison to the control	2013 LSD (P) value for comparison to the surfactant
4Cl-IAA	1*10-4 M	2737	nd	nd	3285	nd	0.23
	1*10-5 M	2912	nd	nd	3311	nd	0.17
	1*10-6 M	3179	nd	0.15	3311	nd	0.17
	1*10-7 M	2895	nd	nd	3236	0.20	nd
4Me-IAA	1*10-4 M	2833	nd	nd	3341	nd	0.12
	1*10-5 M	2981	nd	nd	3346	nd	0.11
	1*10-6 M	3126	nd	0.25	3338	nd	0.13
	1*10-7 M	3187	nd	0.14	3307	nd	0.20
Control	Control	2960		nd	3435		nd
Surfactant	Surfactant	2816	nd		3098	0.03	

Summary: Calgary site Canola; Seed yield

- **2012 and 2013 ANOVA Treatment Effect not significant, but a trend in increasing seed yield (13% increase) with application of 4-Cl-IAA at 1E-6M and 4-Me-IAA at 1E-7M was observed in the Canola variety Canterra 1852H (used in 2012) (single-degree of freedom contrast of surfactant control with of 4-Cl-IAA at 1E-6M or 4-Me-IAA at 1E-7M, P<0.2). A similar trend in increasing seed yield (8% increase) with the surfactant control was observed for 4-Cl-IAA at 1E-5 and 1E-6M, and 4-Me-IAA at 1E-4M, 1E-5M and 1E-6M (P<0.2) for the canola variety SY4114 in 2013.**
- **No plant injury effects observed with hormone treatments at any concentration in 2012 and 2013.**

The maximum day temperature at the Calgary site prior to the time of hormone application on the canola plots was greater in 2013 than in 2012 (see below).

Canola Calgary site 2012	Temperature Maximum (°C)
June 22	21
June 23	19
June 24	19
June 25	24
June 26	14
June 27	21
June 28	22
Hormone application date	

Canola Calgary site 2013	Temperature Maximum (°C)
July 2	33
July 3	24
July 4	25
July 5	20
July 6	19
July 7	21
July 8	17
Hormone application date	

Calgary site Canola Component Analyses:

Calgary							
Hormone type	Conc	Number of pods per plant 2012; Treatment Effect P=0.7695	Number of pods per plant 2013; Treatment Effect P=0.7961	Number of racemes per plant 2012; Treatment Effect P=0.6865	Number of racemes per plant 2013; Treatment Effect P=0.1161	Plant height (cm) 2012; Treatment Effect P=0.3339	Plant height (cm) 2013; Treatment Effect P=0.6518
4Cl-IAA	1*10-4 M	112	131	4.8	5.2	115.9	102.0
	1*10-5 M	104	129	5.0	4.8	119.5	100.6
	1*10-6 M	102	119	5.0	5.0	114.7	99.8
	1*10-7 M	109	117	4.5	4.7	113.5	100.2
4Me-IAA	1*10-4 M	112	131	4.8	5.2	121.2	99.4
	1*10-5 M	117	119	4.5	5.2	116.3	97.5
	1*10-6 M	96	129	4.8	5.7	116.9	101.7
	1*10-7 M	110	138	5.0	5.0	116.8	102.2
Control	Control	95	125	4.5	5.2	116.5	101.6
Surfactant	Surfactant	131	111	5.3	4.8	118.2	100.2

Calgary				
Hormone type	Conc	1000KWt (g) 2012; Treatment Effect P=0.0786	1000KWt (g) 2013; Treatment Effect P=0.3365	Seed oil content (%) 2012; Treatment Effect P=0.9366
4Cl-IAA	1*10-4 M	3.41	3.83	45.15
	1*10-5 M	3.53	3.99	45.80
	1*10-6 M	3.49	3.78	45.62
	1*10-7 M	3.46	3.86	46.23
4Me-IAA	1*10-4 M	3.41	3.74	45.83
	1*10-5 M	3.35	3.82	45.49
	1*10-6 M	3.54	3.84	46.01
	1*10-7 M	3.43	3.74	45.51
Control	Control	3.33	3.82	45.94
Surfactant	Surfactant	3.53	3.84	45.85

Summary: Saskatoon site Canola Component Analyses:

- In 2012 and 2013, hormone treatment did not significantly affect number of racemes per plant, number of pods per plants, plant height, 1000 KWT, or seed oil content (2012).

Red Deer-Canola

Canola Dose-Response

2012 Canola variety: Canterra 1852H (Round-up Ready)

2013 Canola variety: SY4114 (Round-up Ready)

Red Deer			
Hormone type	Conc	Yield corrected for dockage (Kg/ha); 2012 Treatment Effect P=0.5957	Yield corrected for dockage (Kg/ha); 2013 Treatment Effect P=0.7298
4Cl-IAA	1*10-4 M	3982	1860
	1*10-5 M	3958	1801
	1*10-6 M	4203	1915
	1*10-7 M	3825	1707
4Me-IAA	1*10-4 M	4207	1737
	1*10-5 M	3894	1505
	1*10-6 M	3719	1984
	1*10-7 M	3605	1726
Control	Control	3897	2027
Surfactant	Surfactant	4380	1679

Summary: Red Deer site Canola; Seed yield

- **2012 and 2013 ANOVA Treatment Effect not significant. In 2013, the Red Deer canola site experienced major water-logging issues across the plots as well as minor hail damage.**

The maximum day temperature at the Red Deer site prior to the time of hormone application on the canola plots was similar in 2012 and 2013 (see below).

Canola Red Deer site 2012	Temperature Maximum (°C)
June 26	19
June 27	21
June 28	22
June 29	23
June 30	25
July 1	22
July 2	23
Hormone application date	

Canola Red Deer site 2013	Temperature Maximum (°C)
June 25	18
June 26	23
June 27	23
June 28	26
June 29	27
June 30	26
July 1	26
Hormone application date	

Summary: Red Deer site Canola Component Analyses:

Red Deer									
Hormone type	Conc	Plant height (cm) 2012; Treatment Effect P=0.5985	Plant height (cm) 2013; Treatment Effect P=0.0530	2013 LSD (P) value for comparison to the control	2013 LSD (P) value for comparison to the surfactant	Number of pods per plant 2012; Treatment Effect P=0.2861	Number of pods per plant 2013; Treatment Effect P=0.7428	Number of racemes per plant 2012; Treatment Effect P=0.8161	Number of racemes per plant 2013; Treatment Effect P=0.8107
4Cl-IAA	1*10-4 M	130.5	113.7	nd	nd	111	80	5.0	4.2
	1*10-5 M	129.2	109.5	0.0654	nd	106	76	5.0	4.2
	1*10-6 M	128.0	113.3	nd	nd	104	74	5.0	4.2
	1*10-7 M	127.7	110.0	0.0893	nd	126	68	4.8	4.3
4Me-IAA	1*10-4 M	130.3	110.8	0.1479	nd	117	71	4.8	4.3
	1*10-5 M	128.7	108.5	0.0343	nd	101	71	4.5	4.3
	1*10-6 M	127.2	116.8	nd	0.1249	99	78	4.8	4.5
	1*10-7 M	131.6	105.9	0.0047	0.0875	126	65	5.3	4.0
Control	Control	130.4	115.7		nd	100	75	4.8	4.5
Surfactant	Surfactant	127.8	111.6	0.2256		109	77	4.8	4.3

Red Deer						
Hormone type	Conc	1000KWt (g) 2012; Treatment Effect P=0.1823	1000KWt (g) 2013; Treatment Effect P=0.9959	Seed oil content (%) 2012; Treatment Effect P=0.1764	2012 LSD (P) value for comparison to the control	2012 LSD (P) value for comparison to the surfactant
4Cl-IAA	1*10-4 M	4.22	4.89	47.92	nd	0.03
	1*10-5 M	4.19	4.95	47.90	nd	0.03
	1*10-6 M	4.37	4.95	47.51	nd	0.13
	1*10-7 M	4.15	4.89	47.69	nd	0.07
4Me-IAA	1*10-4 M	4.39	4.89	48.55	0.14	0.00
	1*10-5 M	4.31	4.92	48.11	nd	0.02
	1*10-6 M	4.36	4.89	47.82	nd	0.05
	1*10-7 M	4.35	4.92	48.16	nd	0.01
Control	Control	4.47	4.91	47.66		nd
Surfactant	Surfactant	4.28	4.88	46.61	0.08	

Summary: Saskatoon site Canola Component Analyses:

- In 2012, seed oil content was significantly higher in almost all of the 4-Cl-IAA and 4-Me-IAA treatments compared to the surfactant control (3-4% oil content increase). The most significant increase was obtained with 4-Me-IAA at 1E-4M compared to the surfactant control.
- In 2013, the plant height significantly varied across treatments (P=0.05). This was the results of the water-logging damage to the plots.

- In 2012 and 2013, hormone treatment did not significantly affect number of racemes per plant, number of pods per plants, or 1000 KWT.

Regina-Canola

Canola Dose-Response

2012 Canola variety: Canterra 1852H (Round-up Ready)

2013 site lost to hail

Regina							
Hormone type	Conc	Yield corrected for dockage (Kg/ha); 2012 Treatment Effect P=0.4798	Plant height (cm) 2012; Treatment Effect P=0.1593	Number of pods per plant 2012; Treatment Effect P=0.1161	Number of racemes per plant 2012; Treatment Effect P=0.2210	1000Kwt (g) 2012; Treatment Effect P=0.8399	Seed oil content (%) 2012; Treatment Effect P=0.4319
4Cl-IAA	1*10-4 M	1810	94.5	344	5.0	3.51	45.83
	1*10-5 M	2055	97.6	288	5.0	3.56	47.41
	1*10-6 M	1692	97.7	320	5.0	3.58	46.02
	1*10-7 M	1803	94.9	267	4.8	3.61	46.51
4Me-IAA	1*10-4 M	1929	95.7	263	4.8	3.65	45.96
	1*10-5 M	1710	96.3	292	4.5	3.58	46.19
	1*10-6 M	1739	97.8	325	4.8	3.53	45.93
	1*10-7 M	1600	95.8	300	5.3	3.54	46.07
Control	Control	1845	93.5	270	4.8	3.57	46.26
Surfactant	Surfactant	2021	93.6	285	4.8	3.57	46.90

Summary:

Regina site Canola seed yield and Component analyses:

- **2012 ANOVA Treatment Effect not significant for seed yield. Hormone treatment did not significantly affect the plant height, number of racemes per plant, number of pods per plants, 1000 KWT, or seed oil content. Canola plots at the Regina site had uneven seed germination and plant stands due to frost damage during seedling emergence in 2012.**

The maximum day temperature at the Red Deer site during the time of hormone application on the canola plots is given below.

Canola Regina site 2012	Temperature Maximum (°C)
June 26	32
June 27	22
June 28	25
June 29	28
June 30	26
July 1	29
July 2	26
Hormone application date	

Overall summary for Canola:

No negative effects on canola plant growth or development were observed with hormone treatment at all sites.

Saskatoon site: Application of 4-Me-IAA at 1E-4M was associated with a trend to increase seed yield (36%) and increase the seed 1000KWT in SY4114 in 2013 when compared to the surfactant control.

Calgary site: Application of 4-Me-IAA at 1E-4M also was associated with a trend to increase seed yield (8% increase) compared to the surfactant control for the canola variety SY4114 in 2013. A trend in increasing seed yield (13% increase) with application of 4-Cl-IAA at 1E-6M and 4-Me-IAA at 1E-7M was observed in the Canola variety Canterra 1852H (used in 2012).

Red Deer site: In 2012, seed oil content was significantly higher in almost all of the 4-Cl-IAA and 4-Me-IAA treatments compared to the surfactant control (3-4% oil content increase) in Canterra 1852H. The most significant increase was obtained with 4-Me-IAA at 1E-4M compared to the surfactant control. 2013 experiment compromised by field water-logging

Regina site: No significant hormone treatment effects in 2012. 2013 experiment lost to hail.

Saskatoon Wheat

Wheat Dose-Response–Wheat variety: 5604HR. (nd= no difference, P>0.3)

Wheat Saskatoon 2012						Wheat Saskatoon 2013			
Hormone type	Conc	Yield corrected for dockage (Kg/ha)	ANOVA Treatment effect	LSD (P) value for comparison to the control	LSD (P) value for comparison to the surfactant	Yield corrected for dockage (Kg/ha)	ANOVA Treatment effect	LSD (P) value for comparison to the control	LSD (P) value for comparison to the surfactant
4-Cl-IAA	1*10-4 M	4218	0.0177	nd	nd	4617	0.5524	0.2515	nd
	1*10-5 M	4250		nd	nd	4553		nd	nd
	1*10-6 M	4429		0.0268	0.1447	4779		0.0679	0.2504
	1*10-7 M	4600		0.0016	0.0106	4484		nd	nd
Control	Control	4135				4358			
Surfactant	Surfactant	4246				4515			

Wheat Saskatoon 2012						Wheat Saskatoon 2013			
Hormone type	Conc	Yield corrected for dockage (Kg/ha)	ANOVA Treatment effect	LSD (P) value for comparison to the control	LSD (P) value for comparison to the surfactant	Yield corrected for dockage (Kg/ha)	Treatment effect	LSD (P) value for comparison to the control	LSD (P) value for comparison to the surfactant
4-Me-IAA	1*10-4 M	4451	0.5496	0.1592	nd	4649.08	0.6418	0.1144	nd
	1*10-5 M	4196		nd	nd	4447.85		nd	nd
	1*10-6 M	4444		0.1783	nd	4402.52		nd	nd
	1*10-7 M	4442		0.1712	nd	4575.23		0.2303	nd
Control	Control	4133			nd	4338.31			
Surfactant	Surfactant	4247		nd		4467.01		nd	

Summary: Saskatoon site Wheat cv. 5604HR; Seed yield

- **2102: Significant increase in seed yield (P<0.05) for 4-Cl-IAA at 1E-6M and 1E-7M (7 to 11.2% seed yield increase when compared to no treatment control).**
- **2013: ANOVA Treatment Effect not significant, but the single degree of freedom contrast for no treatment control versus 4-Cl-IAA at 1E-6M was significant at P=0.068 for increasing seed yield (10% seed yield increase)**
- **2012 and 2013: ANOVA Treatment Effect not significant, but trend (P<0.2) for increasing seed yield for 4-Me-IAA at 1E-4M.**
- **No plant injury effects observed with hormone treatments at any concentration in 2012 and 2013.**

Saskatoon site Wheat cv. 5604HR Component Analyses:

Wheat Saskatoon 2012						Wheat Saskatoon 2013			
Hormone type	Conc	1000KWt (g)	ANOVA Treatment effect	LSD (P) value for comparison to the control	LSD (P) value for comparison to the surfactant	1000KWt (g)	ANOVA Treatment effect	LSD (P) value for comparison to the control	LSD (P) value for comparison to the surfactant
4Cl-IAA	1*10-4 M	31.63	0.0399	0.02	nd	36.72	0.2562	nd	nd
	1*10-5 M	32.10		0.01	nd	36.85		0.2385	nd
	1*10-6 M	32.80		0.00	nd	37.35		0.0307	0.1612
	1*10-7 M	31.97		0.01	nd	37.46		0.0179	0.1057
4Me-IAA	1*10-4 M	30.47		nd	0.03	37.41		0.0226	0.1269
	1*10-5 M	31.40		0.04	0.19	37.33		0.0337	0.1733
	1*10-6 M	31.97		0.01	nd	36.92		0.1819	nd
	1*10-7 M	31.69		0.02	nd	36.86		0.2293	nd
Control	Control	29.42		nd	nd	36.27			nd
Surfactant	Surfactant	32.65		0.00	nd	36.66		nd	

Saskatoon Wheat									
Hormone type	Conc	Spikes per plant 2012; Treatment Effect P=0.6871	Spikes per plant 2013; Treatment Effect P=0.4333	Spike weight (g) 2012; Treatment Effect P=0.1103	Spike weight (g) 2013; Treatment Effect P=0.7116	# Seeds per spike 2012; Treatment Effect P=0.4992	# Seeds per spike 2013; Treatment Effect P=0.9477	Seed protein content (%) 2012; Treatment Effect P=0.6634	Seed protein content (%) 2013; Treatment Effect P=0.3461
4Cl-IAA	1*10 ⁻⁴ M	3.3	2.3	1.04	0.92	25	28	13.34	12.31
	1*10 ⁻⁵ M	3.3	2.7	1.18	0.95	27	28	13.38	11.99
	1*10 ⁻⁶ M	3.0	2.5	1.09	0.88	25	28	13.28	11.96
	1*10 ⁻⁷ M	3.5	2.3	1.07	0.95	26	28	13.82	11.89
4Me-IAA	1*10 ⁻⁴ M	3.3	2.5	1.19	0.92	27	28	13.26	12.10
	1*10 ⁻⁵ M	3.3	2.5	1.10	0.92	26	28	13.10	12.22
	1*10 ⁻⁶ M	3.0	2.3	1.04	1.07	25	28	13.62	12.22
	1*10 ⁻⁷ M	3.0	2.8	1.19	1.03	27	27	13.83	12.06
Control	Control	3.0	2.7	1.09	0.93	26	28	13.85	11.85
Surfactant	Surfactant	3.3	2.5	1.06	0.91	25	28	13.57	11.92

Saskatoon Wheat					
Hormone type	Conc	Plant height (cm) 2012; Treatment Effect P=0.5177	Plant height (cm) 2013; Treatment Effect P=0.9292	Plant dry weight (g); 2012 Treatment Effect P=0.3658	Plant dry weight (g); 2013 Treatment Effect P=0.9751
4Cl-IAA	1*10 ⁻⁴ M	100.5	101.8	3.28	3.70
	1*10 ⁻⁵ M	102.5	102.5	3.58	3.79
	1*10 ⁻⁶ M	102.0	102.0	3.71	3.80
	1*10 ⁻⁷ M	101.5	101.3	3.36	3.93
4Me-IAA	1*10 ⁻⁴ M	100.5	102.2	3.40	3.85
	1*10 ⁻⁵ M	100.8	101.2	3.48	3.83
	1*10 ⁻⁶ M	100.8	100.7	3.74	3.83
	1*10 ⁻⁷ M	100.3	99.7	3.51	4.02
Control	Control	100.0	101.2	3.68	3.87
Surfactant	Surfactant	100.3	101.7	3.75	3.86

Summary: Saskatoon site Wheat cv. 5604HR; Component Analyses:

- **2012: Seed size (1000 KWT) increased (Treatment effect P=0.04) with application of 4-Cl-IAA and 4-Me-IAA at most concentrations used when compared to the no treatment control.**
- **2013: A trend in Seed size (1000 KWT) increase (Treatment Effect P=0.26) with application of 4-Cl-IAA at 1E-6M and 1E-7M, and 4-Me-IAA at 1E-4M and 1E-5M was observed when compared to the**

no treatment control.

- **2012 and 2013: No significant hormone treatment effects (P>0.1) were observed for the components, number of spikes per plant, spike weight, number of seeds per spike, seed protein content, plant height and plant dry weight.**

The maximum day temperature at the Saskatoon site at time of hormone application on the wheat plots was greater in 2012 than in 2013 (see below).

Wheat Saskatoon site 2012	Temperature Maximum (°C)
July 9	27
July 10	29
July 11	32
July 12	30
July 13	29
July 14	27
July 15	23
Hormone application date	

Wheat Saskatoon site 2013	Temperature Maximum (°C)
July 5	25
July 6	18
July 7	21
July 8	21
July 9	24
July 10	28
July 11	29
Hormone application date	

Red Deer-Wheat

Wheat Dose-Response--Wheat variety: 5604HR. (nd= no difference, P>0.3)

Wheat Red Deer 2012						Wheat Red Deer 2013			
Hormone type	Conc	Yield corrected for dockage (Kg/ha)	ANOVA Treatment effect	LSD (P) value for comparison to the control	LSD (P) value for comparison to the surfactant	Yield corrected for dockage (Kg/ha)	ANOVA Treatment effect	LSD (P) value for comparison to the control	LSD (P) value for comparison to the surfactant
4-Cl-IAA	1*10-4 M	3971	0.3795	nd	nd	4586	0.8385	nd	nd
	1*10-5 M	3486		0.0778	0.0645	4838		nd	nd
	1*10-6 M	3840		nd	nd	4655		nd	nd
	1*10-7 M	4169		nd	nd	4539		nd	nd
Control	Control	4241				4671			
Surfactant	Surfactant	4292		nd		4721		nd	

Wheat Red Deer 2012						Wheat Red Deer 2013			
Hormone type	Conc	Yield corrected for dockage (Kg/ha)	ANOVA Treatment effect	LSD (P) value for comparison to the control	LSD (P) value for comparison to the surfactant	Yield corrected for dockage (Kg/ha)	ANOVA Treatment effect	LSD (P) value for comparison to the control	LSD (P) value for comparison to the surfactant
4MeIAA	1*10-4 M	4033	0.7975	nd	nd	5029	0.4618	0.1109	0.1592
	1*10-5 M	4249		nd	nd	4776		nd	nd
	1*10-6 M	4053		nd	nd	4599		nd	nd
	1*10-7 M	4252		nd	nd	4802		nd	nd
Control	Control	4038			nd	4672			
Surfactant	Surfactant	4037		nd		4700		nd	

Summary: Red Deer site Wheat cv. 5604HR; Seed yield

- **2102 and 2013: No Significant increase in seed yield (P>0.05) for 4-Cl-IAA or 4-Me-IAA treatments when compared to controls. However, a trend (single degree of freedom contrast for no treatment control versus 4-Me-IAA at 1E-4M P=0.11) for increasing seed yield (8% increase) was observed in 2013.**
- **No plant injury effects observed with hormone treatments at any concentration in 2012 and 2013.**

The maximum day temperature at Red Deer site at time of hormone application was 23°C in 2012, with the daily temperature increasing after hormone application. In 2013, the day temperature peaked at 31°C one day before hormone treatment, than decreased in the days following hormone application.

Wheat Red Deer site 2012	Temperature Maximum (°C)
July 3	18
July 4	17
July 5	22
July 6	23
July 7	27
July 8	29
July 9	31
Hormone application date	

Wheat Red Deer site 2013	Temperature Maximum (°C)
June 30	26
July 1	26
July 2	31
July 3	24
July 4	22
July 5	21
July 6	17
Hormone application date	

Red Deer site Wheat cv. 5604HR Component Analyses:

Red Deer Wheat									
Hormone type	Conc	Spikes per plant 2012; Treatment Effect P=0.3649	Spikes per plant 2013; Treatment Effect P=0.8497	Spike weight (g) 2012; Treatment Effect P=0.3838	Spike weight (g) 2013; Treatment Effect P=0.6368	# Seeds per plant 2012; Treatment Effect P=0.3167	# Seeds per plant 2012; Treatment Effect P=0.7014	1000Kwt (g) 2012; Treatment Effect P=0.7597	1000Kwt (g) 2013; Treatment Effect P=0.9994
4Cl-IAA	1*10-4 M	4.3	3.8	0.66	0.46	105	93	28.71	34.69
	1*10-5 M	4.0	4.0	0.56	0.46	96	94	28.37	34.60
	1*10-6 M	3.8	3.7	0.67	0.43	95	88	29.40	34.84
	1*10-7 M	4.0	3.5	0.64	0.44	93	85	29.12	34.71
4Me-IAA	1*10-4 M	3.8	3.8	0.61	0.43	100	87	29.14	34.57
	1*10-5 M	4.3	3.8	0.60	0.46	103	93	29.25	34.47
	1*10-6 M	4.8	4.0	0.66	0.43	115	96	29.59	34.87
	1*10-7 M	4.0	4.0	0.72	0.43	103	93	28.88	34.83
Control	Control	4.5	3.8	0.64	0.45	112	87	29.00	34.59
Surfactant	Surfactant	4.3	3.5	0.61	0.43	103	85	29.23	34.95

Red Deer Wheat							
Hormone type	Conc	Plant height (cm) 2012; Treatment Effect P=0.9578	Plant height (cm) 2013; Treatment Effect P=0.5154	Plant dry weight (g); 2012 Treatment Effect P=0.8251	Plant dry weight (g); 2013 Treatment Effect P=0.4449	Seed protein content (%) 2012; Treatment Effect P=0.8077	Seed protein content (%) 2013; Treatment Effect P=0.0569
4Cl-IAA	1*10-4 M	107.3	116.2	4.51	5.14	13.11	12.44
	1*10-5 M	106.8	117.3	4.33	5.60	13.18	12.84
	1*10-6 M	107.8	116.5	4.06	4.98	13.07	12.44
	1*10-7 M	107.8	117.3	3.68	4.96	13.20	12.40
4Me-IAA	1*10-4 M	107.3	116.2	4.28	5.22	13.33	12.58
	1*10-5 M	106.5	114.7	4.45	5.31	13.23	12.38
	1*10-6 M	107.8	116.5	4.81	5.57	13.20	12.60
	1*10-7 M	108.0	116.5	4.42	5.46	12.92	12.27
Control	Control	107.8	116.8	4.57	5.15	13.07	12.67
Surfactant	Surfactant	108.3	116.8	4.25	4.76	13.00	12.67

Summary: Red Deer site Wheat cv. 5604HR; Component Analyses:

- **2012 and 2013: No significant hormone treatment effects (P>0.1) were observed for the components, number of spikes per plant, spike weight, number of seeds per plant, 1000 KWT, plant height and plant dry weight. A decrease in seed protein content of 0.4 % in 2013 was observed for 4-Me-IAA at 1E-7M compared to the controls.**

Calgary-Wheat

Wheat Dose-Response--Wheat variety: 5604HR (nd= no difference, P>0.3)

Wheat Calgary 2012					Wheat Calgary 2013		
Hormone type	Conc	Yield corrected for dockage (Kg/ha) 2012; Treatment Effect P=0.1430	LSD (P) value for comparison to the control	LSD (P) value for comparison to the surfactant	Yield corrected for dockage (Kg/ha) 2013; Treatment Effect P=0.5655	LSD (P) value for comparison to the control	LSD (P) value for comparison to the surfactant
4-Cl-IAA	1*10-4 M	3495	nd	nd	5387	nd	nd
	1*10-5 M	3443	nd	nd	5109	nd	nd
	1*10-6 M	3570	nd	nd	5095	nd	nd
	1*10-7 M	2857	0.2059	0.0178	5320	nd	nd
Control	Control	3235			5270		
Surfactant	Surfactant	3667	0.154		5174	nd	

Wheat Calgary 2012					Wheat Calgary 2013		
Hormone type	Conc	Yield corrected for dockage (Kg/ha) 2012; Treatment Effect P=0.7415	LSD (P) value for comparison to the control	LSD (P) value for comparison to the surfactant	Yield corrected for dockage (Kg/ha) 2013; Treatment Effect P=0.9652	LSD (P) value for comparison to the control	LSD (P) value for comparison to the surfactant
4-Me-IAA	1*10-4 M	3330	nd	nd	5096	nd	nd
	1*10-5 M	3325	nd	nd	5114	nd	nd
	1*10-6 M	3130	nd	0.1681	5156	nd	nd
	1*10-7 M	3469	nd	nd	5218	nd	nd
Control	Control	3249		nd	5228		
Surfactant	Surfactant	3664	nd		5133	nd	

Summary: Calgary site Wheat cv. 5604HR; Seed yield

- **2102 and 2013: No Significant increase in seed yield (P>0.05) for 4-Cl-IAA or 4-Me-IAA treatments when compared to controls.**
- **No plant injury effects observed with hormone treatments at any concentration in 2012 and 2013.**

Calgary site Wheat cv. 5604HR Component Analyses:

Calgary Wheat									
Hormone type	Conc	Spike weight per plant(g) 2012; Treatment Effect P=0.0025	2012 LSD (P) value for comparison to the control	2012 LSD (P) value for comparison to the surfactant	Spike weight per plant(g) 2013; Treatment Effect P=0.7158	# Seeds per plant 2012; Treatment Effect P=0.1086	2012 LSD (P) value for comparison to the control	2012 LSD (P) value for comparison to the surfactant	# Seeds per plant 2013; Treatment Effect P=0.7503
4Cl-IAA	1*10-4 M	3.44	0.0021	0.0955	3.23	94	0.0143	0.1126	87
	1*10-5 M	2.95	nd	0.2228	3.33	80	nd	nd	92
	1*10-6 M	2.79	nd	0.0352	3.16	74	nd	0.1921	85
	1*10-7 M	2.82	nd	0.051	2.98	77	nd	nd	82
4Me-IAA	1*10-4 M	3.31	0.012	nd	3.20	90	0.0516	nd	87
	1*10-5 M	3.35	0.007	0.2377	3.17	88	0.0847	nd	85
	1*10-6 M	3.33	0.0096	nd	3.45	85	0.2089	nd	94
	1*10-7 M	2.96	nd	0.2377	3.39	81	nd	nd	91
Control	Control	2.86			3.21	76		nd	87
Surfactant	Surfactant	3.16			3.38	83	nd	nd	89

Calgary Wheat								
Hormone type	Conc	Spikes per plant 2012; Treatment Effect P>0.5	Spikes per plant 2013; Treatment Effect P=0.9264	Spike weight (g) 2012; Treatment Effect P=0.3284	Spike weight (g) 2013; Treatment Effect P=0.5815	1000Kwt (g) 2012; Treatment Effect P=0.8303	1000Kwt (g) 2013; Treatment Effect P=0.5844	
4Cl-IAA	1*10-4 M	3.0	3.0	1.13	1.15	29.97	35.82	
	1*10-5 M	2.7	3.0	1.09	1.15	29.18	35.68	
	1*10-6 M	2.7	2.8	1.01	1.17	30.25	35.87	
	1*10-7 M	3.0	3.0	0.95	1.10	29.32	35.73	
4Me-IAA	1*10-4 M	3.0	3.0	1.10	1.13	30.43	35.31	
	1*10-5 M	2.9	3.0	1.12	1.16	29.70	35.82	
	1*10-6 M	3.0	3.0	1.10	1.17	30.33	36.28	
	1*10-7 M	2.8	3.0	1.05	1.16	30.06	35.71	
Control	Control	2.7	3.0	1.09	1.15	30.04	35.60	
Surfactant	Surfactant	2.8	2.8	1.13	1.23	30.55	35.95	

Calgary Wheat							
Hormone type	Conc	Plant height (cm) 2012; Treatment Effect P=0.4232	Plant height (cm) 2013; Treatment Effect P=0.4765	Plant dry weight (g); 2012 Treatment Effect P=0.3607	Plant dry weight (g); 2013 Treatment Effect P=0.8026	Seed protein content (%) 2012; Treatment Effect P=0.8672	Seed protein content (%) 2013; Treatment Effect P=0.9477
4Cl-IAA	1*10-4 M	85.0	109.3	3.08	4.53	14.55	13.00
	1*10-5 M	84.7	108.3	2.50	4.78	14.46	13.05
	1*10-6 M	83.7	107.3	2.92	4.41	14.38	13.14
	1*10-7 M	82.3	109.0	3.04	4.27	14.63	13.05
4Me-IAA	1*10-4 M	85.0	107.3	2.87	4.35	14.51	13.04
	1*10-5 M	84.3	107.0	2.87	4.36	14.58	13.17
	1*10-6 M	84.3	108.0	3.39	4.85	14.62	13.09
	1*10-7 M	86.3	108.5	2.67	4.47	14.76	13.05
Control	Control	80.3	106.5	2.56	4.61	14.57	13.30
Surfactant	Surfactant	85.0	108.2	2.81	4.48	14.89	13.11

Summary: Calgary site Wheat cv. 5604HR; Component Analyses:

- **2012: A significant increase in spike weight per plant for 4-Cl-IAA and 4-Me-IAA at 1E-4M treatments was observed when compared to the no treatment control. The increase in spike weight per plant was correlated with a significant increase in the number of seeds per spike for 4-Cl-IAA and 4-Me-IAA at 1E-4M treatments (single degree of freedom contrast for no treatment control versus 4-Cl-IAA at 1E-4M P=0.01; no treatment control versus 4-Me-IAA at 1E-4M P=0.05).**
- **2012 and 2013: No significant hormone treatment effects (P>0.3) were observed for the components, number of spikes per plant, spike weight, 1000 KWT, seed protein content, plant height and plant dry weight.**
- **Note, in 2013 at the Calgary site, the hormone treatments were applied after the optimal plant developmental stage (the spikes were completely emerged from the boot at stage BBCH 61 at time of hormone application). The optimal timing for hormonal application in wheat is between BBCH stage 43-45. This may be a major factor in the lack of seed yield increase with hormonal treatment in 2013 at this site.**

The maximum day temperature at the Calgary site at time of hormone application was 28°C in 2012, with high temperatures preceding the hormone application date. In 2013, the maximum day temperatures preceding and following hormone application were lower than that in 2012.

Wheat Calgary 2012	Temperature Maximum (°C)
July 8	28
July 9	32
July 10	33
July 11	28
July 12	27
July 13	27
July 14	24
Hormone application date	

Wheat Calgary site 2013	Temperature Maximum (°C)
July 8	17
July 9	25
July 10	28
July 11	26
July 12	22
July 13	20
July 14	24
Hormone application date	

Regina-Wheat

Wheat Dose-Response--Wheat variety: 5604HR (nd= no difference, P>0.3)
(Data for the 2012 season will be presented as a Hail storm in July 2103 completely destroyed the 2013 Regina plots)

Wheat Regina 2012			Wheat Regina 2012		
Hormone type	Conc	Yield corrected for dockage (Kg/ha); Treatment Effect P=0.9933	Hormone type	Conc	Yield corrected for dockage (Kg/ha); Treatment Effect P=0.9033
4MeIAA	1*10-4 M	2973	4ClIAA	1*10-4 M	2930
	1*10-5 M	2893		1*10-5 M	2920
	1*10-6 M	2901		1*10-6 M	2878
	1*10-7 M	2900		1*10-7 M	3022
Control	Control	2871	Control	Control	2850
Surfactant	Surfactant	2945	Surfactant	Surfactant	2940

Summary: Regina site Wheat cv. 5604HR; Seed yield

- **2102: No Significant increase in seed yield (P>0.05) for 4-Cl-IAA or 4-Me-IAA treatments when compared to controls.**
- **No plant injury effects observed with hormone treatments at any concentration in 2012.**

Regina site Wheat cv. 5604HR Component Analyses: (nd= no difference, P>0.3)

Regina Wheat							
Hormone type	Conc	Spike weight (g) 2012; Treatment Effect P=0.0236	LSD (P) value for comparison to the control	LSD (P) value for comparison to the surfactant	Plant dry weight (g); 2012 Treatment Effect P=0.0681	LSD (P) value for comparison to the control	LSD (P) value for comparison to the surfactant
4Cl-IAA	1*10-4 M	1.06	0.01	0.06	3.79	nd	nd
	1*10-5 M	1.10	0.00	0.01	3.83	nd	nd
	1*10-6 M	1.08	0.01	0.04	4.30	0.02	0.01
	1*10-7 M	0.98	0.16	nd	4.15	0.08	0.03
4Me-IAA	1*10-4 M	1.04	0.03	0.12	3.78	nd	nd
	1*10-5 M	0.96	nd	nd	3.67	nd	nd
	1*10-6 M	0.95	nd	nd	3.73	nd	nd
	1*10-7 M	0.92	nd	nd	3.99	nd	0.15
Control	Control	0.88		nd	3.77		nd
Surfactant	Surfactant	0.93	nd		3.69	nd	

Regina Wheat					
Hormone type	Conc	Spikes per plant 2012; Treatment Effect P=0.013	1000KWt (g) 2012; Treatment Effect P=0.9266	# Seeds per plant 2012; Treatment Effect P=0.3072	Seed protein content (%) 2012; Treatment Effect P=0.7425
4Cl-IAA	1*10-4 M	3.0	33.07	73	14.61
	1*10-5 M	3.0	33.19	77	14.47
	1*10-6 M	3.0	32.87	80	14.43
	1*10-7 M	3.0	33.47	70	14.59
4Me-IAA	1*10-4 M	3.0	33.08	74	14.31
	1*10-5 M	3.0	33.70	71	14.39
	1*10-6 M	3.0	33.33	72	14.46
	1*10-7 M	3.0	33.31	71	14.68
Control	Control	3.5	32.69	71	14.25
Surfactant	Surfactant	3.0	33.61	70	14.11

Summary: Regina site Wheat cv. 5604HR; Component Analyses:

- **2012: A significant increase in spike weight per plant for 4-Cl-IAA at 1E-4M, 1E-5M, and 1E-6M, and 4-Me-IAA at 1E-4M treatments was observed when compared to the no treatment control. The increase in spike weight per plant was correlated with a significant increase in the number of seeds per plant for the 4-Cl-IAA at 1E-6M treatment (single degree of freedom contrast for no treatment control versus 4-Cl-IAA at 1E-6M P<0.05). A significant increase in plant dry weight was also observed for the 4-Cl-IAA at 1E-6M treatment compared to the controls.**

- **2012: No significant hormone treatment effects ($P>0.3$) were observed for the components, 1000 KWT and seed protein content.**

The maximum day temperature at the Regina wheat site at time of hormone application was 23°C in 2012.

Wheat Regina 2012	Temperature Maximum (°C)
July 2	26
July 3	29
July 4	23
July 5	23
July 6	26
July 7	26
July 8	27
Hormone application date	

Overall summary for Wheat:

No negative effects on wheat plant growth or development were observed with hormone treatment at all sites. It appears that the hormone treatments has the greatest effect on increasing wheat seed yield or yield components when high temperatures immediately precede and/or occur at the time of hormone application, as occurred in Saskatoon in 2012, Red Deer in 2013, and Calgary in 2012.

Saskatoon site: 4-Cl-IAA at 1E-6M was the most effective hormone treatment to increase seed yield. 4-Me-IAA at 1E-4M was the second most effective hormone treatment to increase seed yield. Seed size increase is the likely yield component that is affected by the hormone treatment. Increases in seed yield from 7 to 11 %.

Red Deer site: A trend (LSD $P<0.2$) for increasing seed yield with 4-Me-IAA at 1E-4M (8% increase when compared to the no treatment control) was observed in 2013.

Calgary site: No significant increase in seed yield in 2012 and 2013. However, in 2012, a significant increase in spike weight per plant for 4-Cl-IAA and 4-Me-IAA at 1E-4M treatments was observed when compared to the no treatment control. The increase in spike weight per plant was associated with a significant increase in the number of seeds per spike for 4-Cl-IAA and 4-Me-IAA at 1E-4M treatments.

Regina site: 4-Cl-IAA at 1E-6M treatment led to a significant increase in spike weight per plant, the number of seeds per plant, and plant dry weight compared to the no treatment control.

Saskatoon-Pea

Pea Dose-Response—cultivar Carneval in 2013 (nd= no difference, P>0.3)

2012 Saskatoon pea site lost due to Fusarium root rot infestation

Saskatoon 2013										
Hormone type	Conc	Average Yield (Kg/ha) 2013; Treatment Effect P=0.7114	LSD (P) value for comparison to the control	LSD (P) value for comparison to the surfactant		Hormone type	Conc	Average Yield (Kg/ha) 2013; Treatment Effect P=0.8695	LSD (P) value for comparison to the control	LSD (P) value for comparison to the surfactant
4-Me-IAA	1*10-4 M	5541	nd	0.14		4-Cl-IAA	1*10-4 M	5407	nd	nd
	1*10-5 M	5467	nd	nd			1*10-5 M	5306	nd	nd
	1*10-6 M	5419	nd	nd			1*10-6 M	5489	nd	0.26
	1*10-7 M	5497	nd	0.21			1*10-7 M	5422	nd	nd
Control	Control	5375		nd		Control	Control	5351		nd
Surfactant	Surfactant	5247	nd			Surfactant	Surfactant	5259	nd	

Summary: Saskatoon site Pea; Seed yield

- **2013: No Significant ANOVA Treatment Effect for 4-Me-IAA or 4-Cl-IAA treatment on seed yield; however, a trend (single degree of freedom contrast for the surfactant control versus 4-Me-IAA at 1E-4M and 1E-7M P≤0.2), and the surfactant control versus 4-Cl-IAA at 1E-6M (P=0.26) for increasing seed yield (5% increase) was observed in 2013.**

The maximum day temperature at the Saskatoon pea site at time of hormone application was 21°C in 2013.

Pea Saskatoon site 2013	Temperature Maximum (°C)
July 4	26
July 5	25
July 6	18
July 7	21
July 8	21
July 9	24
July 10	28
Hormone application date	

Saskatoon site Pea Component Analyses: (nd= no difference, P>0.3)

Saskatoon 2013					
Hormone type	Conc	Number of pods per plant 2013; Treatment Effect P=0.1053	1000KWt (g) 2013; Treatment Effect P=0.6351	Plant dry weight (g); 2013 Treatment Effect P=0.2526	Plant height (cm) 2013; Treatment Effect 0.3092
4Cl-IAA	1*10-4 M	7.2	181	5.3	88.8
	1*10-5 M	8.0	165	5.9	88.8
	1*10-6 M	7.0	163	5.4	87.9
	1*10-7 M	6.3	167	4.9	84.8
4Me-IAA	1*10-4 M	6.3	179	5.4	86.0
	1*10-5 M	7.3	158	5.7	86.7
	1*10-6 M	6.8	160	5.0	82.1
	1*10-7 M	8.0	170	5.8	89.2
Control	Control	7.8	161	6.0	89.4
Surfactant	Surfactant	6.8	180	5.6	86.6

Summary: Saskatoon site Pea Component Analyses

- **2013: No significant hormone treatment effects (P>0.3) were observed for the components, number of pods per plant, 1000 KWT, plant dry weight, and plant height.**

Calgary-Pea

Pea Dose-Response—cultivar Carneval in 2013 (nd= no difference, P>0.3)

Calgary 2012									
Hormone type	Conc	Average Yield (Kg/ha) 2012; Treatment Effect P=0.5286	LSD (P) value for comparison to the control	LSD (P) value for comparison to the surfactant	Hormone type	Conc	Average Yield (Kg/ha) 2012; Treatment Effect P=0.9692	LSD (P) value for comparison to the control	LSD (P) value for comparison to the surfactant
4-Me-IAA	1*10-4 M	7211	0.139	nd	4-Cl-IAA	1*10-4 M	6909	nd	nd
	1*10-5 M	6455	nd	nd		1*10-5 M	6209	nd	nd
	1*10-6 M	6914	nd	nd		1*10-6 M	6594	nd	nd
	1*10-7 M	6222	nd	nd		1*10-7 M	6666	nd	nd
Control	Control	6304		nd	Control	Control	6288		nd
Surfactant	Surfactant	6656	nd		Surfactant	Surfactant	6680	nd	

Calgary 2012				
Hormone type	Conc	Number of pods per plant 2012; Treatment Effect P=0.5024	1000KWt (g) 2012; Treatment Effect P=0.6896	Plant dry weight (g); 2012 Treatment Effect P=0.4012
4Cl-IAA	1*10 ⁻⁴ M	11	215.5	10.1
	1*10 ⁻⁵ M	11	218.5	9.5
	1*10 ⁻⁶ M	12	217.3	10.5
	1*10 ⁻⁷ M	13	219.0	11.2
4Me-IAA	1*10 ⁻⁴ M	13	219.5	10.1
	1*10 ⁻⁵ M	14	217.8	10.9
	1*10 ⁻⁶ M	13	219.8	10.9
	1*10 ⁻⁷ M	13	215.8	10.8
Control	Control	13	219.8	11.5
Surfactant	Surfactant	13	219.0	10.4

Calgary 2013						
Hormone type	Conc	Average Yield (Kg/ha) 2013; Treatment Effect P=0.2088	Number of pods per plant 2013; Treatment Effect P=0.391	1000KWt (g) 2013; Treatment Effect P=0.5659	Plant dry weight (g); 2013 Treatment Effect P=0.8421	Plant height (cm) 2013; Treatment Effect P=0.6206
4Cl-IAA	1*10 ⁻⁴ M	2620	9.0	151	6.70	65.7
	1*10 ⁻⁵ M	2663	8.5	150	6.55	62.9
	1*10 ⁻⁶ M	2573	9.0	152	6.52	62.0
	1*10 ⁻⁷ M	2357	8.2	152	6.32	63.1
4Me-IAA	1*10 ⁻⁴ M	2591	8.3	153	5.67	58.7
	1*10 ⁻⁵ M	2556	9.3	145	6.17	58.7
	1*10 ⁻⁶ M	2306	6.2	175	5.32	59.1
	1*10 ⁻⁷ M	2577	6.8	157	5.55	57.5
Control	Control	2470	8.8	158	5.92	57.8
Surfactant	Surfactant	2741	9.5	138	6.43	59.0

Summary: Calgary site Pea seed yield and Component Analyses

- **2012 and 2013: No Significant ANOVA Treatment Effect for 4-Me-IAA or 4-Cl-IAA treatment on seed yield; however, a trend for increasing seed yield (14% increase) in 2012 was observed for 4-Me-IAA at 1E-4M (single degree of freedom contrast for the no treatment control versus 4-Me-IAA at 1E-4M P≤0.15)**
- **2012 and 2013: No significant hormone treatment effects (P>0.3) were observed for the**

components, number of pods per plant, 1000 KWT, plant dry weight, and plant height.

The maximum day temperature at the Calgary pea site at time of hormone application was greater in 2012 than in 2013 (see below).

Pea Calgary site 2012	Temperature Maximum (°C)
July 6	24
July 7	27
July 8	29
July 9	32
July 10	32
July 11	29
July 12	28
Hormone application date	

Pea Calgary site 2013	Temperature Maximum (°C)
July 2	33
July 3	24
July 4	25
July 5	20
July 6	19
July 7	21
July 8	17
Hormone application date	

Red Deer-Pea

Pea Dose-Response—cultivar Carneval in 2013 (nd= no difference, P>0.3)
2012 Red Deer pea site lost due to Hail late in season.

Red Deer 2013						
Hormone type	Conc	Average Yield (Kg/ha) 2013; Treatment Effect P=0.1372	1000Kwt (g) 2013; Treatment Effect P=0.3925	Plant dry weight (g); 2013 Treatment Effect P=0.6502	Plant height (cm) 2013; Treatment Effect 0.2837	Number of pods per plant 2013; Treatment Effect P=0.4246
4Cl-IAA	1*10-4 M	3031	198.8	7.4	106.7	5.7
	1*10-5 M	2923	210.0	6.3	100.8	4.7
	1*10-6 M	3007	209.6	7.0	103.3	4.7
	1*10-7 M	2967	222.5	6.9	106.0	5.3
4Me-IAA	1*10-4 M	2938	193.8	7.5	105.6	5.5
	1*10-5 M	3060	207.5	7.5	108.1	5.5
	1*10-6 M	3127	192.5	7.9	109.7	7.0
	1*10-7 M	3182	204.6	7.4	106.8	5.5
Control	Control	2955	192.1	7.3	104.8	5.2
Surfactant	Surfactant	3374	197.9	7.6	109.6	5.8

Summary: Red Deer site Pea seed yield and Component Analyses

- 2013: No significant hormone treatment effects (P>0.3) were observed for seed yield or the components, number of pods per plant, 1000 KWT, plant dry weight, and plant height.

Regina-Pea

Pea Dose-Response—cultivar Carneval in 2012 (nd= no difference, P>0.3)

2013 Regina pea site lost due to Hail in July.

Regina 2012					
Hormone type	Conc	Average Yield (Kg/ha) 2012; Treatment Effect P=0.7719	Number of pods per plant 2012; Treatment Effect P=0.2129	1000KWt (g) 2012; Treatment Effect P=0.1325	Plant dry weight (g); 2012 Treatment Effect P=0.3099
4Cl-IAA	1*10-4 M	3685	14	213.0	8.90
	1*10-5 M	3641	12	213.0	7.45
	1*10-6 M	3462	15	217.8	9.38
	1*10-7 M	3517	14	213.0	8.21
4Me-IAA	1*10-4 M	3616	17	213.0	10.13
	1*10-5 M	3921	15	207.0	8.38
	1*10-6 M	3720	12	214.8	7.58
	1*10-7 M	3621	15	218.8	9.07
Control	Control	3750	15	214.3	9.26
Surfactant	Surfactant	3413	13	212.5	8.50

Summary: Red Deer site Pea seed yield and Component Analyses

- **2012: No Significant ANOVA Treatment Effect for 4-Me-IAA or 4-Cl-IAA treatment on seed yield; however, an increase in seed yield (15% increase) in 2012 was observed for 4-Me-IAA at 1E-5M with a single degree of freedom contrast for the surfactant control versus 4-Me-IAA at 1E-5M significant at P=0.06.**
- **No significant hormone treatment effects (P>0.1) were observed for seed yield or the components, number of pods per plant, 1000 KWT, and plant dry weight.**

The maximum day temperature at the Regina pea site at time of hormone application was 23°C in 2012.

Pea Regina 2012	Temperature Maximum (°C)
July 2	26
July 3	29
July 4	23
July 5	23
July 6	26
July 7	26
July 8	27
Hormone application date	

Overall summary for Pea:

No negative effects on pea plant growth or development were observed with hormone treatment at all sites.

Saskatoon site: A trend to increase seed yield (5% increase) was observed for 4-Me-IAA at 1E-4M and 4-Cl-IAA at 1E-6M in 2013.

Red Deer site: 2013: No significant hormone treatment effects ($P>0.3$) were observed.

Calgary site: A trend for increasing seed yield (14% increase) in 2012 was observed for 4-Me-IAA at 1E-4M.

Regina site: An increase in seed yield (15% increase) in 2012 was observed for 4-Me-IAA at 1E-5M

Over all Crops: 4-Me-IAA at 1E-4M and 4-Cl-IAA at 1E-6M were the most effective treatments for increasing seed yield.

Technology Transfer Activities To-Date	<ul style="list-style-type: none"> Given that this project at an early stage of efficacy trials, there has been limited technology transfer.
Research Plan for Upcoming Years/Next Steps	

Short-Term Outcomes (As indicated in original application)	X	Improved knowledge of potential innovative products, processes, technologies	Improved knowledge of solutions/strategies analyzed/tested to address issues/opportunities
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Actual Short –Term Outcomes (if applicable): See performance story

Long-Term Outcomes	X	Reduced production or processing costs
		Improved product quality
		Improved market share
		Preserving market share
	X	Other: increased yields
Actual Progress towards Long-Term Outcomes: (if applicable)	Our 2012 and 2013 field season data indicate that 4-Cl-IAA/ 4-Me-IAA hormone treatments can be use as a tool to increase seed yield and ameliorate heat stress in pea, canola and wheat crops. Additional field trials will be important to confirm these results and to fine-tune the use of these crop enhancement treatments under various ecological regions.	

Financial Information: (please use original budget used in application)

	CAAP	Applicant	Industry (APG and Syngenta)	Provincial Government	Federal Government	Other	Total Revenue
Cash Budget	\$252,000	\$12,000	\$30,000				\$294,000
Cash Actual	\$0	\$0	\$				\$0
In-Kind Budget		\$2,500					\$2,500
In-Kind Actual		\$2,959					
Total Revenue Budget (cash + eligible in-kind)	\$252,000	\$14,500	\$30,000				\$296,500
Total Revenue Actual (cash)	\$0	\$2,959	\$0				\$0

+ eligible in-kind)							
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	Total Budget - Cash	Total Actual - Cash
Personnel	\$220,000	\$237,889.25
Travel	\$20,000	\$11,536.52
Supplies	\$24,000	\$25,455.63
Communications	\$10,000	
Capital Assets		
Overhead		
Greenhouse/Growth Chamber	\$20,000	\$19,118.60
Total	\$294,000	\$294,000.00

Any significant changes, challenges?	None to report.
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