Using crop rotation to manage root rot in field peas:
Results from long-term crop rotation studies in Carrington and Hettinger, ND

A collaborative research effort led by Michael Wunsch, plant pathologist at the NDSU Carrington Research Extension Center, and John Rickertsen, agronomist at the NDSU Hettinger Research Extension Center.

Crop rotation is a key tool for managing many crop diseases, but the effectiveness of crop rotation for management of root rot in field peas has been unclear due to limited data and the known persistence of the causal pathogens, *Aphanomyces euteiches* and *Fusarium* spp., in the soil.

To evaluate the use of crop rotation to manage root rot in field peas, the Northern Pulse Growers Association has been funding long-term crop rotation studies at the NDSU Research Extension Centers in Carrington and Hettinger since 2014. The study in Carrington was established on a field with a long history of field pea production and severe root rot pressure in field peas, and it is designed to evaluate the use of crop rotation to manage an existing root rot problem. The study in Hettinger was established on a field with no prior history of field peas, and it is designed to evaluate the use of crop rotation to prevent the development of root rot pressure in field peas.

Both studies are being conducted within a no-till production system. Six rotation treatments are being tested: peas grown every 2 years (pea / wheat), peas grown every 3 years in rotation with wheat (pea / wheat / wheat), peas grown every 4 years in rotation with wheat (pea / wheat / wheat / wheat), peas grown every 4 years in rotation with wheat and canola (pea / wheat / canola / wheat), peas grown every 4 years in rotation with wheat and flax (pea / wheat / flax / wheat), and peas grown every 6 years in a diverse rotation (pea / wheat / barley / canola / wheat / corn). Each plot is 30 feet by 60 feet, and all treatments are repeated in a randomized pattern six times. At the Carrington location, the North Dakota Crop Protection Product Harmonization Board and Registration Board provided supplemental funding to evaluate the response to fungicide seed treatments in 2018 and 2020, when rotational strategies in peas were compared. In 2018, peas were seeded April 30 in Carrington ('Salamanca' yellow peas) and May 8 in Hettinger ('Bridger' yellow peas). In 2020, peas were seeded April 27 in Carrington ('LG Sunrise' yellow peas) and April 27 in Hettinger ('DS Admiral' yellow peas).

Crop rotation, combined with early planting, was an effective tool for root rot management in field peas in Carrington. When planted with a fungicide seed treatment, peas yielded 48-49 bu/ac when grown once every 6 years, 37 to 41 bu/ac when grown once every 4 years, and 39-40 bu/ac when grown every 3 years, and 28-39 bu/ac when grown every 2 years (Tables 1 and 2). The use of a fungicide seed treatment package targeting Pythium, Rhizoctonia and Fusarium increased yield by 4.9 to 5.4 bu/ac in 2020, and the addition of active ingredients targeting Rhizoctonia and Fusarium to a base seed treatment targeting Pythium increased yield by 0.8 to 4.0 bu/ac in 2018. The addition of Intego Solo (targeting Aphanomyces) had a variable impact on yield.

Crop rotation was also an effective tool for reducing root rot severity in field peas in Hettinger (Table 3). By 2020, the seventh year of this study, significant differences in root rot severity were observed across rotational treatments, with root rot severity decreasing with increased crop rotation interval, but root rot severity was not yet a yield-limiting constraint.

Laboratory testing of symptomatic roots indicates that root rot at both locations was caused by multiple Fusarium species and *Aphanomyces euteiches.*

These studies indicate that crop rotation can be a useful tool for managing root rot in field peas, but it is important to emphasize that crop rotation was used in conjunction with early planting. Fusarium and Aphanomyces root rot are favored by warm soils, and early planting when soils are cool allows field peas to get established before conditions become favorable for Fusarium and Aphanomyces. Data on the impact of planting date on field pea agronomic performance under root rot pressure will be presented at the NPGA virtual convention on January 19 and will also be available on the NDSU Carrington Research Extension Center website after the convention.

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Table 1. Impact of crop rotation interval and seed treatment on field pea establishment, root rot, wilted plants, and yield; Carrington, ND (2020). 'LG Sunrise' yellow peas were seeded at 330,000 viable seeds/ac on April 30.

	2-YEAR ROTATION	3-YEAR ROTATION	6-YEAR ROTATION
	PEAS / WHEAT	PEAS / WHEAT / WHEAT / WHEAT	PEAS / WHEAT / BARLEY / CANOLA / WHEAT / CORN
	Peas grown **2014, 2016, 2018, 2020**	Peas grown in **2014, 2017, 2020**	Peas grown in **2014, 2020**
Seed treatment	**PLANT POPULATION** (plants/acre)		
No seed treatment	**185,856** a*	**189,728** a*	**189,341** a*
Obvius (4.6 fl oz/cwt) + **Gaucho** (1.60 fl oz/cwt)	**194,471** a	**201,828** a	**192,342** a
Obvius (4.6 fl oz/cwt) + **Gaucho** (1.60 fl oz/cwt) + **Intego** (0.3 fl oz/cwt)	**200,182** a	**197,956** a	**194,471** a
CV:	9.2	8.4	6.0
Seed treatment	**ROOT ROT SEVERITY** (percent, early vegetative growth)		
No seed treatment	**32** b*	**23** a*	**10** a*
Obvius (4.6 fl oz/cwt) + **Gaucho** (1.60 fl oz/cwt)	**28** b	**18** a	**7** a
Obvius (4.6 fl oz/cwt) + **Gaucho** (1.60 fl oz/cwt) + **Intego** (0.3 fl oz/cwt)	**17** a	**15** a	**7** a
CV:	29.1	27.8	46.2
Seed treatment	**WILTED PLANTS** (percent, mid pod-fill)		
No seed treatment	**7** b*	**6** b*	**2** b*
Obvius (4.6 fl oz/cwt) + **Gaucho** (1.60 fl oz/cwt)	**4** a	**2** a	**1** a
Obvius (4.6 fl oz/cwt) + **Gaucho** (1.60 fl oz/cwt) + **Intego** (0.3 fl oz/cwt)	**4** a	**2** a	**1** a
CV:	13.0	18.7	52.5
Seed treatment	**YIELD** (bushels/acre, 13.5% moisture)		
No seed treatment	**32** b*	**35** b*	**44** b*
Obvius (4.6 fl oz/cwt) + **Gaucho** (1.60 fl oz/cwt) *pests targeted:* Rhizoctonia, Fusarium, Pythium, insects	**37** a	**40** a	**49** a
Obvius (4.6 fl oz/cwt) + **Gaucho** (1.60 fl oz/cwt) + **Intego** (0.3 fl oz/cwt) *pests targeted:* Aphanomyces, Rhizoctonia, Fusarium, Pythium, insects	**39** a	**39** a	**48** a
	6.8	4.9	3.5

* **Within-column means followed by different letters are significantly different (***P* < 0.05; Tukey multiple comparison procedure).

Table 2. Impact of crop rotation interval and seed treatment on field pea establishment, root rot, and yield; Carrington, ND (2018). 'Salamanca' yellow peas were seeded April 30 at 300,000 viable seeds/ac.

	2-YEAR ROTATION	4-YEAR ROTATION	4-YEAR ROTATION	4-YEAR ROTATION
	PEAS / WHEAT	PEAS / WHEAT / WHEAT / WHEAT	PEAS / WHEAT / CANOLA / WHEAT	PEAS / WHEAT / WHEAT / WHEAT
	Peas grown in **2014, 2016, 2018**	Peas grown in **2014, 2018**	Peas grown in **2014, 2018**	Peas grown in **2014, 2018**
Seed treatment	**PLANT POPULATION** (plants/acre)			
Allegiance (0.196 fl oz/cwt) + **Gaucho** (1.60 fl oz/cwt)	**207,491** a*	**245,243** a*	**215,883** a*	**214,025** a*
Evergol Energy (1.0 fl oz/cwt) + **Gaucho** (1.60 fl oz/cwt)	**236,966** a	**240,742** a	**211,411** a	**225,786** a
Evergol Energy (1.0 fl oz/cwt) + **Gaucho** (1.60 fl oz/cwt) + **Intego** (0.2 fl oz/cwt)	**224,770** a	**234,643** a	**231,739** a	**228,980** a
CV:	9.3	6.4	9.6	7.9
Seed treatment	**ROOT ROT SEVERITY** (percent, early vegetative growth)			
Allegiance (0.196 fl oz/cwt) + **Gaucho** (1.60 fl oz/cwt)	**52** a*	**45** a*	**43** a*	**45** a*
Evergol Energy (1.0 fl oz/cwt) + **Gaucho** (1.60 fl oz/cwt)	**54** a	**45** a	**36** a	**44** a
Evergol Energy (1.0 fl oz/cwt) + **Gaucho** (1.60 fl oz/cwt) + **Intego** (0.2 fl oz/cwt)	**53** a	**40** a	**38** a	**41** a
CV:	12.6	11.0	22.4	18.2
Seed treatment	**YIELD** (bushels/acre, 13.5% moisture)			
Allegiance (0.196 fl oz/cwt) + **Gaucho** (1.60 fl oz/cwt) *pests targeted:* Pythium, insects	**24** a*	**35** a*	**37** a*	No Data
Evergol Energy (1.0 fl oz/cwt) + **Gaucho** (1.60 fl oz/cwt) *pests targeted:* Rhizoctonia, Fusarium, Pythium, insects	**28** a	**37** a	**38** a	No Data
Evergol Energy (1.0 fl oz/cwt) + **Gaucho** (1.60 fl oz/cwt) + **Intego** (0.2 fl oz/cwt) *pests targeted:* Aphanomyces, Rhizoctonia, Fusarium, Pythium, insects	**32** a	**41** a	**41** a	No Data
	25.1	23.5	8.2	

Table 3. Impact of crop rotation interval on field pea establishment, root rot, and yield; Carrington and Hettinger, ND (2018 and 2020). In Hettinger, 'Bridger' yellow peas were seeded at 300,000 seeds/ac in 2018 on May 8 and 'DS Admiral' yellow peas were seeded at 180 lbs/ac in 2020 on April 27. See tables 1 and 2 for seeding information for Carrington.

		HETTINGER, ND (2018) field with no field pea production prior to 2014			CARRINGTON, ND (2018) field with a long history of field pea production		
		PLANT POPULATION 4-5 nodes	ROOT ROT SEVERITY early bloom	YIELD	PLANT POPULATION 6 nodes	ROOT ROT SEVERITY 10 nodes	YIELD
		UNTREATED SEED			AVERAGE RESULTS, TREATED & UNTREATED SEED		
Crop rotation	**Years peas planted**	plants/ac	%	bu/ac	plants/ac	%	bu/ac
2-YEAR ROTATION: WHEAT / FIELD PEA	**2014, 2016, 2018**	**143,264** a*	**2** a*	**32** a*	**223,076** ab*	**53** b*	**28** b**
4-YEAR ROTATION: WHEAT / WHEAT / WHEAT / FIELD PEA	**2014, 2018**	**141,715** a	**1** a	**36** a	**240,209** a	**44** ab	**37** ab
4-YEAR ROTATION: WHEAT / CANOLA / WHEAT / FIELD PEA	**2014, 2018**	**143,070** a	**2** a	**32** a	**219,901** b	**39** a	**38** a
4-YEAR ROTATION: WHEAT / FLAX / WHEAT / FIELD PEA	**2014, 2018**	**148,878** a	**2** a	**33** a	**222,930** ab	**44** ab	NO DATA
	CV:	9.1	30.3	10.7	9.3	12.6	25.1

		HETTINGER, ND (2020) field with no field pea production prior to 2014			CARRINGTON, ND (2020) field with a long history of field pea production		
		PLANT POPULATION	ROOT ROT SEVERITY early pod-fill	YIELD	PLANT POPULATION 3-5 nodes	ROOT ROT SEVERITY 4-7 nodes	YIELD
		UNTREATED SEED			AVERAGE RESULTS, TREATED & UNTREATED SEED		
Crop rotation	**Years peas planted**	plants/ac	%	bu/ac	plants/ac	%	bu/ac
2-YEAR ROTATION: WHEAT / FIELD PEA	**2014, 2016, 2018, 2020**	**354,481** a*	**36** c*	**31** b*	**193,503** a*	**26** b*	**36** b*
3-YEAR ROTATION: WHEAT / WHEAT / FIELD PEA	**2014, 2017, 2020**	**328,348** a	**27** b	**34** a	**196,504** a	**19** b	**38** ab
6-YEAR ROTATION: WHEAT / BARLEY CANOLA / WHEAT / CORN / FIELD PEA	**2014, 2020**	**319,286** a	**20** a	**32** ab	**192,051** a	**8** a	**47** a
	CV:	13.6	14.6	7.6	8.0	18.0	5.0

* **Within-column means followed by different letters are significantly different** ($P < 0.05$; Tukey multiple comparison procedure).

** **Within-column means followed by different letters are significantly different** ($P < 0.10$; Tukey multiple comparison procedure).