ACPC 110 – AR 18

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Fall rye cover Crop termination date effect on canola emergence – controlled study

Project for Palliser Agricultural Management Society (PAMS)[1]
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Objective:
To evaluate the potential for canola emergence issues when planted into fall rye cover crop terminated with glyphosate at different timings (7, 14 and 21 days) ahead of no-till canola.

Background:
Soil erosion through the winter/spring period is a challenge for irrigated rotations that include crops like potato, bean and other crops with minimal or unanchored soil residue cover. The most vulnerable period is in early spring following numerous freeze-thaw cycles and the erosive impact of blowing snow that tends to break down soil aggregates, dislodge unanchored residues and level field surfaces. In addition to soil loss, crop damage can occur from soil erosion on vulnerable fields following planting in spring.

Cover cropping on vulnerable soils with fall rye or other species planted before mid-September is one of the best tools to help anchor previous crop residues, increase vegetative cover during the most vulnerable periods and improve soil structure through it's extensive topsoil rooting pattern. Winter cereals have the benefit of surviving to spring, improving soil protection through the vulnerable spring period. While this is a good practice for soil management, some species like fall rye have been shown to produce allelopathic compounds that inhibit the germination of other plants. Allelopathy is the chemical effect of one organism, plant or microbe, on another through the release of chemicals into the environment[2], and has long been used as a tool to enhance weed control with rye and other crops in rotation[3]. These allelopathic effects often occur in conjunction with other effects like nutrient immobilization or shading, making it very challenging to determine the exact cause for poor growth in field situations. Recent studies at the U of M confirmed that fall rye leaf biomass (rather than root biomass) was the main source for allelopathic effects on germination and emergence for several species including canola[4]. In this study, canola germination was reduced by 55% and root radicle elongation by 47% when an aqueous extract prepared from vegetative fall rye was compared to distilled water for canola planted into a silty clay loam soil under controlled conditions.

While we know that the chemicals produced by fall rye can affect canola in a more controlled situation, the risks for an actual field situation have not been studied. Some studies have shown that benzoxazinoids (the allelochemicals in fall rye) can degrade to inactive compounds after a few days in soil under the right conditions[5]. This would be affected by temperature and soil moisture, presumably requiring some rainfall to leach the allelochemicals from leaf biomass into the soil to initiate degradation. Given that, there are questions on the persistence of allelopathic effects, including the influence of tillage, previous crop residue or rainfall pattern. The timing of herbicide is also a factor given that the rye vegetation would presumably release more of the allelopathic compounds as the plants begin to desiccate after application. Tillage to bury the rye biomass may hasten decomposition of the chemical

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[1] PAMS is a not for profit farm organization based in southern Alberta comprising 12 farmers who network and conduct applied research in support of their member's farming goals.

[2] Rice, E.L. (1984) Allelopathy. Physiological Ecology: A Series of Monographs, Texts, and Treaties. 2nd Edition, Academic Press Inc., Orlando.

[3] Fall Rye Allelopathy and Cover Crops. NRCS publication, January, 2016. https://www.nrcs.usda.gov/Internet/FSE_PLANTMATERIALS/publications/mopmstn2825.pdf)

[4] Geddes, C.M., Cavalieri, A., Daayf, F. and Gulden, R.H. (2013) The Allelopathic Potential of Hairy Vetch, Fall Rye and Winter Wheat in a Silty Clay Loam Soil. Poster Presentation. CSSS/MAC/ASA, CSSA, and SSSA. Tampa. https://scisoc.confex.com/crops/2013am/webprogram/Paper80586.html

[5] Concentrations and Allelopathic Effects of Benzoxazinoid Compounds in Soil Treated with Rye (Secale cereal) Cover Crop. Clifford Rice, etal. J. Agric. Food Chem., 2012, 60 (18), pp 4471 – 4479.

substances but may also be undesirable for erosion risk or seedbed quality. General recommendations based on limited research for no till corn planted into rye cover crop is to terminate with herbicide at least 14 days before planting and seed deeper to avoid exposure to the allelopathic chemicals[6].

This project by PAMS looked at the effect of fall rye on canola emergence and vigour with different pre-plant termination timings. To simulate the situation for spring planted canola, soil cores containing established fall rye were collected, placed in a controlled setting and terminated with glyphosate at different times before hand planting.

Methods:

- Soil core samples of fall rye, winter wheat and soil without winter crop were collected from a Brown Soil Zone, sandy loam irrigated field south of Burdett on October 11, 2017
- Samples were collected by inserting a 20 cm diameter, 20 cm length metal irrigation pipe to a 15 to 17 cm depth and excavating with a shovel (see Figure 1)
- Samples included:
    - 9 from for a field planted to fall rye in mid-August (NW 27-8-12 W4)
    - 3 from representative areas for a winter wheat field planted in early-September (SW 35-8-12)
    - 3 from a dryland corner adjacent to the fall rye collection area (NW 27-8-12 W4)
- Core samples were left in the pipe and placed on the soil surface of a greenhouse owned by Hamman Ag Research near Lethbridge (see Figure 2)
- Supplemental heating was used (small space heater) to prevent freezing temperatures during colder periods (temperature was not regulated or monitored in greenhouse but observed to range from 2 to 20˚ C)
- All samples had soil moisture near field capacity at time of sampling and were watered on a weekly basis to maintain adequate soil moisture
- Dissolved urea fertilizer was added with the first water application to all the samples at the equivalent rate of 50 kg/ha actual N
- Samples were left for one week following removal from the field prior to the first glyphosate timing
- Glyphosate was applied with a hand-held boom sprayer equipped with flat fan nozzles at a rate of .75 kg/ha AI, with the following timings:
    - For rye, at 8, 13 and 21 days before planting
    - For winter wheat at 8 days before planting
    - Three cores (replicates) for each herbicide timing
- Water was applied evenly to samples with a plant showering container at a rate that was equivalent to a 5 mm depth, twice weekly to simulate rainfall
- Canola was hand planted on November 8, 2017 with 20 seeds planted directly using a golf tee to open and close the soil to a 2 cm depth; seeds were distributed uniformly within each container (canola germ was confirmed to be 96%)
- Winter cereal vegetation was clipped at a 3 to 5 cm height, removed for planting and redistributed evenly onto the surface after planting
- Samples were then watered evenly with an equivalent rate of 7.5 mm to ensure good moisture for germination and placed in a heated shop area with a temperature of 18˚ C for one week following planting, then watered again with the 7.5 mm rate and returned to the greenhouse for the final week
- Canola germination/emergence was evaluated as follows:
    - Percent of seeds emerged at one and two weeks after planting
    - Visual assessment for relative seedling vigour at 2 weeks after planting (1 to 9 scale with 1=low and 9=high)

[6] Planting corn into a cereal rye cover crop. Article by Paul Jasa, University of Nebraska-Lincoln, April, 2016. https://cropwatch.unl.edu/2016/planting-corn-cereal-rye-cover-crop

Results:

Canola emergence had varying levels of suppression when planted into fall rye soil cores extracted from a Brown Soil Zone irrigated sandy loam field in mid-October. Suppression was highest for fall rye terminated with glyphosate 8 days before planting, diminishing when terminated 13 days before and minimal when terminated 21 days before planting (Table 1 and Figure 1). The relative vigour for emerged seedlings also tended to improve with earlier termination dates.

Canola planted into winter wheat soil cores terminated 8 days before planting also showed some suppression (only one date for winter wheat termination). The winter wheat field was seeded three weeks after the fall rye and had much less accumulated biomass (visual, not measured), so that may have been a factor. Extracts of winter wheat leaf tissue in the vegetative stage has been shown to reduce canola germination and vigour, similar but not to the same extent as fall rye[7].

Emergence was poor in the "no-cover" soil cores with seedlings showing what appeared to be Group 4 herbicide injury symptoms, possibly from residual dicamba applied in a mixture with glyphosate before planting of the fall rye (Figure 4). These cores were extracted from a dry pivot corner that was sprayed and planted but received no rainfall until a few days before the soil cores were extracted. Dicamba is the active ingredient in Banvel and requires some soil moisture to initiate microbial decomposition.[8] Several water applications since planting to the irrigated portion of the field would have ensured that no residues were remaining in those areas, although that was not confirmed with soil testing in this study.

Table 1. Effect of cover type and termination timing on canola emergence and vigour.

Cover Crop	Glyphosate timing	Emergence Rating (seedlings/core)								Vigour Rating			
		Rep 1		Rep 2		Rep 3		Average (%)					
	Days before planting	7 DAP	14 DAP	7 DAP	14 DAP	7 DAP	14 DAP	7 DAP	14 DAP	Rep 1	Rep 2	Rep 3	Avg.
Fall Rye	21 days	16	16	17	17	19	19	87%	87%	9	9	8	8.7
	13 days	6	11	5	11	0	7	18%	48%	5	4	3	4.0
	8 days	0	0	0	0	0	3	0%	5%	-	-	1	-
Winter Wheat	8 days	11	15	9	13	13	18	55%	77%	6	6	6	6.0
No cover	8 days	2	6	11	16	0	0	22%	37%	5	6	-	3.7

*** 20 canola seeds planted per core; DAP = days after planting; vigour ratings 14 DAP, relative score based on height and cotyledon size with 1 = low and 9 = high**

These results suggest that allelopathic effects from fall rye cover crop can inhibit canola emergence and that an earlier termination date will help to mitigate those effects. This supports the findings of earlier work reported by Geddes where vegetative rye extracts reduced canola germination[9]. Other possible causes include nutrient

[7] Geddes, C.M., Cavalieri, A., Daayf, F. and Gulden, R.H. (2013) The Allelopathic Potential of Hairy Vetch, Fall Rye and Winter Wheat in a Silty Clay Loam Soil. Poster Presentation. CSSS/MAC/ASA, CSSA, and SSSA. Tampa. https://scisoc.confex.com/crops/2013am/webprogram/Paper80586.html

[8] Microbial degradation of the herbicide dicamba in moist soils at different temperatures. Allan E. Smith, D.R. Cullimore. Weed Research 15:1, pp 59-72. 1975.

[9] Geddes, C.M., Cavalieri, A., Daayf, F. and Gulden, R.H. (2013) The Allelopathic Potential of Hairy Vetch, Fall Rye and Winter Wheat in a Silty Clay Loam Soil. Poster Presentation. CSSS/MAC/ASA, CSSA, and SSSA. Tampa. https://scisoc.confex.com/crops/2013am/webprogram/Paper80586.html

immobilization or other soil biological interactions resulting from the rapid decomposition of the fall rye root biomass following termination with glyphosate, although the most likely cause based on previous work is the effect of allelopathic compounds[10].

The controlled conditions for this trial, with placement of soil cores in a greenhouse and regular watering throughout, was an ideal situation for both the activation (through leaching of allelopathic compounds into soil) and subsequent degradation of compounds responsible for allelopathy. It was also ideal temperature for canola emergence (18˚ C). While temperatures were not monitored through the 6-week study period, they were maintained above freezing at night with a space heater and observed to range from about 5 to 20˚ C. To ensure rapid germination, soil cores were moved into a shop area with a temperature of 18˚ C for a one-week period following planting and then returned to the greenhouse for the final week.

Summary:

This study indicates a potential risk for suppression of canola emergence when planted into fall rye cover. Allelopathic effects were the most likely cause for near zero emergence in soil cores containing fall rye terminated with glyphosate 8 days before planting. Emergence improved to near normal (87%) when terminated 21 days before planting. Canola planted into winter wheat terminated 8 days before planting also showed some suppression, possibly due to lower allelopathic effects or because of reduced winter wheat biomass at the time of planting.

Next steps:

More research on the benefits and risks for cover crops, including fall rye ahead of irrigated crops like canola is warranted. Future project work and potential funding is being considered to build on this more controlled study to confirm any of these effects and mitigation strategies under actual field conditions.

Figures 1 and 2. Core samples removed from irrigated fall rye field and placed in greenhouse, October 11, 2017

[10] Fall Rye Allelopathy and Cover Crops. NRCS publication, January, 2016. https://www.nrcs.usda.gov/Internet/FSE_PLANTMATERIALS/publications/mopmstn2825.pdf)

Figure 3. Canola emergence one week after planting for fall rye terminated 21, 13 and 8 days before planting.

Figure 4. Possible dicamba injury on emerging canola for cores extracted from dryland corner area.

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PAMS

Palliser Agricultural Management Society
Box 747 Coalhurst, AB T0L 0V0

March 8, 2018

Palliser Agricultural Management Society (PAMS)
Box 747 Coalhurst, AB T0L 0V0

Payment for contract costs to conduct and report on the following PAMS research trial:
"Fall rye cover crop termination date effect on canola emergence – controlled study"

Attention:

Ward Toma, General Manager
Alberta Canola Producers Commission
14560 – 116 Avenue NW
Edmonton, AB T5M 3E9

Description	$ Total
PAMS contract costs for project implementation and reporting (see total costs below)	$3430.00
Total payable	$3430.00

No GST

Payable to: Palliser Agricultural Management Society

PAMS contract costs for fall rye project (FarmWise Inc.)				
Item	hours/km	Cost	GST	Total
Manpower	54	$ 3,510.00	$ 175.50	$ 3,685.50
Travel	645	$ 322.50	$ 16.13	$ 338.63
Greenhouse & equipment rent		$ 260.00	$ 13.00	$ 273.00
total				$ 4,297.13