2023 Final Report

for the

Saskatchewan Pulse Crop Development Board (SPG)

Minor Use Seed Treatment on Fenugreek

(AP2318a)

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1. **Project Code (as is in contract):** AP2318a

2. **Project Title:** Minor Use Seed Treatment on Fenugreek

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Objectives and Rationale

Project Objectives:

The objectives of the proposed project are: 1) to demonstrate the efficacy of Vibrance Maxx RFC on soil-borne pathogens and diseases in fenugreek, 2) to generate tolerance data of Vibrance Maxx RFC in fenugreek for registration label expansion and 3) to demonstrate the effect of Vibrance Maxx RFC on vigour, plant establishment and yield of fenugreek.

Rationale:

Increasing adoption of pulse production across Saskatchewan has led to an increase in the prevalence of fungal pathogens such as Fusarium spp., Rhizoctonia spp., and Pythium spp. These pathogens cause infections commonly referred to as seedling blight, damping off, or wirestem. As a result of increasing fungal infections and pathogens, the use of seed treatments in pulse crops has become an established practice across western Canada over the last 10-15 years. Seed treatments are commonly utilized as the main control method for these early-season fungal pathogens and crop establishment. Fenugreek is a newly adopted pulse crop under the Saskatchewan Pulse Growers (SPG) mandate that requires significant registration and agronomic label expansion research to support grower adoption and establishment in Saskatchewan. A key part of this work is registering a seed treatment on Fenugreek that controls and

prevents fungal pathogen seedling infections. Existing research shows Rhizoctonia solani, Fusarium culmorum and F. solani pose significant risks to fenugreek production in India, Australia, and the United States (Ghule et al., 2021; Rashad et al., 2022). The current lack of a registered seed treatment that provides effective seedling protection, crop establishment, wide inoculant compatibility, and improved vigour and emergence poses a significant barrier to the continued adoption of fenugreek by Saskatchewan producers.

Due to increased infections by these root rot pathogens coupled with the onset of *Aphanomyces euteiches* in 2012, pulse acres have been consistently decreasing since 2017 (SCIC, 2023). Fenugreek is a non-host crop for aphanomyces and provides an alternative pulse crop option for growers struggling with aphanomyces in peas and lentils. The lack of agronomic controls such as seed treatment, inoculant, herbicide etc. are current barriers to increasing adoption of fenugreek in Saskatchewan. This project aims to establish tolerance and efficacy data of a commonly used pulse seed treatment in western Canada, Vibrance Maxx RFC (sedaxane/metalaxyl-M and S-isomer/fludioxonil, PCP No. 32272) (Syngenta Canada Inc). With support and direction from Syngenta, SPG feels Vibrance Maxx RFC is the best option for the pursuit of a minor use label expansion due to a) a long history of safe and effective use by growers familiar with this product, b) inoculant compatibility and c) residue data for Crop Group 26A has been established and only tolerance and efficacy data are required for a User Requested Minor Use Label Expansion (URMULE).

Methodology and Results

Methodology:

The study was arranged as a randomized complete block design (RCBD) with four replications. Treatments consisted of an untreated check, Vibrance Maxx RFC at 100 ml/100 kg of seed (labelled or 1X rate), Vibrance Maxx RFC at 200 ml/100 kg of seed (2X rate), and Apron XL (the commercial standard) at 10 ml/100 kg of seed (Table 1). The rationale for comparing Vibrance Maxx RFC to Apron XL was to understand the disease control differences between the two products, as Apron XL only controls Pythium while Vibrance Maxx RFC controls Fusarium spp., Rhizoctonia spp., and Pythium spp. This allowed for sites to distinguish which fungal pathogens were controlled by the Vibrance Maxx RFC compared to a single active chemistry in Apron XL and an untreated check. The 2X rate of Vibrance Maxx RFC will test for crop safety in the event of potential variability in the dose of the active ingredients applied to the seed.

This trial was conducted at four sites throughout Saskatchewan, including Scott, Indian Head, Prince Albert, and Swift Current. The fenugreek variety used at all sites was CDC Canafen (Appendix A1). The Scott, Prince Albert and Swift Current sites used a Fabro drill with Scott and Prince Albert on 10-inch row spacing and Swift Current on 8.25-inch row spacing. Indian Head used a SeedMaster drill with 12-inch

row spacing. Seed depths ranged from ¾" to 1.5", depending on each locations soil conditions at time of seeding. Celltech NS inoculant was used at each location.

The stubble type varied at each site, consisting of wheat at Scott and Indian Head, oat in Prince Albert and durum in Swift Current. Fertility management was guided by spring soil test recommendations, ensuring that no nutrients would be limiting. Each site calculated seeding rates based on a target plant stand of 250 plants/m^2. Pesticides (herbicides, insecticides, fungicides) were applied based on the site manager's discretion to ensure all pests were kept non-limiting and pesticides were used according to registration guidelines. Plots were combined with small plot combines (Wintersteiger or Zurn) at physiological maturity.

Table 1. Treatment list for "Minor Use Seed Treatment on Fenugreek" at Scott, Indian Head, Prince Albert, and Swift Current, SK., 2023.

#	**Treatment**	**Application Rate**
1	Untreated check	
2	1X rate Vibrance Maxx RFC	100 ml/100 kg seed
3	2X rate Vibrance Maxx RFC	200 ml/100 kg seed
4	Apron XL[a]	10 ml/100 kg seed
[a] delivers the same amount of metalaxyl-m as in Vibrance Maxx RFC and provides control of only Pythium to compare what diseases controlled with Vibrance Maxx RFC.		

Data Analysis

The data was statistically analyzed using R Studio (ver.2021.9.2.382) (Rstudio Team, 2022) to determine the effects of seed treatment products on plant density, plant height, root rot severity, and yield of fenugreek at four locations in Saskatchewan. A random intercept mixed effects model was used with seed treatment product and site as fixed effects and replication as a random effect. When analysis of variance (ANOVA) indicated significant differences ($p < 0.05$), means were separated using the estimated marginal means comparison.

Data Collection

Composite soil samples were collected in the fall of 2022 and/or the spring of 2023 at two soil depths and submitted to Agvise laboratories for analysis of organic matter, pH, cation exchange capacity, and macronutrient concentrations. Plant emergence counts were conducted by counting 4 x 1 meter row lengths per plot approximately 2-3 weeks after seeding (WAS) and again at 4-6 weeks after emergence (WAE). Vigour was measured by recording plant height of 3 plants per plot, coinciding with plant counts. Disease ratings were conducted 4-6 WAE by digging up a minimum of one representative plant per plot for

each replication. Visual root rot assessments were performed according to *fusarium* infection rating scale developed by Dr. Syama Chatterton and pictures were taken to correspond with ratings (Figure 1). Dates were recorded at beginning of flower along with general visual plant health assessments (scale of 1 to 10; where 1 indicated small, chlorotic plants and 5 indicated large, green, healthy plants). Yields were determined from cleaned harvested grain samples and corrected to 12% moisture content. The 2023 and long-term weather data was collected by on-site weather stations and/or Environment Canada, depending on the location.

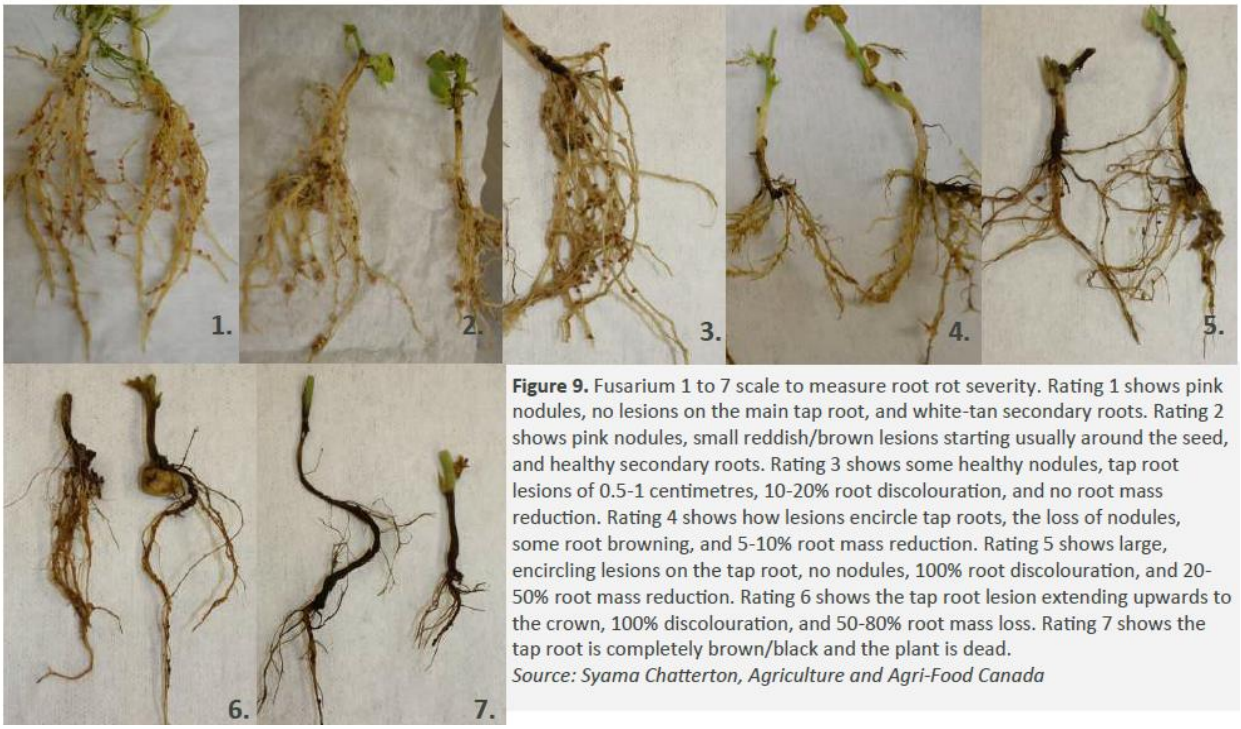

Figure 1. Visual rating scale (1-7) to measure root rot severity.

Growing Conditions

Overall, the growing conditions across all four sites were relatively similar. All sites had temperatures above the long-term average for their areas (Table 2). Swift Current had the lowest seasonal temperature compared to their long-term average (107%), while Scott had the highest temperatures compared to their long-term average (112%). Indian Head had the lowest precipitation compared to their long-term average at 49%, while Swift Current had the highest at 96%. Despite below average precipitation at all sites, most sites had sufficient residual moisture and/or timely rains. On July 22nd, Swift Current's trial was hit with a hail storm, resulting in significant yield losses (estimated 20% yield loss).

Table 2. Total monthly precipitation (mm) and mean monthly temperature (°C) for the 2023 growing season at Indian Head, Prince Albert, Scott, and Swift Current, SK.

Site	Year	May	June	July	August	Total/Average	% of Long Term
		----------total precipitation (mm)----------					
Indian Head	2023	12.9	49.6	15.9	40.8	119.2	49%
	Long-term[x]	51.7	77.4	63.8	51.2	244.1	
Prince Albert	2023	22.8	52.8	40.8	51.2	167.6	67%
	Long-term	44.7	68.6	76.6	61.6	251.5	
Scott	2023	16.6	81.1	11.3	31.7	140.7	65%
	Long-term	36.3	61.8	72.1	45.7	215.9	
Swift Current	2023	48.8	33.8	76.7	47.5	206.8	96%
	Long-term	48.5	72.8	52.6	41.5	215.4	
		----------mean temperature (°C)----------					
Indian Head	2023	14.0	19.4	16.7	17.7	17.0	109%
	Long-term	10.8	15.8	18.2	17.4	15.6	
Prince Albert	2023	14.4	18.8	16.6	17.1	16.7	111%
	Long-term	10.4	15.3	18.0	16.7	15.1	
Scott	2023	14.9	17.2	17.1	17.4	16.7	112%
	Long-term	10.8	15.3	17.1	16.5	14.9	
Swift Current	2023	10.9	15.9	19.8	20.9	16.9	107%
	Long-term	10.9	15.4	18.5	18.2	15.8	

[x]Long-term average: 1981 to 2010 Climate Normal's for each location from Environment Canada

Results:

Soil Test Results

Each site collected soil samples in the fall or spring prior to seeding the trial to determine soil nutrient levels and characteristics. Nitrogen (N) levels followed the order of Swift Current<Indian Head<Scott<Prince Albert, ranging from 4 to 24 lbs/ac. Phosphorus (P) levels were highest at Scott (13 ppm), followed by Swift Current (12 ppm), Prince Albert (7 ppm), and Indian Head (4 ppm). Potassium (K) levels were above adequate at all sites, ranging from 205 ppm (Scott) to 509 ppm (Indian Head). Sulfur (S) levels at the 0-15 cm depth ranged from 6-20 lbs/ac in the order of Swift Current<Indian Head<Scott<Prince Albert. Organic matter ranged from 2.1-4.6% across all four sites. Soil pH at the 0-15 cm soil depth was slightly acidic at Scott (5.5), Prince Albert (5.6), and Swift Current (6.7), and slightly alkaline at Indian Head (8.2). Fenugreek is adapted to grow well in soil pH ranging from 5.3 – 8.2 according to Sask Pulse Growers (2024). Cation exchange capacity (CEC) followed the order of Scott<Swift Current<Prince Albert<Indian Head and is a good indicator of soil texture with higher values generally indicating finer textured, clay soils.

Table 3. Soil test results for Scott, Indian Head, Prince Albert, and Swift Current, SK.

Location	Depth (cm)	N (lb/ac)	P (ppm)	K (ppm)	S (lb/ac)	Organic Matter (%)	Soil pH	CEC (meq)
Scott	0-15	10	13	205	16	3.3	5.5	15.2
	15-30	12	-	-	18	-	6.8	-
Indian Head	0-15	8	4	509	15	4.6	8.2	48.8
	15-60	8	-	-	38	-	8.3	-
Prince Albert	0-15	24	7	238	20	4.1	5.6	15.7
	15-30	24	-	-	24	-	6.5	-
Swift Current	0-15	5	12	207	6	2.1	6.7	15.4
	15-30	4	-	-	6	-	6.9	-

Plant Densities

Plant density of fenugreek was recorded at 2-3 weeks after seeding (WAS) and 3-4 weeks after emergence (WAE). Optimum plant density for fenugreek is 135 plants/m^2 (Sask Pulse Growers, 2024). Plant counts at all sites and both timings recorded plant densities above the optimum, except the Swift Current site. The interaction of seed treatment product and site did not significantly affect plant density of fenugreek at 2-3 WAS ($p=0.782$) or 3-4 WAE ($p=0.942$) (Table 4). Seed treatment products did significantly affect plant density at 2-3 WAS ($p=0.050$), but not at 3-4 WAE ($p=0.081$) (Table 4). This could indicate that the seed treatment, Apron XL, provided an early season vigour response, particularly in Scott, and to a lesser degree at Prince Albert (Table 4). The seed treated fenugreek emerged quicker at the 2-3 WAS than the untreated check, but by 3-4 WAE there was little difference between the treatments. This could largely indicate that the seed treatment provided early season vigour to enhance establishment compared to the untreated check. At 2-3 WAS, the highest plant density was observed by Apron XL (183 plants/m^2), followed by the untreated control (176 plants/m^2), 2X rate Vibrance Maxx RFC (176 plants/m^2), and 1X rate Vibrance Maxx RFC (170 plants/m^2). Similarly, the highest plant density at 3-4 WAE was the untreated control (167 plants/m^2), followed by Apron XL (165 plants/m^2), 2X rate Vibrance Maxx RFC (164 plants/m^2), and 1X rate Vibrance Maxx RFC (156 plants/m^2). Despite minimal differences between seed treatment products, significant differences were observed between the four sites ($p<0.001$) (Figure 3). At both 2-3 WAS and 3-4 WAE, fenugreek plant densities followed the order of Indian Head>Prince Albert>Scott>Swift Current. The response to seed treatments can certainly be noted at Scott and to a smaller extent at Prince Albert.

Table 4. Mean plant density (plants/m^2) for fenugreek planted with seed treatment products at four sites across Saskatchewan, 2023.

Product	All Sites		Scott		Prince Albert		Indian Head		Swift Current	
	----------plant density (plants/m^2) at 2-3 WAS[w]----------									
Untreated Control	176	a[x]	144	a	214	a	262	a	85	a
2X Rate Vibrance Maxx RFC	176	a	153	a	204	a	262	a	87	a
1X Rate Vibrance Maxx RFC	170	a	156	a	210	a	232	a	81	a
Apron XL	183	a	173	a	218	a	258	a	84	a
Site Mean	176		157		212		254		84	
p-value	0.050		0.421		0.961		0.075		0.502	
SEM[z]	36.9		11.8		19.4		9.8		2.6	
	----------plant density (plants/m^2) at 3-4 WAE----------									
Untreated Control	167	A[y]	143	A	186	A	234	A	106	A
2X Rate Vibrance Maxx RFC	164	A	141	A	176	A	228	A	110	A
1X Rate Vibrance Maxx RFC	156	A	132	A	180	A	219	A	93	A
Apron XL	165	A	136	A	194	A	228	A	104	A
Site Mean	163		138		184		227		103	
p-value	0.081		0.710		0.473		0.353		0.229	
SEM	27.2		7.3		9.7		5.6		9.4	

[w]WAS (weeks after seeding), WAE (weeks after emergence).
[x]Different lowercase letters (a-c) within each column indicate significance at $p<0.05$ using estimated marginal means comparison.
[y]Different uppercase letters (A-B) within each column indicate significance at $p<0.05$ using estimated marginal means comparison.
[z]SEM is standard error of the mean.

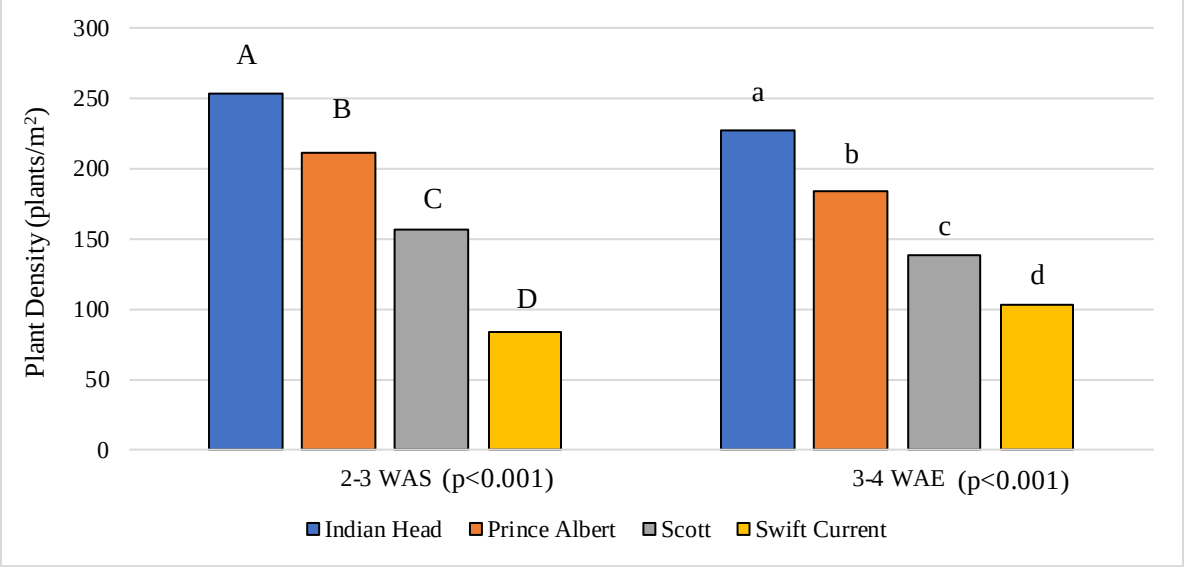

Figure 3. Mean plant density (plants/m^2) of fenugreek at 2-3 weeks after seeding (WAS) and 3-4 weeks after emergence (WAE) at four sites (Indian Head, Prince Albert, Scott, Swift Current) in Saskatchewan, 2023. Different upper-case letters (A-C) indicate significance for data recorded at 2-3 WAS. Different lower-case letters (a-c) indicate significance for data recorded at 3-4 WAE. Significance at $p<0.05$ using estimated marginal means comparison.

Plant Heights

In this study, plant heights were measured to indicate plant vigour of fenugreek. Combined analysis of the four sites, determined no significant difference for product x site interaction at 2-3 WAS (p=0.573) and 3-4 WAE (p=0.242) (Table A3). There was a plant height difference with Apron XL at 2-3 WAS, that corresponds with the early season vigour at plant establishment, but was not significant (p=0.155) (Figure 4; Table 4A). These differences diminished over time as the difference in height between treated and untreated was relatively similar at 3-4 WAS, with the exception of 2X Vibrance. At this rate, there was a significant reduction in plant height (p=0.040). This is a note worthy effect as a high seed treatment rate of Vibrance Max RFC may in fact hinder plant development rather than provide a boost; however, the response was small and heights at the 2X Vibrance did not differ from either 1X Vibrance and Apron XL.

When evaluating site effects on plant height, significance was observed at 2-3 WAS (p<0.001) and 3-4 WAE (p<0.001) (Figure 5). Early in the season (2-3 WAS), Prince Albert had significantly greater plant heights compared to Indian Head and Scott. The Swift Current site did not have data for plant heights at this timing. Plant height trends were slightly different between sites later in the season (3-4 WAE). The Indian Head site showed the greatest plant heights, followed by Prince Albert and Swift Current. The Scott site showed the lowest plant heights. Overall, slight improvements in plant vigour occurred with standard rates of Vibrance Maxx RFC and Apron XL as opposed to 2X rate of Vibrance Maxx RFC; however, plant vigour seemed to be affected to a greater degree by differences between sites across Saskatchewan.

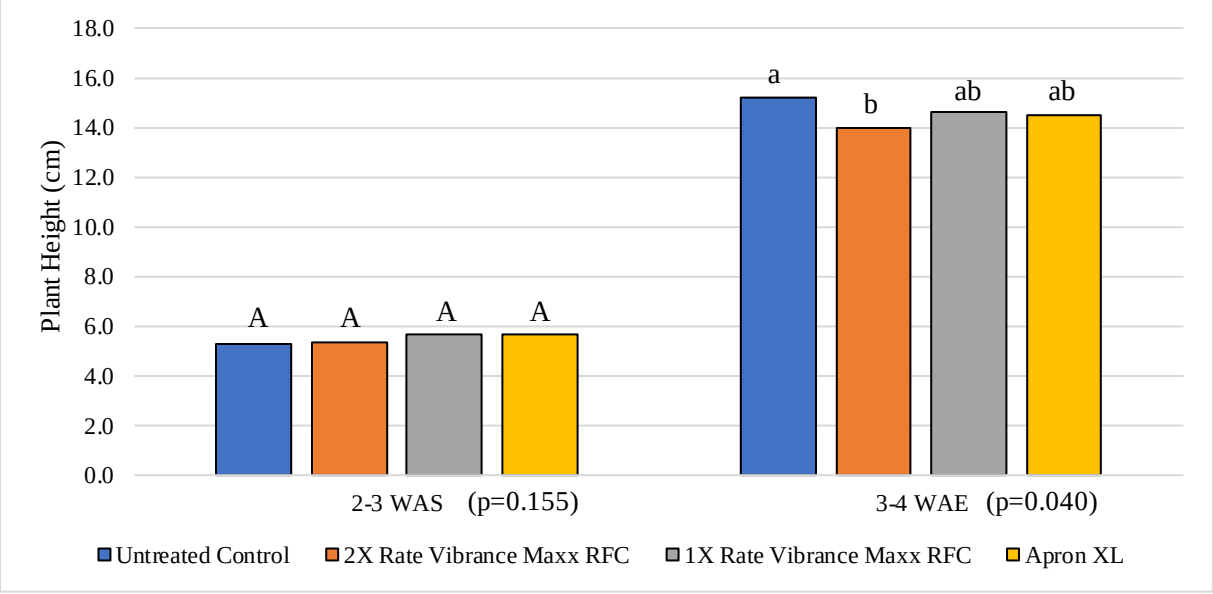

Figure 4. Effect of seed treatments (1X rate Vibrance Maxx RFC, 2X rate Vibrance Maxx RFC, Apron XL) on plant height (cm) of fenugreek at 2-3 weeks after seeding (WAS) and 3-4 weeks after emergence (WAE) at four sites (Indian Head, Prince Albert, Scott, Swift Current) in Saskatchewan, 2023. Different upper-case letters (A-C) indicate significance for data recorded at 2-3 WAS. Different lower-case letters (a-c) indicate significance for data recorded at 3-4 WAE. Significance at p<0.05 using estimated marginal means comparison.

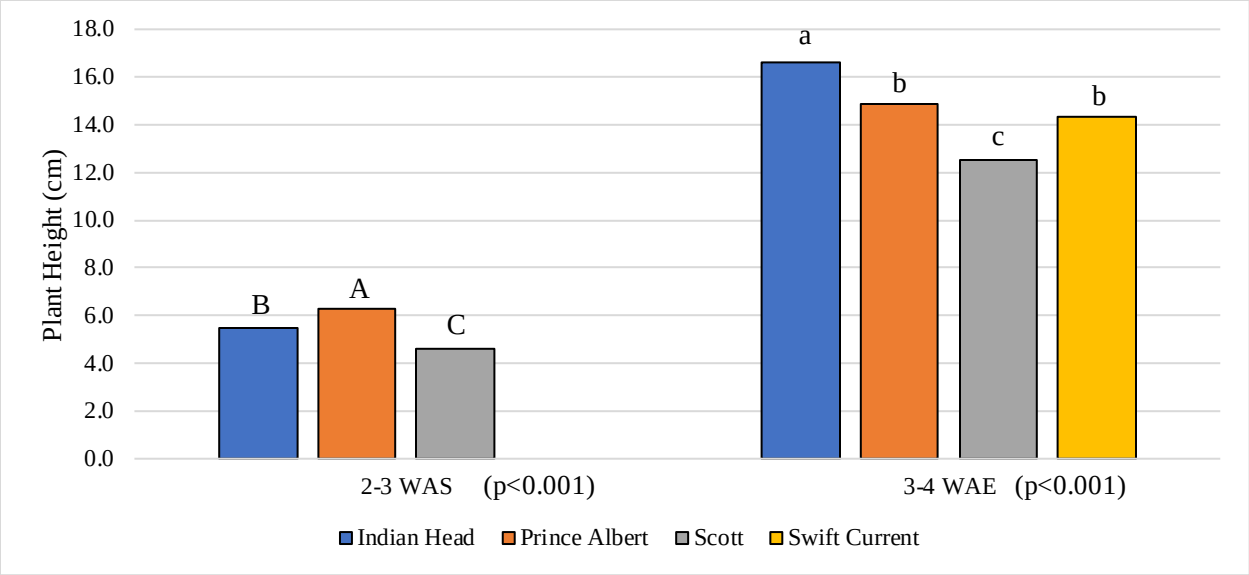

Figure 5. Mean plant height (cm) of fenugreek at 2-3 weeks after seeding (WAS) and 3-4 weeks after emergence (WAE) at four sites (Indian Head, Prince Albert, Scott, Swift Current) in Saskatchewan, 2023. Different upper-case letters (A-C) indicate significance for data recorded at 2-3 WAS. Different lower-case letters (a-c) indicate significance for data recorded at 3-4 WAE. Significance at $p<0.05$ using estimated marginal means comparison. No data available for Swift Current at 2-3 WAS.

Root Rot Severity & Plant Health Assessments

Plants were assessed 4-6 weeks after emergence for visual symptoms of root rot according to fusarium infection rating scale to demonstrate the efficacy of seed treatment products in fenugreek. It is important to note that ratings were conducted on a minimum of one representative plant per plot, which may not provide sufficient sample size for a meaningful data analysis. At the beginning of flowering, visual plant health assessments were conducted to support disease ratings. Assessments were delayed in Prince Albert, occurring during pod fill. The analysis of root rot assessments determined the interaction of seed treatment products and site was not significant ($p=0.917$); nor was the effect of seed treatment product ($p=0.336$) (Table 5). The lowest root rot severity rating occurred with Apron XL, followed by 2X rate Vibrance Maxx RFC, and 1X rate Vibrance Maxx RFC. Similarly, seed treatment x product interaction ($p=0.874$) and seed treatment ($p=0.629$) were insignificant for plant health ratings (Table 5). Treatments from highest to lowest plant health ratings occurred in Apron XL$\geq$2X rate Vibrance Maxx RFC>1X rate Vibrance Maxx RFC. When comparing performance of seed treatment products, Apron XL resulted in lower root rot severity than Vibrance Maxx RFC. Without knowledge of the presence or pressure of fungal pathogens present in the soil, reduced root rot severity in fenugreek treated with Apron XL could indicate that only Pythium species were present. Different results may have been observed with presence of other fungal species, as the single active chemistry in Apron XL only protects against Pythium species. It can be assumed that if soil pathogens were present that could not be controlled by Apron XL, but could be

controlled by Vibrance Maxx, that Vibrance Maxx may result in lower root rot severity. Significant differences were evident between sites for root rot severity ($p<0.001$) and plant health ($p<0.001$) assessments. Root rot severity was greatest at the Scott and Swift Current sites. Whereas the Prince Albert and Indian Head sites had overall low root rot severity. It would be expected that the level of disease pressure and environmental conditions would differ between sites, resulting in varying levels of symptoms in fenugreek. Each site experienced a fairly warm and dry spring compared to their respective long-term averages. Overall, root rot severity was generally low for all treatments at all sites.

Table 5. The effects of seed treatment product and site on visual assessments of root rot severity (1-7) and plant health (1-10) of fenugreek, 2023.

	Root Rot Severity		Plant Health	
Product	----------(1-7)----------		----------(1-10)--------	
Untreated Control	2.70	*a**	7.8	*a*
2X Rate Vibrance Maxx RFC	2.58	*a*	8.0	*a*
1X Rate Vibrance Maxx RFC	2.68	*a*	7.9	*a*
Apron XL	2.48	*a*	8.1	*a*
p-value	0.210		0.562	
SEM	1.00		0.7	
Site				
Indian Head	1.03	*c*	7.0	*c*
Prince Albert	1.00	*c*	7.0	*c*
Scott	5.16	*a*	8.0	*b*
Swift Current	3.25	*b*	9.8	*a*
p-value	<0.001		<0.001	
SEM	0.09		0.2	

*Different letters within columns indicate significance at $p<0.05$ using estimated marginal means comparison for the effects of seed treatment products and sites. SEM is standard error of the mean.

Yield

Fenugreek yields were not significantly different between seed treatment products ($p=0.179$) or the seed treatment x site interaction ($p=0.792$) (Table A6). Seed treatment products yielded relatively similar with large variability between sites (Figure 6). Evaluating stand establishment, the 2X rate had one of the lowest establishment rates at Scott and Prince Albert and had a significant height reduction. Pertaining to this study, height was an indicator of vigour, suggesting fenugreek may not have tolerance to higher seed treatment rates. Although there was no yield difference, the plants were also not abundantly stressed and therefore, a yield difference between treatments did not occur. It would be interesting to see that in cases where the plants are stressed if the 2X rate would improve plant health or hinder it.

Despite minimal differences between products, significant differences were observed between sites ($p<0.001$). The Indian Head site resulted in the highest yields (2721 kg/ha), followed by Prince Albert (2331

kg/ha), Scott (2237 kg/ha), and Swift Current (850 kg/ha) (Figure 7). Average fenugreek yields grown in dryland conditions in Saskatchewan are 1500 kg/ha, with yields ranging from 150-2800 kg/ha (Sask Pulse Growers, 2024). In this study, all sites achieved yields greater than the average except the Swift Current site. Cumulative precipitation from May to August was below the long-term average for each site respectively (Table 2). Despite high yields achieved at Indian Head, Prince Albert, and Scott, precipitation at these sites only ranged from 49-81% of their respective long-term averages. While the Swift Current site was close to their long-term average (96%), the site unfortunately experienced a severe hail storm that greatly reduced yields. Overall, seed treatment products and higher rates of Vibrance Maxx RFC had minimal impact on yield, in moderately good conditions.

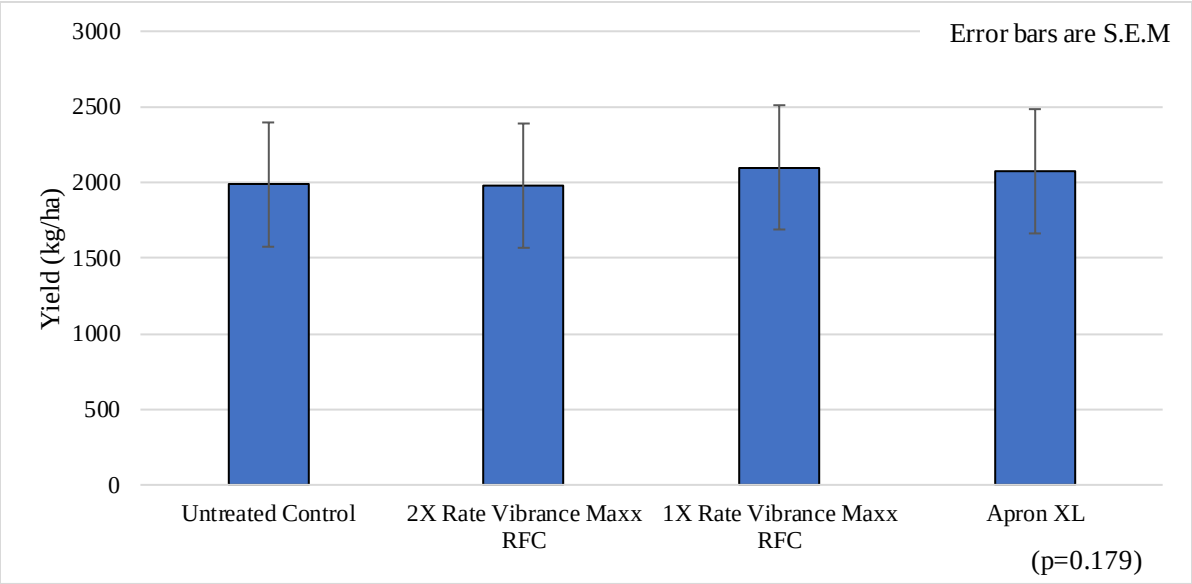

Figure 6. Effect of seed treatments (1X rate Vibrance Maxx RFC, 2X rate Vibrance Maxx RFC, Apron XL) on yield (kg/ha) of fenugreek at four sites (Indian Head, Prince Albert, Scott, Swift Current) in Saskatchewan, 2023. Significance at $p<0.05$ using estimated marginal means comparison.

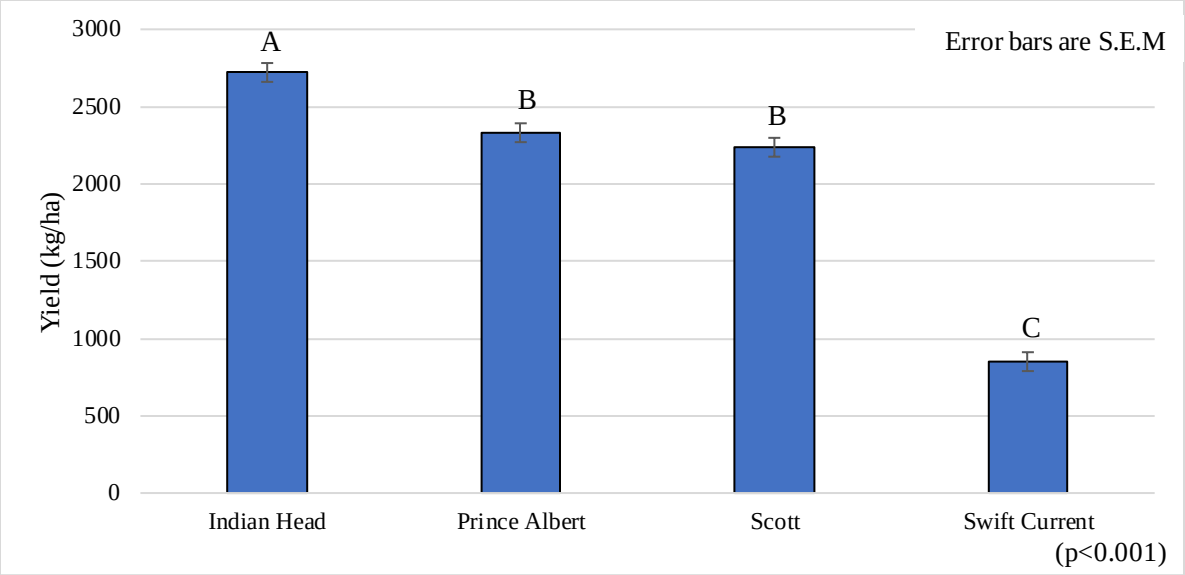

Figure 7. Mean yield (kg/ha) of fenugreek at four sites (Indian Head, Prince Albert, Scott, Swift Current) in Saskatchewan, 2023. Different upper-case letters (A-C) indicate significance at $p<0.05$ using estimated marginal means comparison.

Conclusion:

This study demonstrated performance of seed treatment products (Apron XL and Vibrance Maxx RFC) in fenugreek at various locations in Saskatchewan. Seed treatments did significantly affect plant density at 2-3 WAS ($p=0.050$), but not at 3-4 WAE ($p=0.081$) (Figure 2). This could indicate that the seed treatment, Apron XL, provided an early season vigour response, particularly at Scott, and to a lesser degree at Prince Albert (Table 4). The difference in plant densities between treatments declined over time with the mean plant densities ranging between 170 to 183 plants/m^2 at 3- 4 WAS. Plant height was used as an assessment for plant health and the results indicated that the 2X rate of Vibrance Maxx RFC reduced plant height by 8% compared to the untreated check. This is a note worthy effect as a high seed treatment rate of Vibrance Maxx RFC may in fact hinder plant development rather than provide a boost.

Root rot severity was reduced with application of seed treatment products; however, differences between products were minimal. Greater differences between products may have been observed depending on type of pathogen species present in the soil. Differences in performance of fenugreek between sites was substantial. The greatest plant establishment, vigour and yield was observed at the Indian Head and Prince Albert sites. These sites experienced below average precipitation; however, soil characteristics such as organic matter and CEC were much higher at these sites. Unfortunately, the Swift Current site experienced a significant hail storm which greatly reduced yields. Despite similar warm and dry spring conditions at each site, symptoms of root rot severity were lower at the Indian Head and Prince Albert sites. In conclusion, performance of fenugreek was improved and root rot symptoms lessened with application of seed treatments, although differences between products were minimal.

Extension Activities

A fact sheet will be created and distributed on the websites for all six locations as well as participating in local events to ensure the information will be transferred to producers.

Supporting Information

Acknowledgements

Financial support was provided by Saskatchewan Pulse Growers (SPG). Syngenta Canada and PPMUC are in support of this work as it will serve as submission data for an URMULE label expansion submission of Vibrance Maxx RFC on fenugreek in 2024. The Scott site would like to acknowledge Alex Waldner for statistical analysis and report writing, along with Jessica Enns, Stacy Hawkins, Koralie Mack, Herb Schell, and summer staff for assistance throughout this project. Indian Head, Prince Albert and Swift Current would like to acknowledge all of their staff for their support in conducting this trial.

Appendices:

Appendix A

Table A1. Agronomic information for the study of "Minor Use Seed Treatment on Fenugreek" at a) Scott, b) Indian Head, c) Prince Albert, d) Swift Current.

a) Scott, SK			
Agronomic Information	Product	Rate	Date
Fertilizer	62-19-9-9	180 lbs/ac	May 12, 2023
Seed	Canafen Fenugreek	250 seeds/m^2	May 12, 2023
Herbicide: Pre-plant In-Crop	 Glyphosate 540 & AIM Poast Ultra & Merge	 1 L/ac & 0.35 L/ac 0.45 L/ac & 0.5 L/100L	 May 11, 2023 June 7, 2023
Fungicide	-	-	-
Insecticide: Blister Beetles Grasshoppers	 Decis Decis	 60 mL/ac 60mL/ac	 June 13, 2023 July 7, 2023
Desiccation	Reglone Ion	0.83L/ac	September 5, 2023
Harvest	-	-	September 12, 2023

b) Indian Head, SK			
Agronomic Information	Product	Rate	Date
Fertilizer	Urea (46-0-0), monoammonium phosphate (11-52), potash (0-0-60) and ammonium sulfate (21-0-0-24)	125-35-17-17 kg N-P_2O_5-K_2O-S/ha (sideband)	May 15, 2023
Seed	Canafen Fenugreek	250 seeds/m^2	May 15, 2023
Herbicide: Pre-plant In-Crop	 Roundup Weathermax Odyssey NXT, Caziva Ultra & Merge	 0.67 L/ac 17.3 g/ac, 154 mL/ac & 0.5 L/100L	 May 20, 2023 June 6, 2023
Fungicide	Dyax & Agrol 90	0.160 L/ac & 0.125%	June 26, 2023
Insecticide**:** 1st Grasshoppers 2nd Grasshoppers 3rd Grasshoppers	 Coragen Max Coragen Max Coragen Max	 33.3 mL/ac 33.3 mL/ac 33.3 mL/ac	 June 16, 2023 June 22, 2023 July 21, 2023
Desiccation	Roundup Weathermax	0.67 L/ac	August 15, 2023
Harvest	-	-	August 29, 2023

c) Prince Albert, SK			
Agronomic Information	Product	Rate	Date
Fertilizer	Urea (46-0-0), monoammonium phosphate (11-52), potash (0-0-60) and ammonium sulfate (21-0-0-24)	216-80-37-94 kg N-P2O5-K2O-S/ha (sideband)	May 17, 2023
Seed	Canafen Fenugreek	250 seeds/m^2	May 17, 2023
Herbicide: Pre-plant In-Crop	 Roundup Transorb HC Poast Ultra	 0.67 L/ha 1.1 L/ha	 May 12, 2023 June 8, 2023
Fungicide	-	-	-
Insecticide	-	-	-
Desiccation	Reglone Ion	2.04 L/ha	September 7, 2023
Harvest	-	-	September 14, 2023

d) Swift Current, SK			
Agronomic Information	Product	Rate	Date
Fertilizer	30-15-0-6	333 lb/ac	May 17, 2023
Seed	Canafen Fenugreek	250 seeds/m^2	May 17, 2023
Herbicide: Pre-plant In-Crop	 Roundup Transorb HC 540 Odyssey & Merge	 0.5 L/ac 17.4 g/ac & 0.5 L/100L	 May 12, 2023 June 9, 2023

Fungicide	-	-	-
Insecticide	-	-	-
Desiccation	Reglone Ion & LI700	0.83 L/ac & 0.25 L/100L	September 6, 2023
Harvest	-	-	September 11, 2023

Table A2. Overall test of fixed effects (Pr > F, p-values) for seed treatment products (2X rate Vibrance Maxx RFC, 1X rate Vibrance Maxx RFC, Apron XL) applied to fenugreek at four sites across Saskatchewan, 2023.

Effect	Plant Density		Plant Height		Root Rot Severity	Plant Health	Yield
	2-3 WAS	3-4 WAE	2-3 WAS	3-4 WAE	(1-7)	(1-10)	kg ha-1
Product (P)	0.050	0.236	0.182	0.105	0.336	0.629	0.306
Site (S)	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.001**
P x S	0.782	0.942	0.573	0.242	0.917	0.874	0.792

*Bold p-values indicate significance at p<0.05 using estimated marginal means comparison.
**WAS (weeks after seeding), WAE (weeks after emergence)

Table A3. Mean plant heights (cm) for fenugreek planted with seed treatment products at four sites across Saskatchewan, 2023.

Product	All Sites		Scott		Prince Albert		Indian Head		Swift Current	
	----------plant height (cm) at 2-3 WAS[v]----------									
Untreated Control	5.3	a[w]	4.4	a	6.1	a	5.4	a	NA[Z]	
2X Rate Vibrance Maxx RFC	5.3	a	4.4	a	6.2	a	5.5	a	NA	
1X Rate Vibrance Maxx RFC	5.7	a	4.7	a	6.8	a	5.6	a	NA	
Apron XL	5.7	a	5.2	a	6.3	a	5.5	a	NA	
Site Mean	5.5		4.6		6.3		5.5		--	
p-value	0.155		0.332		0.319		0.643		--	
SEM[Y]	0.5		0.3		0.3		0.1		--	
	----------plant height (cm) at 3-4 WAE----------									
Untreated Control	15.2	A[x]	14.0	A	16.1	A	16.6	A	13.9	A
2X Rate Vibrance Maxx RFC	14.0	B	11.6	A	13.8	A	16.8	A	14.0	A
1X Rate Vibrance Maxx RFC	14.6	AB	12.4	A	15.3	A	16.2	A	14.5	A
Apron XL	14.5	AB	11.8	A	14.5	A	16.8	A	14.9	A
Site Mean	14.6		12.5		14.9		16.6		14.3	
p-value	0.040		0.033		0.082		0.782		0.232	
SEM	0.9		0.6		0.8		0.5		0.7	

[v]WAS (weeks after seeding), WAE (weeks after emergence).
[w]Different lowercase letters (a-c) within each column indicate significance at p<0.05 using estimated marginal means comparison.
[x]Different uppercase letters (A-B) within each column indicate significance at p<0.05 using estimated marginal means comparison.
[y]SEM is standard error of the mean.
[z]NA, no data available

Table A4. Mean disease rating (1-7) for fenugreek planted with seed treatment products at four sites across Saskatchewan, 2023.

Product	All Sites		Scott		Prince Albert	Indian Head		Swift Current	
	----------disease ratings (1-7)----------								
Untreated Control	2.70	a	5.30	a	1.00	1.00	a	3.50	a
2X Rate Vibrance Maxx RFC	2.58	a	5.05	a	1.00	1.00	a	3.25	a
1X Rate Vibrance Maxx RFC	2.68	a	5.35	a	1.00	1.12	a	3.25	a
Apron XL	2.48	a	4.92	a	1.00	1.00	a	3.00	a
Site Mean	2.6		5.2		1.0	1.0		3.3	
p-value	0.210		0.457		--	0.433		0.631	
SEM	1.0		0.2		--	0.1		0.3	

Different letters within each column indicate significance at $p<0.05$ using estimated marginal means comparison.
SEM is standard error of the mean

Table A5. Mean plant health rating (1-10) for fenugreek planted with seed treatment products at four sites across Saskatchewan, 2023.

Product	All Sites		Scott		Prince Albert		Indian Head	Swift Current	
	----------plant health ratings (1-10)----------								
Untreated Control	7.8	a	7.5	a	6.8	a	7.0	9.8	a
2X Rate Vibrance Maxx RFC	8.1	a	8.5	a	6.8	a	7.0	10.0	a
1X Rate Vibrance Maxx RFC	7.9	a	8.0	a	7.0	a	7.0	9.8	a
Apron XL	8.1	a	8.0	a	7.5	a	7.0	9.8	a
Site Mean	8.0		8.0		7.0		7.0	9.8	
p-value	0.562		0.692		0.567		--	0.783	
SEM	0.7		0.6		0.4		--	0.2	

Different letters within each column indicate significance at $p<0.05$ using estimated marginal means comparison. SEM, standard error of the mean.
SEM is standard error of the mean

Table A6. Mean yields (kg/ha) for fenugreek planted with seed treatment products at four sites across Saskatchewan, 2023.

Product	All Sites		Scott		Prince Albert		Indian Head		Swift Current	
	----------yield (kg/ha)----------									
Untreated Control	1986	a	2176	a	2224	a	2706	a	838	a
2X Rate Vibrance Maxx RFC	1979	a	2274	a	2136	a	2680	a	828	a
1X Rate Vibrance Maxx RFC	2100	a	2282	a	2494	a	2730	a	895	a
Apron XL	2074	a	2216	a	2470	a	2771	a	838	a
Site Mean	2034.8		2237.0		2331.0		2721.8		849.8	
p-value	0.179		0.510		0.425		0.532		0.450	
SEM	411		58		203		77		35	

Different letters within each column indicate significance at $p<0.05$ using estimated marginal means comparison.
SEM is standard error of the mean

Abstract/Summary

A field study was conducted at Indian Head, Prince Albert, Scott, and Swift Current in 2023 to demonstrate performance of seed treatment products (Apron XL and Vibrance Maxx RFC) in fenugreek. The objectives of the study were to demonstrate the performance and efficacy of Vibrance Maxx RFC on plant establishment, vigour, root rot symptoms, and yield of fenugreek. In addition, this study provided subsequent data on crop tolerance to higher rates of Vibrance Maxx RFC. Seed treatment had a significant effect on plant density at 2-3 WAS, but not at 3-4 WAE. The difference in plant densities between treatments declined over time with the mean plant densities ranging between 170 to 183 plants/m^2 at 3- 4 WAS. Plant height was used as an assessment for plant health and the results indicated that the 2X rate of Vibrance Maxx RFC reduced plant height by 8% compared to the untreated check. This is a note worthy effect as a high seed treatment rate of Vibrance Maxx RFC may in fact hinder plant development rather than provide a boost. Root rot severity was reduced with application of seed treatment products; however, differences between products were minimal. Greater differences between products may have been observed depending on type of pathogen species present in the soil. Although there was no significant yield difference, the plants were also not abundantly stressed and therefore, a yield difference between treatments did not occur. It would be interesting to see that in cases where the plants are stressed if the 2X rate would improve plant health or hinder it. In conclusion, performance of fenugreek was improved and root rot symptoms lessened with application of seed treatments, although differences between products were minimal.

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