2014 Annual Report

for the

Agricultural Demonstration of Practices and Technologies (ADOPT) Program

Project Title: Fall 2, 4-D Preceding Canola, Field Pea and Flax

(Project #20130311)

Principal Applicant: Chris Holzapfel, MSc, PAg

Indian Head Agricultural Research Foundation, Box 156, Indian Head, SK, S0G 2K0

Collaborator(s): Laryssa Grenkow, Western Applied Research Corporation

Correspondence:

Project Identification

1. **Project Title:** Fall 2, 4-D Preceding Canola, Field Pea and Flax
2. **Project Number:** 20130311
3. **Producer Group Sponsoring the Project:** Indian Head Agricultural Research Foundation
4. **Project Location(s):** Indian Head, Saskatchewan, R.M. #156
5. **Project start and end dates (month & year):** September 2014-January 2015
6. **Project contact person & contact details:**

Chris Holzapfel, Research Manager
Indian Head Agricultural Research Foundation
P.O. Box 156, Indian Head, SK, S0G 2K0
Phone: 306-695-4200
Email:

Objectives and Rationale

7. **Project objectives:**

In partnership with several other Agri-ARM sites and under leadership of the Northeast Agricultural Research Foundation (NARF), a field demonstration was conducted near Indian Head, Saskatchewan in 2014. The objective of the project was to demonstrate the frequency and extent of subsequent canola, field pea and flax damage arising from fall applied 2,4-D at high rates as used for long-term control of perennial weed species.

8. **Project Rationale:**

Wet weather favours greater infestation of grain crops by perennial broadleaf weed species, which can be both persistent and difficult to control with herbicides. One relatively inexpensive control strategy has been to use fall applied 2,4-D; however, wet weather can also delay seeding and extend maturity, often meaning that harvest and fall applications of 2,4-D are postponed. Delaying application of high rates of 2,4-D increases the risk of residues remaining in the soil and potentially damaging sensitive crops such as canola, field peas and flax. In fact, fall 2,4-D applications at even the lowest rates are not recommended for either canola or flax due to the high risk of crop injury. In the case of field pea, early fall applications at low rates are not likely to cause crop injury, but late fall and early spring applications should be avoided. This demonstration was intended to provide updated information on the risks associated with fall applied 2,4-D and encourage growers to choose alternative control measures or management practices that pose less risk.

Methodology and Results

9. **Methodology:**

A field demonstration with canola, field pea and flax was initiated in the fall of 2013 on a heavy clay soil near Indian Head, Saskatchewan (50°33’32” N, 103°38’52 W) with five rates of fall-applied 2,4-D amine (0, 210, 420, 840, or 1680 g 2,4-D ha^{-1}) and three crop types (canola, field pea and flax) as treatments. A separate RCBD was established for the three crop types, with 2,4-D rates applied randomly within each of four replicates. The specific 2,4-D rates that were evaluated are provided in Table 1.

Table 1. Treatments evaluated in fall-applied 2,4-D demonstration at Indian Head.

Crop Types	**2,4-D* Rates**
1) Canola	1) 0 g ai ha^{-1}
2) Field Pea	2) 210 g ai ha^{-1}
3) Flax	3) 420 g ai ha^{-1}
	4) 840 g ai ha^{-1}
	6) 1680 g ai ha^{-1}

* 2,4-D amine 600

The site was established on no-till spring wheat stubble as soon as possible in the fall of 2013 after the previous crop was harvested. Based on soil test (0-30 cm) results (Fig. 1, appendices), the soil texture was a heavy clay with a pH of 7.4 and 3.3% organic matter. Soil tests from adjacent studies estimated organic matter for the upper 15 cm as approximately 4.5%. Fall 2,4-D treatments were applied on October 13, 2013 using a custom-built field sprayer and 225 l ha^{-1} solution volume. While this is later than recommended, even for field pea, earlier application was not possible due to the delayed harvest on the site. Furthermore, applying the 2,4-D as an amine formulation later in the fall than recommended created a high risk scenario and, therefore, an enhanced opportunity to demonstrate the potential risks of fall 2,4-D application on these sensitive crops.

Seeding for all crops was completed as early as possible (May 14) using a Conserva-Pak plot drill with 12 openers spaced 30 cm apart. Seeding rates, fertility, pesticide applications and harvest operations were all tailored to the specific crop types and pests encountered at this location. Pertinent agronomic information is provided in Table 2. Heavy rain in late June and early July caused flooding damage in many plots and delayed some field operations. As a result, all pea plots were lost at the early flowering stage and, when it was clear they would not set seed, these plots were terminated with glyphosate. The canola was also affected by the prolonged wet conditions with delay maturity and low yields in all plots. As a result, yield data from three of the four replicates (1-3) was not considered to be reliable and is excluded from this report. The flax fared through the wet weather reasonably well and was uniform across the study area; however, yields were considered below average for the region. Prevharvest glyphosate was applied to the flax to kill any green weeds and assist with crop dry down. The centre 5 rows from each flax and canola plot were straight-combined when mature and fit to harvest. Pertinent agronomic information is provided in Table 2.

Table 2. Pertinent agronomic information for ADOPT Fall 2,4-D Trial at Indian Head (2014).

Agronomic Factor / Field Operation	**Canola**	**Field Pea**	**Flax**
Pre-emergent herbicide	890 glyphosate ha^{-1} (May-22-2014)	890 glyphosate ha^{-1} + 292 ml Authority ha^{-1} (May-18-2014)	890 glyphosate ha^{-1} + 292 ml Authority ha^{-1} (May-18-2014)
Seeding Date	May-14-2014	May-14-2014	May-14-2014
Variety	46H75	Golden yellow	CDC Bethune
Seeding Rate	5.7 kg ha^{-1}	229 kg ha^{-1}	53 kg ha^{-1}
Fertility (kg N-P_2O_5-K_2O-S ha^{-1})	119-20-10-10	14-20-10-10	93-20-10-10
In-crop Herbicide	42 g Odyssey ha^{-1} + 166 ml Equinox ha^{-1} (Jun-10-2014)	42 g Odyssey ha^{-1} + 166 ml Equinox ha^{-1} (Jun-10-2014)	2 L Curtail M ha^{-1} + 0.47 L Poast Ultra ha^{-1} (Jul-7-2014)
Fungicide Applications	351 g Lance WDG (Jul- 11-2014)	0.4 L Headline EC ha^{-1} (Jul-8-2014)	0.4 L Headline EC ha^{-1} (Jul-8-2014)
Pre-harvest Herbicide	—	—	890 g glyphosate ha^{-1} (Sep-5-2014)
Harvest	Oct-9-2014	—	Sep-24-2014

In-season data collection focussed on crop emergence and seed yield. Emergence was first noted in late May. The same five 0.5 m sections of crop row were counted on two separate dates. Field pea and flax plots were counted on June 10 and June 25, while canola plots were counted on June 9 and June 26. The second count was not completed on reps 1 and 2 of canola because there was standing water in the plots at this time. Deformed seedlings were noted at the time of the plant counts; however, some of the noted abnormalities were likely caused by environmental factors such as stress from excess water. Abnormalities that were noted included cupped leaves, leaf tips curled inwards, and leaf edge not fully developed with field pea, missing or misshaped cotyledons and yellowed or curled leaf edges in canola, and necrotic seedlings or dead growing points in flax. The maturity dates was recorded for each flax plot and for rep 4 of canola; however, no differences in maturity or apparent treatment effects on crop stage were observed at any point during the growing season. Seed yields for all crops are corrected for dockage and to standard moisture contents for each crop type. Weather data were based on daily measurements from an Environment Canada weather station which was located near the site.

Data were analyzed separately for each crop using the mixed procedure of SAS 9.1. Means are separated using Fisher's protected LSD test and results were considered significant at $P \leq 0.05$.

10. Results:

In the fall of 2013, treatments were applied on October 13 and it was the second week in November when the fields were first covered in snow (which did not melt until spring) in mid-November. Due to the heavy residues and late spring, the soils at seeding were relatively cool and wet; however, adequate seed and fertilizer placement was achieved and the weather immediately following seeding was warm and dry. Excellent emergence was noted for all crops. Mean monthly temperatures and total precipitation levels for May through August are provided relative to the long-term (1981-2010) averages in Table 3. On average, May was drier and warmer than normal which allowed seeding to progress in the region; however, June was extremely wet (257% of long term normal precipitation) and slightly cooler than average, resulting in significant crop damage and delays in herbicide applications. July was dry and warmer than normal; however, August was also much wetter than average with close to normal temperatures.

Table 3. Mean monthly temperatures and precipitation amounts along with long-term (1981-2010) normals for the 2014 growing season at Indian Head, Saskatchewan.

Year	May	June	July	August	Avg. / Total
	Mean Temperature (°C)				
2014	14.4	14.4	17.3	17.4	15.9
Long-term	10.8	15.8	18.2	17.4	15.6
	Precipitation (mm)				
2014	36	199.2	7.8	142.2	385
Long-term	51.8	77.4	63.8	51.2	244

Results: Canola

Tests of fixed effects and treatment means for canola are provided in Table 4. Even at very high rates, fall-applied 2,4-D amine did not affect canola emergence (*P* = 0.87-0.98) or the proportion of deformed seedlings (*P* = 0.59-0.61). While yield data for canola was not statistically analyzed due to the lack of replication, there was no indication of high rates of fall applied 2,4-D negatively impacting seed yield. There was a slight trend towards a greater plant density loss with increasing rates of applied 2,4-D, but this was not statistically (*P* = 0.27) or agronomically significant.

Table 4. Fall applied 2,4-D effects on canola establishment and yield.

	T1		T2			
	Deformed Seedlings	Plant Density	Deformed Seedlings	Plant Density	Plant Density Change	Seed Yield
	Type III Tests of Fixed Effects					
Effect	p-values					
Treatment	0.592	0.867	0.606	0.979	0.265	—
	Least Squares Means					
	(%)	*(plants m^{-2})*	*(%)*	*(plants m^{-2})*	*(%)*	*(kg ha^{-1})*
1) 0 g ai ha^{-1}	5.2	65.6	0.0	55.8	-2.6	1764
2) 210 g ai ha^{-1}	11.9	58.4	0.0	57.1	-5.4	1771
3) 420 g ai ha^{-1}	8.4	62.0	0.0	53.8	-8.1	1890
4) 840 g ai ha^{-1}	14.8	63.0	0.9	57.1	-9.7	1824
5) 1680 g ai ha^{-1}	8.1	62.3	0.8	51.8	-10.8	1885
SE	5.16	4.66	0.55	7.35	4.35	—

Results: Field Pea

Overall F-test results and treatment means for field pea are provided in Table 5. Similar to the results observed for canola, neither pea emergence (*P* =0.74-0.82) nor deformed seedlings (*P* = 0.74-0.79) were affected by fall-applied 2,4-D and there was no trend in plant density loss with the higher rates (*P* = 0.79).

Table 5. Fall applied 2,4-D effects on field pea establishment and yield.

	T1		T2		
	Deformed Seedlings	Plant Density	Deformed Seedlings	Plant Density	Plant density change
	Type III Tests of Fixed Effects				
Effect	p-values				
Treatment	0.737	0.820	0.792	0.742	0.788
	Least Squares Means				
	(%)	*(plants m^{-2})*	*(%)*	*(plants m^{-2})*	*(%)*
1) 0 g ai ha^{-1}	3.8	87.9	0.7	88.9	1.6
2) 210 g ai ha^{-1}	6.6	86.9	2.2	85.6	-1.3
3) 420 g ai ha^{-1}	5.9	84.6	0.8	84.3	-0.3
4) 840 g ai ha^{-1}	5.9	92.5	1.3	90.9	-1.8
5) 1680 g ai ha^{-1}	3.6	89.6	1.1	90.9	1.5
SE	1.9	4.9	1.0	4.4	2.4

Results: Flax

Overall *F*-test results and treatment means for flax are provided in Table 6. As with the other two crops, none of the variables of interest were affected by the rate of fall-applied 2,4-D (*P* = 0.14-0.88).

Table 6. Fall applied 2,4-D effects on flax establishment and yield.

	T1		T2				
	Deformed Seedlings	Plant Density	Deformed Seedlings	Plant Density	Plant Density Change	Days to Maturity	Seed Yield
	Type III Tests of Fixed Effects						
Effect	p-values						
Treatment	0.615	0.674	0.878	0.647	0.139	0.138	0.444
	Least Squares Means						
	(%)	*(plants m^{-2})*	*(%)*	*(plants m^{-2})*	*(%)*	*(days)*	*(kg ha^{-1})*
1) 0 g ai ha^{-1}	2.4	448	1.2	462	3.0	108.8	1234
2) 210 g ai ha^{-1}	2.4	396	0.9	427	7.8	108.5	1170
3) 420 g ai ha^{-1}	1.5	429	0.7	426	-0.4	108.3	1240
4) 840 g ai ha^{-1}	2.3	464	0.7	482	3.9	108.8	1277
5) 1680 g ai ha^{-1}	2.3	428	1.3	425	-0.5	108.3	1177
SE	0.6	33	0.6	34	2.4	0.3	68

Extension and Acknowledgement

This demonstration was shown at the Indian Head Crop Management Field Day on July 22 which was attended by over 200 producers and industry representatives. The field trial was shown as part of an extended discussion on current issues in flax production and agronomy which was led by a provincial oilseed specialist. Signs were in place to identify treatments and acknowledge the support of the Agricultural Demonstrations of Technologies and Practices (ADOPT) program. Results from this project will be made available in the 2014 IHARF Annual Report (available online) and also combined with data from other locations in a more comprehensive report which will be made available through a variety of other media (i.e. oral presentations, agriculture press, fact sheets, etc.).

11. Conclusions and Recommendations

The observed effects of fall applications of high rates of 2,4-D amine at Indian Head in 2014, were unexpected in that no reductions in emergence, seedling injury or seed yield were detected for canola, flax or field pea. Based on previous research and anecdotal evidence, we expected to find some evidence of reduced plant stands and/or an increase in numbers of abnormal seedlings. However, these results were consistent with those observed at Indian Head in 2013 and with the results of all the other Agri-ARM organizations that participated in this demonstration. However, these results should not mislead us to conclude that such applications are always safe. Previous research has shown that fall applications of 2, 4-D amine preceding these crops can cause significant injury and yield reduction, particularly at high rates required for effective perennial weed control. Previous research has shown that damage can be higher on heavy clay or clay soils than on coarser textured soils, and that risk of damage may be higher on low compared with high organic matter soils. The fact that seedling injury or yield reductions were not observed may be related to the trials having been conducted under no-till conditions. To the best of our knowledge, previous studies have all been conducted under conventional tillage conditions. Having organic matter stratified at the soil surface and not mixing soil with tillage in a no-till system could promote greater losses or inactivation of the herbicide compared with conventional tillage. It would be of interest to compare 2,4-D rate effects under contrasting tillage systems.

Supporting Information

12. Acknowledgements

This project was supported by the Agricultural Demonstration of Practices and Technologies (ADOPT) initiative under the Canada-Saskatchewan Growing Forward bi-lateral agreement. Signs acknowledging the Saskatchewan Ministry of Agriculture's support for this demonstration were in place for the IHARF Crop Management field day. Further acknowledgement will be included as part of all written reports and oral presentations that arise from this work. Canola seed was provided in-kind by Dupont-Pioneer and crop protection products were provided in-kind by BASF and FMC.

13. Appendices

ALS Laboratory Group Agricultural Services

SOIL TEST REPORT

Phone: 1-800-667-7645

Dealer / Crop Consultant:	Client Information:
INDIAN HEAD AG RESEARCH FOUNDATI	CHRIS HOLZAPFEL
BOX 156	
INDIAN HEAD,SK S0G 2K0	
Phone: 306-695-5220	
Fax: 306-695-3445	
Email:cholzapfel@iharf.ca	

Sample / Field Information:

Crop Year	2014
Field Name	14-557
Legal Location	SW 31 18 12 W2
Soil Climatic Zone	Black
GPS Reference	
Acres	1
Previous Crop	Wheat, CWRS
Yield	60
Stubble Management	Spread
Rotation	Continuous

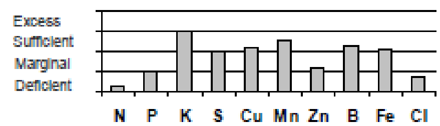
Sample ID 1367954 Date Sampled 02-NOV-13

SOIL TEST CHARACTERISTICS

Depth (inches)	Texture	pH 1S:2W	E.C. 1S:2W (mS/cm)	E.C. Calc.Sat.Extr. (mS/cm)	Salinity Rating	Organic Matter %	NH_4-N (lb/ac)	Calculated CEC meq/100g	Ca (ppm)	Mg (ppm)	K (ppm)	Na (ppm)	Base Saturation Ca (% of CEC)	Mg (% of CEC)	K (% of CEC)	Na (% of CEC)
0-12	Clay	7.4	0.7	1.5	Non Saline	3.3										

SOIL TEST NUTRIENT LEVELS

Depth (inches)	NO_3-N (lb/ac)	P (lb/ac)	K (lb/ac)	SO_4-S (lb/ac)	Cu (lb/ac)	Mn (lb/ac)	Zn (lb/ac)	B (lb/ac)	Fe (lb/ac)	Cl (lb/ac)
0-12	14	31	>1020	33	7.8	21.4	1.7	4.8	61	10



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NUTRIENT RECOMMENDATION RATES (lb/ac)

Soil Available Moisture: ☐ Actual: ______ ☑ Typical: 2.8 inches

Flax		N	P_2O_5	K_2O	S	Cu	Mn	Zn	B	Fe	Cl
28 bu/ac	9.0 in. of ppt - 25% chance of this ppt.	65-75	25-30	0 or 15	0-10	0-0	0-0	2-6	0-0	0-0	0-15
22 bu/ac	6.8 in. of ppt - 50% chance of this ppt.	60-70	20-25	0 or 15	0-10	0-0	0-0	0-4	0-0	0-0	0-15
13 bu/ac	3.7 in. of ppt - 75% chance of this ppt.	40-50	10-15	0-0	0-10	0-0	0-0	0-2	0-0	0-0	0-0
40 bu/ac	13.4 in. of ppt - <25% chance of this ppt.	115-125	25-30	0 or 15	0-10	0-0	0-0	2-6	0-0	0-0	0-15

User Specified: Target Yield of 40 bu/ac ☐ Irrigation

Other Recommendations And Comments

Organic matter in the 0-12" depth is not a valid criterion for gauging herbicide use. A 0-6" sample is necessary.

A 0 or 15 lbs/ac K2O recommendation is made for high K soils because K may not be available to the plant in cool (particularly cool and dry) soils.

The P2O5 recommendation is based on banding or seed-placement (if rate is safe). For broadcast and incorporation the P2O5 rate should be 2 times that shown.

K2O recommendations < 30 lbs/ac are for seed-placement or banding, and > 30 lbs/ac are for broadcast and incorporation. The banding rate X 2 = the broadcast and incorporation rate.

Walkley Black Method used for Organic Matter analysis.

Figure 1. Soil test report for the field site at Indian Head in 2014 and a soil depth of 30 cm.

Abstract

14. Abstract/Summary

A field demonstration to demonstrate the potential risks of applying fall 2,4-D at high rates on the emergence and yield of sensitive crops (canola, field pea and flax) was continued at a site near Indian Head in 2014. While seeding was completed in mid-May and emergence was excellent, extremely wet weather in June resulted in the loss of the field pea plots and yield data for 3 of 4 replicates of the canola; however, emergence data from all crops were considered to representative of the treatments. Similar to the previous season but unexpectedly, no negative impacts of fall-applied 2,4-D were observed for any of the three crops, even at rates as high as 1680 g 2,4-D ha^{-1}. The lack of response may have been due to the combination of good soil moisture and late seeding, or potentially related to the fact that the trials were located in long-term no-till fields with heavy crop residues stratified near the soil surface. This demonstration was shown at the IHARF Crop Management Field Day which was attended by more than 200 producers and agronomists. The data from this demonstration will be combined with that of several other Agri-ARM sites for a more comprehensive analysis which will hopefully provide a better understanding of the potential risks and frequency of crop injury associated with fall 2,4-D application preceding canola, field pea and flax.