2022

AGTIV®

EFFICACY REPORT

SOYBEANS

PREMIER TECH

3.4 bu/ac 228 kg/ha

SOYBEANS

AVERAGE YIELD INCREASE

87 sites over 7 years
Canada and Europe

7.7%

Soybean split field with AGTIV® SOYBEAN vs competitor inoculant.
Plant growth and health is enhanced on the right,
and row closure occurs sooner in AGTIV® soybean fields.

AGTIV® soybean plants have a better developed root system
with more branching and more nodules.

PREMIER TECH

EFFICACY REPORT
SUMMARY – MYCORRHIZAL & RHIZOBIAL INOCULANT

SOYBEAN

► PLOT & STRIP TRIALS

Research partners: ICMS, AgQuest, New Era Ag research, Stoney Ridge Ag Services, and South East Research Farm (SERF), Tall Pines Agricultural Research Ltd and Black Creek Research.

Research sites: Portage La Prairie (MB), Morden (MB), Oakville (MB), Swan River (MB), Binscarth (MB), Redvers (SK), Elm Creek(MB), Rockwood (ON) and Bright (ON)

Treatments: a) AGTIV® SOYBEAN – Dual inoculant*;
b) Competitor inoculant A*;
c) Competitor inoculant B*;
d) Competitor inoculant C*;
e) Competitor inoculant D*;
f) Competitor inoculant E*.

Experimental design: Total of 88 replicated plots per treatment in randomized complete block design, and one strip trial with 2 replicated strips.

*Products applied according to manufacturers recommended rate.

Table 1. **Summary of Soybean yields (bu/ac)[1] per trial[2].**

Location	Year	Seed variety	AGTIV® SOYBEAN Dual Inoculant	Competitor inoculant				
				A	B	C	D	E
Morden (MB)	2015	Northstar, Anola	31.8 a	27.8 b	30.5 a,b			
Portage La Prairie (MB)	2015	Pride Seeds, PS0035	57.3	55.4	58.2			
Oakville (MB)	2016	Legend Seeds, Eclipse	79.7	77.8	77.7			
Swan River (MB)	2017	Prograin, Dario	40.7 a	35.0 b,c		32.5 c		
Portage La Prairie (MB)	2017	Northstar, Richer	58.3	54.5	54.5	54.7		
Binscarth (MB)	2017	Pioneer Ultra Early	30.11 a	27.71 b	28.99 a,b	28.46 b		
Redvers (SK)	2018	Prograin, Dario	31.1	28.2	25.8			
Swan River (MB)	2018	Prograin, Dario	57.7	47.2	54.3	55.5		
Portage La Prairie (MB)	2018	Secan, Barker	49.4	47.2	47.8			
Elm Creek (MB)	2019	Gray R2	37.1	36.9			35.9	
Redvers (SK)	2019	NSC Watson RR2Y	16.3	14.9		15.8		
Swan River (MB)	2019	Syngenta M2	35.7 a	29.9 b		35.7 a		
Rockwood (ON)	2021	Katonda R2	N/A	43.4	48.4			48.4
Bright (ON)	2021	Katonda R2	72.2	70.7	70.1			69.3

[1] Average yields followed by different letters are significantly different at p≤0.05.
[2] To obtain kg/ha results, multiply bushels per 60 and then by 1.12085 (n*60*1.12085).

PREMIER TECH

EFFICACY REPORT
2021 – RHIZOBIAL AND BACILLUS ON SEED INOCULANT

SOYBEAN

► PLOT TRIAL

Research partner: Black Creek Research

Research site: Bright, ON

Treatments: a) Untreated Check
b) AGTIV® BRADY • Liquid*
c) AGTIV® BB COMBO • Liquid*
d) Competitor B*
e) Competitor A*
f) Competitor E*

* Liquid inoculant applied according to manufacturer's recommended rate

Experimental design: Complete Randomized Block Design, 8 repetitions, 24 m^2 plots

Variety: Katonda R2

Previous crop: Corn

Seeding details: Seeded on May 19, 2021, with a cone seeder at a rate of 60 kg/ha. Seeds pretreated with a commercial rhizobium.

Table 1. **Summary of yields and protein content per treatment.**

Treatment	Yield (bu/ac)	Yield increase (bu/ac)	Protein content (%)
Untreated Check	70.0	-	35.2
AGTIV® BRADY • Liquid	69.9	-	35.9
AGTIV® BB COMBO • Liquid	72.2	2.2	35.3
Competitor B	70.1	0.1	35.5
Competitor A	70.7	0.7	34.9
Competitor E	69.3	-	35.1

Plot operational notes and rain fall.

- No fertilization
- Pesticides:
  - Boundary LQD on May 22
  - Roundup Transorb on June 23
- Harvested on September 29, 2021

Month	Precipitation (mm)
May	26.4
June	86.3
July	84.6
August	121.0
September	162.4
TOTAL	**480.7**

PREMIER TECH

EFFICACY REPORT
2021 – RHIZOBIAL AND BACILLUS ON SEED INOCULANT

SOYBEAN

► PLOT TRIAL

Research partner: Tall Pines Agricultural Research Ltd

Research site: Rockwood, ON

Treatments: a) Untreated Check
b) AGTIV® BRADY • Liquid*
c) AGTIV® BB COMBO • Liquid*
d) Competitor B*
e) Competitor A*
f) Competitor E*

* Liquid inoculant applied according to manufacturer's recommended rate

Experimental design: Complete Randomized Block Design, 8 repetitions, 12 m^2 plots

Variety: Katonda R2

Previous crop: Potato

Seeding details: Seeded on June 11, 2021, with a cone seeder at a rate of 60 kg/ha. Seeds pretreated with a commercial rhizobium

Table 1. **Summary of yields per treatment.**

Treatment	Yield (bu/ac)	Yield increase (bu/ac)
Untreated Check	45.6	-
AGTIV® BRADY • Liquid	47.4	1.8
AGTIV® BB COMBO • Liquid	N/A	
Competitor B	48.4	2.8
Competitor A	43.4	-
Competitor E	48.4	2.8

Plot operational notes and rain fall.

- No fertilization
- Pesticides:
  - July 10, Roundup transorb
- Harvested on November 7, 2021

Month	Precipitation (mm)
May	28
June	95.5
July	128.4
August	28.2
September	142.6
TOTAL	**422.7**

PREMIER TECH

EFFICACY REPORT
2021 – MYCORRHIZAL & RHIZOBIAL INOCULANT

SOYBEAN

► PLOT TRIAL

Research partner: New Era Ag Technologies

Research site: Swan River, MB

Treatments: a) Untreated Check
b) AGTIV® SOYBEAN • Granular*
c) Competitor inoculant E*

* Granular inoculant applied according to manufacturer's recommended rate

Experimental design: Complete Randomized Block Design, 6 repetitions, 20 m^2 plots

Variety: Syngenta M2

Previous crop: Wheat

Seeding details: Seeded on May 18, 2021, with a cone seeder at a rate of 70 kg/ha. Seeds pretreated with a commercial rhizobium.

Table 1. **Summary of yields and protein content per treatment.**

Treatment	Yield [1] (bu/ac)	Yield increase (bu/ac)	Protein content (%)
Untreated Check	41.9 [a]	-	29.5
AGTIV® SOYBEAN • Granular	46.3 [b]	4.4	31.7
Competitor inoculant E	43.5 [b]	1.6	31.1

[1] Yields with same letter are not statistically different according to a Tukey HSD test ($p \leq 0.05$).

Plot operational notes and rain fall.

- Fertilization of 11-52-0 on May 28 at a rate of 86 kg/ha
- Pesticides:
  - June 15 and July 6, RT 540 to control emerged weeds
- Harvested on September 28, 2021

Month	Precipitation (mm)
May	33.0
June	65.9
July	45.5
August	77.1
September	39.0
TOTAL	**260.5**

PREMIER TECH

EFFICACY REPORT
2021 – MYCORRHIZAL & RHIZOBIAL INOCULANT

SOYBEAN

► PLOT TRIAL

Research partner: South East Research Farm (SERF)

Research site: Redvers, SK

Treatments: a) Untreated Check
b) AGTIV® SOYBEAN • Granular*
c) Competitor inoculant E*

* Granular inoculant applied according to manufacturer's recommended rate

Experimental design: Complete Randomized Block Design, 6 repetitions, 8 m^2 plots

Variety: Watson

Previous crop: Wheat

Seeding details: Seeded on May 29, 2021, with a cone seeder at a rate of 75 kg/ha. Seeds pretreated with a commercial rhizobium

Table 1. **Summary of yields and protein content per treatment.**

Treatment	Yield [1] (bu/ac)	Yield increase (bu/ac)	Protein content (%)
Untreated Check	19.1	-	36.9
AGTIV® SOYBEAN • Granular	21.0	1.9	36.4
Competitor inoculant E	20.0	0.9	36.9

Plot operational notes and rain fall.

- Fertilization of MAP 11-48-0 at seeding at a rate of 65 kg/ha
- Pesticides:
  - June 24, Glyphosate to control emerged weeds
- Harvested on September 17, 2021

Month	Precipitation (mm)
May	52.9
June	70.5
July	19.9
August	55.4
TOTAL	**198.7**

PREMIER TECH

EFFICACY REPORT
2019 – MYCORRHIZAL & RHIZOBIAL INOCULANT

SOYBEAN

► PLOT TRIAL

Research partner: AgQuest

Research site: Elm Creek (MB), Canada

Treatments: a) ALPINE G22™ Liquid*;
b) ALPINE G22™ and AGTIV® COMBO • Liquid for SOYBEAN*;
d) ALPINE G22™ and Competitor inoculant A*;
e) ALPINE G22™ and Competitor inoculant D*.

Experimental design: 6 replicated plots per treatment in randomized complete block design

Soybean variety: Gray R2 with *Bradyrhizobium* pre-inoculated on the seed

Previous crop: Barley

Seeding details: Seeded May 28, 2019, with a 21 cm row spacing

*Products applied according to manufacturers' recommended rate

Table 1. **Summary of Soybean yields per treatment.**

Treatment	Yield (bu/ac)	Yield (kg/ha)
ALPINE G22™ Liquid	34.6	2327
ALPINE G22™ and AGTIV® COMBO • Liquid for SOYBEAN	37.1	2495
ALPINE G22™ and Competitor inoculant A	36.9	2482
ALPINE G22™ and Competitor inoculant D	35.9	2414

Plot operational notes and rain fall.

- Three Roundup WeatherMax applications on June 14, July 9, and 24, 2019
- Insecticide (CORAGEN) August 14, 2019
- Combined on October 26, 2019.

Month	Precipitation (mm)
May	42.2
June	59.5
July	91.7
August	40.9
September	196.7
TOTAL	**431**

PREMIER TECH

EFFICACY REPORT
2019 – MYCORRHIZAL & RHIZOBIAL INOCULANT

SOYBEAN

► PLOT TRIAL

Research partner: New Era Ag Research

Research site: Swan River (MB), Canada

Treatments: a) Untreated
b) AGTIV® SOYBEAN • Granular*;
c) Competitor inoculant A applied*;
d) Competitor inoculant C applied*.

Experimental design: 6 replicated plots per treatment in randomized complete block design

Soybean variety: Syngenta M2 with *Bradyrhizobium* pre-inoculated on the seed

Previous crop: Canola stubble

Seeding details: Seeded May 24, 2019, with a 22.4 cm row spacing and a rate of 190 000 seeds/acre.

*Products applied according to manufacturers' recommended rate

Table 1. **Summary of yields and protein content of Soybean per treatment**

Treatment	Yield[1] (bu/ac)	Yield[1] (kg/ha)	Protein content[1] (%)
Untreated	26.5 [a]	1782 [a]	32.87 [a]
AGTIV® SOYBEAN • Granular	35.7 [b]	2401 [b]	37.59 [c]
Competitor inoculant A	29.9 [a]	2011 [a]	35.27 [b]
Competitor inoculant C	35.7 [b]	2401 [b]	37.87 [c]

[1] Yields and protein contents followed by different letters are significantly different (Tukey's test HSD at p≤0.05).

Plot operational notes and rain fall.

- Fertilization:
  - 0-20-10-0 fertilizer applied at season start
- Herbicides applied June 12 and 25, and July 12 (Glyphosate). Insecticide (POUNCE) applied August 12, 2019
- Combined October 7, 2019.

Month	Precipitation (mm)
May	25.7
June	26.1
July	59.4
August	51.8
September	48.8
TOTAL	**211.8**

PREMIER TECH

EFFICACY REPORT
2019 – MYCORRHIZAL & RHIZOBIAL INOCULANT

SOYBEAN

► PLOT TRIAL

Research partner: South East Research Farm (SERF)

Research site: Redvers (SK), Canada

Treatments: a) Untreated
b) AGTIV® SOYBEAN • Granular*;
c) Competitor inoculant A*;
d) Competitor inoculant C*.

Experimental design: 6 replicated plots per treatment in randomized complete block design

Soybean variety: NSC Watson RR2Y with *Bradyrhizobium* pre-inoculated on the seed

Previous crop: Canola

Seeding details: Seeded May 27, 2019, at a rate of 210 000 seeds/acre.

*Products applied according to manufacturers' recommended rate

Table 1. **Summary of Soybean yields per treatment**

Treatment	Yield (bu/ac)	Yield (kg/ha)
Untreated	13.4	901
AGTIV® SOYBEAN • Granular	16.3	1096
Competitor inoculant A	14.9	1002
Competitor inoculant C	15.8	1063

Plot operational notes and rain fall.

- Herbicides applied June 18 (Glyphosate) and July 1 (Viper and UAN)
- Combined October 6, 2019.

Month	Precipitation (mm)
May	18
June	79
July	54
August	88
September	99
TOTAL	**338**

PREMIER TECH

EFFICACY REPORT
2018 – MYCORRHIZAL & RHIZOBIAL INOCULANT

SOYBEAN

► PLOT TRIAL

Research partner: South East Research Farm (SERF)

Research site: Redvers (SK), Canada

Treatments: a) AGTIV® SOYBEAN • Granular*;
b) COMBO AGTIV® • Liquid for SOYBEAN*;
c) Competitor inoculant A*;
d) Competitor inoculant B*.

Experimental design: 8 replicated plots per treatment in randomized complete block design

Soybean variety: Dario

Previous crop: Canola stubble

Seeding details: Seeded May 28, 2018, at 210 000 seeds/ac with 15 cm row spacing

*Products applied according to manufacturers' recommended rate.

Table 1. **Summary of Soybean yields per treatment.**

Treatment	Yield (bu/ac)	Yield (kg/ha)	Protein (%)
AGTIV® SOYBEAN • Granular	31.1	2092	32.5
COMBO AGTIV® • Liquid for SOYBEAN	28.2	1896	29.0
Competitor inoculant A	25.8	1735	28.5
Competitor inoculant B	29.7	1997	30.8

Plot operational notes and rain fall.

- No tillage
- Fertilization: 58 lb/ac of P
- Glyphosate applied twice during growth.
- Combined on September 27, 2018.

Month	Precipitation (mm)
May	13.8
June	44.3
July	19.5
August	17.4
September	27.6
TOTAL	**122.6**

PREMIER TECH

EFFICACY REPORT
2018 – MYCORRHIZAL & RHIZOBIAL INOCULANT

SOYBEAN

► PLOT TRIAL

Research partner: Integrated Crop Management Services (ICMS)

Research site: Portage La Prairie (MB), Canada

Treatments: a) AGTIV® SOYBEAN • Granular*;
b) COMBO AGTIV® • Liquid for SOYBEAN*;
c) Competitor inoculant A*;
d) Competitor inoculant B*.

Experimental design: 8 replicated plots per treatment in randomized complete block design

Soybean variety: Barker

Previous crop: Fallow

Seeding details: Seeded June 6, 2018, with 24 m² per plot.

*Granular products applied according to manufacturers' recommended rate.

Table 1. **Summary of Soybean yields per treatment.**

Treatment	Yield (bu/ac)	Yield (kg/ha)
AGTIV® SOYBEAN • Granular	49.4	3322
COMBO AGTIV® • Liquid for SOYBEAN	47.4	3188
Competitor inoculant A	47.2	3174
Competitor inoculant B	47.8	3215

Plot operational notes and rain fall.

- No fertilization
- Pesticides:
  - Round up on July 5
  - Thiram on July 10, 17 and 27
- Combined on October 19, 2018.

Month	Precipitation (mm)
June	65.1
July	41.1
August	31.8
September	115.3
TOTAL	**253.3**

PREMIER TECH

EFFICACY REPORT
2018 – MYCORRHIZAL & RHIZOBIAL INOCULANT

SOYBEAN

► PLOT TRIAL

Research partner: New Era Ag Research

Research site: Swan River (MB), Canada

Treatments: a) AGTIV® SOYBEAN • Granular applied at 5.1 lb/ac*;
b) Competitor inoculant A applied at 5 lb/ac*;
c) Competitor inoculant B applied at 4.45 lb/ac*;
d) Competitor inoculant C applied at 7.14 lb/ac*.

Experimental design: 8 replicated plots per treatment in randomized complete block design

Soybean variety: Dario

Previous crop: Canola stubble

Seeding details: Seeded May 21, 2018, at 200 000 seeds/ac with 25 cm row spacing

*Granular products applied according to manufacturers' recommended rate.

Table 1. **Summary of Soybean yields per treatment.**

Treatment	Yield (bu/ac)	Yield (kg/ha)	Protein (%)
AGTIV® SOYBEAN • Granular	57.7	3880	34.2
Competitor inoculant A	47.2	3174	31.5
Competitor inoculant B	54.3	3651	33.1
Competitor inoculant C	55.5	3732	33.6

Plot operational notes and rain fall.

- No tillage
- Fertilization:
  - 30 lb/ac of P
  - 40 lb/ac of K
- Pesticides:
  - Glyphosate on June 6, 25 and July 5
  - Proline on July 10
  - Round up + Heat on September 12
- Combined on October 6, 2018.

Month	Precipitation (mm)
May	38.4
June	127.6
July	59.3
August	35.4
September	51.1
TOTAL	**311.8**

PREMIER TECH

► STRIP TRIAL

Research partner: Stoney Ridge Ag Services

Research site: Binscarth (MB), Canada

Treatments: a) AGTIV® SOYBEAN • Granular applied at 5.0 lb/ac;
b) Competitor inoculant A applied at 5.0 lb/ac;
c) Competitor inoculant B applied at 5.0 lb/ac;
d) Competitor inoculant C applied at 5.0 lb/ac.

Experimental design: 2 replicated strips of 1.36 acres per treatment

Soybean variety: Pioneer Experimental Ultra-Early variety, treated with Optimize St.

Previous crop: Canola

Seeding details: Seeded May 20, at 180 000 seeds/ac at 15 in row spacing using DB60

Table 1. **Summary of Soybean yields per treatment.**

Treatment	Yield (bu/ac)[1]	Yield (kg/ha)[1]
AGTIV® SOYBEAN • Granular	30.11 [a]	2025 [a]
Competitor inoculant A	27.71 [b]	1864 [b]
Competitor inoculant B	28.99 [a,b]	1950 [a,b]
Competitor inoculant C	28.46 [b]	1914 [b]

[1] Average yields followed by different letters are significantly different (P < 0.05, 1-way ANOVA + Tukey-Kramer Significance Test)

Plot operational notes and rain fall.

- A blend of 5-23-23-13 applied at 231 lb/ac fall broadcast and incorporated
- Preplant application of Roundup Weathermax + Express SG
- Incrop application of Roundup Transorb HC + Xtendimax and second incrop application of Roundup Weathermax + Pursuit.
- Combined on September 18, 2017, and weighed using J&M Speed Tender.

EFFICACY REPORT
2017 – MYCORRHIZAL & RHIZOBIAL INOCULANT

SOYBEAN

► STRIP TRIAL

Research partner: Down to Earth + PAMI

Research site: Saskatoon (SK), Canada

Treatments: a) AGTIV® SOYBEAN • Granular applied at 5.0 lb/ac + Taurus Advanced Acre (TAA) + fungicide application;

b) AGTIV® SOYBEAN • Granular applied at 5.0 lb/ac + Taurus Advanced Acre (TAA) & no fungicide application;

c) AGTIV® BRADY • Granular for SOYBEAN applied at 4.0 lb/ac + designed fertility.

Experimental design: 2 replicated strips for a total of 540 ft^2 per treatment

Soybean variety: Syngenta, M2 variety, treated with 1.82 ml/kg Optimize St.

Previous crop: Canola / wheat / oats split

Seeding details: Seeded May 20, at 180 000 seeds/ac at 10in row spacing using Seed Master plot Drill by Down to Earth

Table 1. **Summary of Soybean yields per treatment.**

Treatment	Yield (bu/ac)	Yield (kg/ha)
AGTIV® SOYBEAN • Granular + TAA + Fungicide	39.1	2630
AGTIV® SOYBEAN • Granular + TAA & No Fungicide	41.1	2764
AGTIV® BRADY • Granular for SOYBEAN + designed fertility	34.9	2347

Plot operational notes and rain fall.

- Fertility - Seed placed 2-15-0 -0 actual lbs/ac
  - Side band 17-20-15-15 actual lbs/ac
- Viper+UAN applied at 400 ml/ac + 81 ml/ac at 2-3 trifoliate,
  - Roundup was applied at 0.67 L/ac at 3-4 trifoliate
- Combined on September 18 with a Wintersteiger and weighed & moisture averaged by PAMI
- Total rainfall: 100.4 mm

1. **Designed Fertility Program:** a calculated fertility program based on soil tests and targeted yield. Target yield for Soybean was 40 bushels/ac
2. **The Taurus Advanced Acre™:** Using the Designed Fertility Program with the addition of key Taurus solutions.
3. **The Taurus Advanced Acre™ with no Fungicide:** Using the Designed Fertility Program with the addition of key Taurus solutions without the addition of fungicide.

PREMIER TECH

EFFICACY REPORT
2017 – MYCORRHIZAL & RHIZOBIAL INOCULANT

SOYBEAN

► PLOT TRIAL

Research partner: ICMS

Research site: Portage la Prairie (MB), Canada

Treatments: a) AGTIV® SOYBEAN • Granular applied at 5 lb/ac*;
b) AGTIV® BRADY • Granular for SOYBEAN applied at 4 lb/ac*;
c) Competitor inoculant A applied at 5.0 lb/ac*;
d) Competitor inoculant B applied at 4.5 lb/ac*;
e) Competitor inoculant C applied at 7 lb/ac*;
f) Competitor inoculant D applied at 0.063 g/1000 seeds*.

Experimental design: 6 replicated plots per treatment in randomized complete block design

Soybean variety: Northstar Seeds, Richer

Previous crop: Canola

Seeding details: Seeded June 1 at 165 000 plants/ac with 15 cm row spacing using a cone planter

*Granular products applied according to manufacturers recommended rate.

Table 1. **Summary of Soybean yields per treatment.**

Treatment	Yield (bu/ac)	Yield (kg/ha)
AGTIV® SOYBEAN • Granular	58.3	3921
AGTIV® BRADY • Granular for SOYBEAN	54.6	3672
Competitor inoculant A	54.5	3665
Competitor inoculant B	54.5	3665
Competitor inoculant C	54.7	3679
Competitor inoculant D	54.9	3692

Plot operational notes and rain fall.

- 288 lb/ac of 0-80-40-20 N-P-K-S blend was applied and incorporated just before seeding
- Conventional tillage before spring
- Roundup TR 540 was applied at 0.7 L/ac on June 26 and July 14. Cygon to control aphids was applied on August 8.
- Combined on October 12, 2017, with Winterstieger plot combine.

Month	Precipitation (mm)
May	26.8
June	69.9
July	29.4
August	8.8
September	83.8
TOTAL	**218.7**

PREMIER TECH

EFFICACY REPORT
2017 – MYCORRHIZAL & RHIZOBIAL INOCULANT

SOYBEAN

► PLOT TRIAL

Research partner: New Era research

Research site: Swan River (MB), Canada

Treatments: a) AGTIV® SOYBEAN • Granular applied at 5.1 lb/ac*;
b) Competitor inoculant A applied at 5.0 lb/ac*;
c) Competitor inoculant A applied at 10 .0 lb/ac;
d) Competitor inoculant C applied at 7.1 lb/ac*;
e) Competitor inoculant C applied at 14.3 lb/ac.

Experimental design: 8 replicated plots per treatment in randomized complete block design

Soybean variety: Prograin, Dario, treated with 2 ml/kg CBMV and 1.82 ml/kg Optimize

Previous crop: Canola

Seeding details: Seeded May 23, at 200 000 seeds/ac at 10 in row spacing using seedhawk air drill

*Granular products applied according to manufacturers recommended rate.

Table 1. **Summary of Soybean yields per treatment.**

Treatment	Yield (bu/ac)[1]	Yield (kg/ha)[1]
AGTIV® SOYBEAN • Granular	40.7 [a]	2737 [a]
Competitor inoculant A low rate	35.0 [b,c]	2354 [b,c]
Competitor inoculant A high rate	36.5 [b]	2455 [b]
Competitor inoculant C low rate	32.5 [c]	2186 [c]
Competitor inoculant C high rate	35.3 [b,c]	2374 [b,c]

[1] Average yields followed by different letters are significantly different (P < 0.05, Student-Newman-Keuls)

Plot operational notes and rain fall.

- A blend of 7-34-20-0 applied at 102 lb/ac spring broadcast
- Viper+UAN applied at 400 ml/ac + 81 ml/ac at 2-3 trifoliate,
  Roundup was applied at 0.67 L/ac at 3-4 trifoliate and Guardsman at 607 ml/ac at R8.
- Combined on October 10 with Hedge 140 plot combine
- Total rainfall: 197.1 mm.

PREMIER TECH

EFFICACY REPORT
2017 – MYCORRHIZAL INOCULANT

SOYBEAN

► PLOT TRIAL

Research partner: Blackcreek Research

Research site: Bright (ON), Canada

Treatments: a) Untreated;
b) AGTIV® ON SEED™ mycorrhizal inoculant.

Experimental design: 8 replicated plots per treatment in randomized complete block design

Soybean variety: ELITE SEED, Katonda R2

Previous crop: Winter Wheat

Seeding details: Seeded June 9 at 168 000 plants/ac with 38 cm row spacing using a cone planter

Table 1. **Soybean yields per treatment.**

Treatment	Yield (bu/ac)[1]	Yield (kg/ha)[1]
Untreated	41.4 [a]	2782 [a]
AGTIV® ON SEED™ mycorrhizal inoculant	44.0 [b]	2957 [b]

[1]Average yields followed by different letters are significantly different (Tukey's test, $p \leq 0.05$)

Plot operational notes and rain fall.

- No fertilizer was applied
- Conventional tillage in spring
- Boundary Lqd applied at 2.47 l/ha, Broadstrike Rc at 87.5 g/ha, on June 10; Classic at 36 g/ha on June 29.
- Combined on October 19, 2017, with Winterstieger plot combine.

Month	Precipitation (mm)
May	120.0
June	53.5
July	81.0
August	106.0
September	32.0
TOTAL	**392.5**

PREMIER TECH

EFFICACY REPORT
2017 – MYCORRHIZAL INOCULANT

SOYBEAN

► PLOT TRIAL

Research partner: Independent consultant

Research site: St-Simon – #1 (QC), Canada

Treatments: a) Untreated;
b) AGTIV® ON SEED™ mycorrhizal inoculant.

Experimental design: 4 replicated plots per treatment in randomized complete block design

Soybean variety: ELITE SEED, Auriga

Previous crop: Corn

Seeding details: Seeded May 25 at 182 000 plants/ac with 33 cm row spacing using a cone planter

Table 1. **Soybean yields per treatment.**

Treatment	Yield (bu/ac)	Yield (kg/ha)
Untreated	46.4	3119
AGTIV® ON SEED™ mycorrhizal inoculant	48.8	3280

Plot operational notes and rain fall.

- No fertilizer was applied
- Conventional tillage before spring. Vibro before seeding.
- Dual II Magnum at 1.75 l/ha, Firstrate at 20.8 g/ha and Pursuit at 0.312 l/ha on May 25
- Combined on September 27, 2017 with Delta plot combine.

Month	Precipitation (mm)
May	81.5
June	120.4
July	57.4
August	57.6
September	45.0
TOTAL	**361.9**

PREMIER TECH

EFFICACY REPORT
2017 – MYCORRHIZAL INOCULANT

SOYBEAN

► PLOT TRIAL

Research partner: Independent consultant

Research site: St-Simon – #2 (QC), Canada

Treatments: a) Untreated;
b) AGTIV® ON SEED™ mycorrhizal inoculant.

Experimental design: 4 replicated plots per treatment in randomized complete block design

Soybean variety: ELITE SEED, Auriga

Previous crop: Corn

Seeding details: Seeded May 25 at 182 000 plants/ac with 33 cm row spacing using a cone planter

Table 1. **Soybean yields per treatment.**

Treatment	Yield (bu/ac)	Yield (kg/ha)
Untreated	44.3	2953
AGTIV® ON SEED™ mycorrhizal inoculant	45.9	3058

Plot operational notes and rain fall.

- No fertilizer was applied
- Conventional tillage before spring. Vibro before seeding.
- Dual II Magnum at 1.75 l/ha, Firstrate at 20.8 g/ha and Pursuit at 0.312 l/ha on May 25
- Combined on September 27, 2017 with Delta plot combine.

Month	Precipitation (mm)
May	81.5
June	120.4
July	57.4
August	57.6
September	45.0
TOTAL	**361.9**

PREMIER TECH

EFFICACY REPORT
2016 – MYCORRHIZAL & RHIZOBIAL INOCULANT

SOYBEAN

► PLOT TRIAL

Research partner: ICMS

Research site: Oakville (MB), Canada

Treatments: a) AGTIV® SOYBEAN • Granular applied at 5 lb/ac*;
b) Competitor inoculant A applied at 5 lb/ac*;
c) Competitor inoculant B applied at 4.5 lb/ac*;
d) Competitor inoculant C applied at 7 lb/ac*.

Experimental design: 5 replicated plots per treatment in randomized complete block design

Soybean variety: Legend Seeds, Eclipse

Previous crop: Fallow

Seeding details: Seeded at 95 kg/ha with 15 cm row spacing using plot dill and double disc openers

*Granular products applied according to manufacturers recommended rate.

Table 1. **Summary of Soybean yields per treatment.**

Treatment	Yield (bu/ac)	Yield (kg/ha)
AGTIV® SOYBEAN • Granular	79.7	5360
Competitor inoculant A	77.8	5232
Competitor inoculant B	77.7	5225
Competitor inoculant C	75.7	5091

Plot operational notes and rain fall.

- The plot area was cultivated one week before planting
- Roundup TR 540 was applied at 0.66 L/ac one month after planting to control weeds.
- Combined with Winterstieger plot combine.

Month	Precipitation (mm)
May	58.5
June	90.3
July	86
August	99.9
September	43.6
TOTAL	378.3

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EFFICACY REPORT
2015 – MYCORRHIZAL & RHIZOBIAL INOCULANT

SOYBEAN

► PLOT TRIAL

Research partner: AgQuest

Research site: Morden (MB), Canada

Treatments: a) AGTIV® SOYBEAN • Granular applied at 5 lb/ac*;
b) Competitor inoculant A applied at 5 lb/ac*;
c) Competitor inoculant B applied at 4.5 lb/ac*.

Experimental design: 8 replicated plots per treatment in randomized complete block design

Soybean variety: NORTHSTAR genetics, ANOLA variety

Previous crop: Canola

*Granular products applied according to manufacturers recommended rate.

Table 1. **Summary of Soybean yields per treatment.**

Treatment	Yield (bu/ac)[1]	Yield (kg/ha)[1]
AGTIV® SOYBEAN • Granular	31.8 [a]	2139 [a]
Competitor inoculant A	27.8 [b]	1870 [b]
Competitor inoculant B	30.5 [a, b]	2051 [a, b]

[1]Yields followed by different letters are statistically different at alpha 0.05.

Plot operational notes and rain fall.

- Soybeans were planted on June 2, 2015, at 18 cm row spacing and 100 kg/ha
- In season maintenance, Roundup TR 540 was applied at 0.61 L/ac
- Combined with Winterstieger plot combine on Sept 30, 2015.

Month	Precipitation (mm)
May	62.8
June	87.1
July	47.0
August	47.3
TOTAL	244.2

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EFFICACY REPORT
2015 – MYCORRHIZAL & RHIZOBIAL INOCULANT

SOYBEAN

► PLOT TRIAL

Research partner: ICMS

Research site: Portage La Prairie (MB), Canada

Treatments: a) AGTIV® SOYBEAN • Granular applied at 5 lb/ac*;
b) Competitor inoculant A applied at 5 lb/ac*;
c) Competitor inoculant B applied at 4.5 lb/ac*.

Experimental design: 7 replicated plots per treatment in randomized complete block design

Soybean variety: PRIDE SEEDS genetics, PS 0035 NR2 variety

Previous crop: Canola

*Granular products applied according to manufacturers recommended rate.

Table 1. **Summary of Soybean yields per treatment.**

Treatment	Yield (bu/ac)	Yield (kg/ha)
AGTIV® SOYBEAN • Granular	57.3	3853
Competitor inoculant A	55.4	3725
Competitor inoculant B	58.2	3913

Plot operational notes and rain fall.

- Soybeans were planted on May 29, 2015, at 15.2 cm row spacing and 100 kg/ha
- In season maintenance, Roundup TR 540 was applied at 0.61 L/ac
- Combined with Winterstieger plot combine on Oct 6, 2015.

Month	Precipitation (mm)
May	76.2
June	52.6
July	176.7
August	64.2
September	18.4
TOTAL	388.1

PREMIER TECH

PREMIER TECH

Making a difference, this is what we are all about at Premier Tech. One team driven by a shared passion to deliver solutions that will better the lives of people, businesses and communities.

At Premier Tech, People and Technologies connect in lasting, transformative ways, giving life to products and services that help feed, protect and improve our world.

We are committed to creating sustainable solutions that help bring beautiful gardens to life, increase crop yields, improve the efficiency of manufacturing facilities, treat and recycle water, and much more as we keep innovating.

We are Premier Tech

PEOPLE AND TECHNOLOGIES
MAKING A DIFFERENCE

95 years OF PASSION

DRIVING CHANGES TO MAKE A DIFFERENCE

IN 5 BUSINESSES

OUR BRANDS

AGTIV

PRO-MIX wilson

C·I·L ALASKAN

CHRONOS

Ecoflo®

Ecoprocess™

OUR DESIRE TO INNOVATE IS DRIVEN BY THE TECHNOLOGIES WE MASTER

At Premier Tech, innovation is in everything we do. Every day, we invest the time and energy necessary to master the science and technology behind the products we offer. This knowledge allows us to connect our technologies with real market needs, creating products that are relevant today — and for years to come.

Here, we not only seek to create new products, we redefine the very process of innovation to deliver upon our ambitions. It's no longer only about delivering transformative solutions, it's about pushing our technologies forward to bring meaningful solutions to life. Ones that can truly make a difference for our clients.

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INNOVATION

AN INTEGRAL PART OF PREMIER TECH COLLECTIVE DNA

At Premier Tech, Innovation goes beyond the concept of research and development. More than a process leading to the creation of new products, it is a **state of mind that is strongly embedded in our corporate DNA**. Always seeking to **create unique and addictive experiences** for our clients, we simply never cease to push the boundaries of our abilities, competencies and technological platforms.

Creativity is a mix of knowledge, expertise and passion for unprecedented efficient solutions. Innovation, Research & Development and biological active ingredients have combined forces to put commercial offers to the agricultural market.

We first structured our Innovation efforts and approach back in 1983, driven by the ambition of developing value-added products derived from peat moss through technological advances. Today, **more than 260 Premier Tech team members** are devoted full-time to mastering the technologies behind the next leading-edge solutions that will make a difference to our clients, helping them stand out in their marketplaces.

Driven by a collective Culture and rooted in Values which revolve around our tradition of Innovation, the entire Premier Tech team holds a restless ambition to shake up the status quo and shift industry paradigms. Through the current innovation program IPSO: Innovation in Products-Processes, Services and commercial Offers, we are **constantly challenging the way we do business and how we can improve everything we do**.

This mindset is key to how we operate on a daily basis. Contributing to the loyalty of our clients around the world, it sets the ground rules for how collaborating with Premier Tech turns out to be a contagious experience they are willing to share with others.

We deeply believe that in order to continue to be sustainable and grow our market share, it is essential to never let our innovative spirit rest — to keep pushing forward and eliminate any barriers on the path to bringing new technologies, products and services to life in the marketplace. With the agility to truly make a difference by tapping into our full potential, **we make a difference for our clients' profitability**, and ultimately ensure our continued relevance as a strategic partner.

CELEBRATING DECADES OF

35 years
OF EXPERTISE
IN ACTIVE
INGREDIENTS

Established manufacturer and marketer, Premier Tech builds on innovation and collaboration with local partners and growers to offer reliable high-quality inoculants. Every day, in our labs, facilities, and in the field, highly experienced scientists, engineers, and specialists from various domains collaborate to maximize the outcomes of research and turn them into effective products making a difference on your bottom line.

PRODUCTION

In 2000, Premier Tech set up a world-first endomycorrhizal inoculum plant, developing a new mycoreactor process for industrial scale production. Backed by more than 35 years of expertise in active ingredients, Premier Tech constantly develops and innovates in terms of production of MYCORRHIZAE, RHIZOBIUM, BACILLUS, SERENDIPITA and other active ingredients:

- **No contamination through a strictly controlled and aseptic environment**
- **Large-scale manufacturing production**
- **Adapted quality control for each step of the production processes, ensuring consistent high-quality inoculum**

PTAGTIV.COM/en/expertise

INNOVATION AND VALUE

FORMULATION

Premier Tech's know-how makes it possible to adapt formulations with multiple active ingredients, concentrations and carriers tailored to different crops and application methods. Because a quality inoculant makes all the difference, our proven formulations are based on these important elements:

- **Carrier compatible with the active ingredients**
- **Formulations that guarantee active ingredient viability until use**
- **Quality control at several key points ensuring the performance of active ingredients**
- **Various formulations also tailored for organic production**

APPLICATION

Caring about our clients' performance, each recommendation for product use takes into consideration validation by our field experts and by farmers themselves, which ensures:

- **Effective application rates, at the right time and place, with the right inoculant**
- **Products adapted to growers' equipment**
- **Easy integration into farming practices**
- **Validation of compatibility with other agricultural inputs**

SERVICE

The AGTIV® experience combines highly effective value-added products and the access to a team of field experts dedicated to supporting your growth. From our management team and research project managers to our field specialists, our multidisciplinary team is listening to growers' needs to continuously improve our products and level of service:

- **Technical support for product application, equipment compatibility and field demonstration**
- **Proud promoter of science education and knowledge sharing**
- **Partnership with agriculture retailers throughout Canada, the United States and Europe**

PLANT

Nutrients and water are essential components for effective plant growth. Adding biological active ingredients, such as beneficial MYCORRHIZAE, RHIZOBIUM, BACILLUS, and SERENDIPITA, allows an earlier and efficient use of water and nutrients and helps plants reach optimum crop yield.

BIOLOGICAL ACTIVE INGREDIENTS

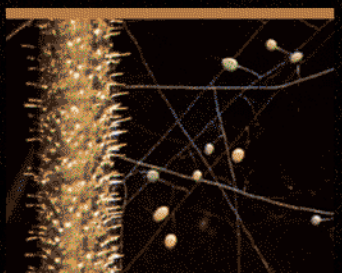
Backed by more than 35 years of expertise in biological active ingredients, Premier Tech masters a unique large-scale manufacturing process that meets the highest quality control standards, allowing you to fully benefit from the highly effective inoculants of our AGTIV® agricultural product line. For stronger growth through better plant resistance to stresses, **higher yields** and superior **crop quality**, you can count on AGTIV®.

M MYCORRHIZAE

PTB297 Technology.
Glomus intraradices

Mycorrhizae are beneficial associations between a mycorrhizal fungus and roots. The mycorrhizal spores germinate in the soil and produce filaments (hyphae) which will enter into root cells. This association will allow the formation of an intra and extra-radical network of filaments that will explore the soil and access more nutrients and water, and transfer them to the plant.

- EXPAND ROOT SYSTEM GROWTH
- ENHANCE NUTRIENT & WATER UPTAKE
- INCREASE TOLERANCE TO STRESSES
- IMPROVE SOIL STRUCTURE



R RHIZOBIUM

PTB160 Technology (pulses).
Rhizobium leguminosarum biovar *viciae*

PTB162 Technology (soybean).
Bradyrhizobium japonicum
Mesorhizobium ciceri (chickpea)

Rhizobium bacteria live and thrive in symbiosis in root nodules produced by the plant. They are responsible for fixing the atmospheric nitrogen and making it available for the plant.

- FIX NITROGEN & MAKE IT AVAILABLE TO THE PLANT

B BACILLUS

PTB180 Technology.
Bacillus pumilus

Bacillus stimulates the plant root system by inducing the proliferation of the root hairs, which favors the absorption of the nutrients. We have selected it for its beneficial action of growth stimulation.

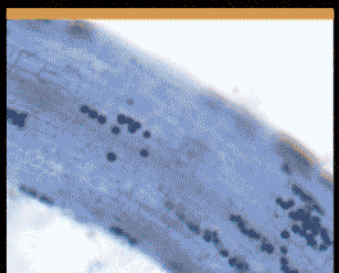
- INCREASES NUMBER OF ROOT HAIRS FOR A BETTER NUTRIENTS' ABSORPTION
- ACCELERATES SEED GERMINATION
- INCREASES PLANT GROWTH

S SERENDIPITA

PTB299 Technology.
Serendipita indica (formerly known as *Piriformospora indica*)

The beneficial fungus *Serendipita indica*, a natural microorganism, forms an association with roots of plants from the Brassicacea family, such as canola. It induces some of the plant gene expression and promotes phytohormone production.

- PROMOTES EARLY SEED GERMINATION
- INCREASES CHLOROPHYLL CONTENT
- BETTER PLANT ESTABLISHMENT, GROWTH AND YIELD



MYCORRHIZAE

EFFICACY – VERSATILITY – COLLABORATION

Why use Premier Tech's mycorrhizae?

Mycorrhizal fungi have existed since the first plants appeared on dry land more than 450 million years ago. AM (Arbuscular Mycorrhizae) symbiosis applies to over 80% of all plants and plays a major role in plant nutrition and productivity. "Over the last 35 years, numerous scientific studies have clearly highlighted the fundamental role that mycorrhizal fungi play in natural eco-systems, and in those managed by man." [A]

How does the technology work? Mycorrhizae develop a network that explores the soil and accesses more nutrients and water to transfer to the plant. The beneficial alliance between mycorrhizal fungi and roots accelerates root development and stimulates plant growth.

Absorption capacity

Premier Tech's mycorrhizal technology makes P more available in the soil, and actively absorbs and transfers it via its filament network (hyphae) directly to the root. The filaments in the soil also have the ability to absorb water and elements such as Cu, Zn, B, Fe, Mn which are important in nodule formation and grain filling.

Mycorrhizae have been shown to improve soil structure by releasing a "biological glue" called glomalin and to increase the presence of other beneficial micro-organisms in the root environment.

"Although mycorrhizal fungi do not fix nitrogen, they transfer energy, in the form of liquid carbon to associative nitrogen fixers." [B]

"Mycorrhiza deliver sunlight energy packaged as liquid carbon to a vast array of soil microbes involved in plant nutrition and disease suppression." [C]

"The absorptive area of mycorrhizal hyphae is approximately 10 times more efficient than that of root hairs and about 100 times more efficient than that of roots." [D]

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PTAGTIV.COM/en/mycorrhizae

Efficient P uptake and transfer

Thonar et al. (2010)[E] compared three species of AMF and observed "*Glomus intraradices*, *Glomus claroideum* and *Gigaspora margarita* were able to take up and deliver P to the plants from maximal distances of 10, 6 and 1 cm from the roots, respectively. *Glomus intraradices* most rapidly colonized the available substrate and transported significant amounts of P towards the roots."

Cavagnaro et al. (2005)[F] found that "*Glomus intraradices* was found to be one of the arbuscular mycorrhizal fungi that was able to control nutrient uptake amounts by individual hyphae depending on differing phosphorus levels in the surrounding soils."

Collaborating Species

The mycorrhizal species used in Premier Tech products (*Glomus intraradices*) is among the most 'collaborative' species in various articles.

"According to the article by Kiers et al. (2011)[G], it has been shown that the different species of mycorrhizae are not equally effective when it comes to transferring nutrients from the soil to the plant. Under controlled conditions, certain species of mycorrhizae have been shown to be more 'cooperative' and to transfer most of the phosphorus absorbed from the soil to the root, while other mycorrhizae species use it or store it as reserve.

"[…] Moreover, when host plants were colonized with three AM fungal species, the RNA of the cooperative species (*G. intraradices*) was again significantly more present than that of the two less-cooperative species (*G. aggregatum* and *G. custos*)" [B]. "This illustrates key differences in fungal strategies, with *G. intraradices* being a 'collaborator' and *G. aggregatum* a less-cooperative 'hoarder'." [G]

Glomus intraradices' versatility in different conditions

There are more than 200 species of AMF (Arbuscular Mycorrhizae Fungi) and Premier Tech offers a versatile species. Selected more than 35 years ago, it has been tested continuously under various conditions and has performed well in a range of soil pH from 5.2 to 8.1.

"*G. intraradices* has turned out to be a "great fungus" in several surveys, and field trials so far has shown it to be equal or superior to mixtures of other fungi." [H]

Indigenous Populations

Some articles demonstrate that mycorrhizal populations in agricultural soils are highly heterogeneous or not sufficient to have the desired beneficial effect.

A survey conducted by Hamel et al. (2008)[I] reported low biodiversity and occurrence of AM fungi in cultivated soils of Saskatchewan. The survey was conducted for 3 years. Dai, M. et al. (2013)[J] noticed that the relative abundance as well as diversity of AM fungal communities is lower in cropland soils of the prairies compared to the roadsides environments which favors diversity.

The recommendation of Premier Tech, approved by Agriculture Canada, to add a mycorrhizal inoculant at the time of seeding stands on 4 points:

- ✓ **The right mycorrhizae for the plant**
  at least 80% of plants can be colonized with *Glomus intraradices*, a collaborative species
- ✓ **Available in the right place**
  on or close to the seed in order to trigger the symbiosis quickly
- ✓ **In the right quantity**
  the proven and registered mycorrhizal rate
- ✓ **At the right time**
  at seeding time to trigger the symbiosis quickly after seed germination

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Quick colonizer

It has been shown that plants favour certain species according to their effectiveness.

"We show that order of arrival can influence the abundance of AMF species colonizing a host. These priority effect can have important implications for AMF ecology and the use of fungal inoculant in sustainable agriculture." [K]

Duan et al. (2011)[L] using our *Glomus intraradices* isolate (DAOM181602) with *G. margarita* (WFVAM 21), wrote "Furthermore, *G. margarita* developed slowly compared with G. intraradices when they were inoculated separately and it seems likely that the latter fungus dominated the symbiosis with medic when both fungi were inoculated together." He adds "The positive effect of *G. intraradices* was probably enhanced by its ability to colonize quickly and it may well have contributed a much larger fraction of fungal biomass than *G. margarita*, when both were inoculated together". In conclusion, he writes "When inoculated together *G. intraradices* may have dominated the activity of symbiosis, both in terms of rapidity of early colonization and functionality, including tolerance to disturbance."

Drought resistance

Mycorrhizae increase tolerance to various environmental stresses (diseases, drought, compaction, salinity, etc.), and play a major role in the soil particle aggregation process and contribute to improving soil structure which leads to better water penetration, better aeration, less erosion and leaching.

Benjamin Jayne and Martin Quigley of the University of Denver mentioned that "[…] our meta-analysis reveals a quantifiable corroboration of the commonly held view that, under water-deficit conditions, plants colonized by mycorrhizal fungi have better growth and reproductive response than those that are not." [K] "Most measures of growth are augmented by the symbiosis when plants are subjected to water stress; […]." [M]

It has been found that plants with AMF association display greater hydraulic conductivity in roots and reduced transpiration rate under drought stress. This may be due to their capacity to regulate their ABA levels (abscisic acid – a plant hormone) better and faster than non-AM plants. This establishes a greater balance between leaf transpiration and root water movement in drought situations and drought recovery.[N]

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RHIZOBIUM

FERTILITY – PRODUCTIVITY – COLLABORATION

Why is rhizobium important?

Peas, lentils and soybeans play a big role in a crop rotation by promoting nitrogen fixation (the conversion of nitrogen gas to plant-available ammonium) and returning some nitrogen to the soil. However, these crops can't take all the credit: because it's only possible thanks to a symbiotic relationship between select legumes and rhizobium bacteria.

These bacteria can't fix nitrogen on their own. To do so, they need to colonize the root of a host plant. As in all symbiotic relationships, both the rhizobium and the pulse or soybean plant get something of value from the relationship. For the legume, it is a readily available form of nitrogen (ammonium) as well as important amino acids. The rhizobium get three things in return:

1. **A Home** – the bacteria inhabit the nodules formed by the plant
2. **Food / energy** – provided in the form carbohydrates (heterotrophic bacteria cannot create their own food through photosynthesis)
3. **Oxygen** – which is necessary for respiration

Roots of the rhizobium relationship

Approximately 20%[A] of all legumes form mutualistic relationships with rhizobium. Soybean, peas, clover, lentils and faba beans are among them. Interestingly, Rhizobium species are very plant specific. Pulses form relationships with a rhizobium called *Rhizobium leguminosarum*, while soybeans engage with another member of the family called *Bradyrhizobium japonicum*.

When a rhizobium and a host legume are present, the plant makes the rhizobium aware of its presence by sending out a chemical signal (via flavonoids and isoflavonoids) from the root. This attracts the rhizobium bacteria, which responds by sending out signals of its own, known as Nod factors.[B]

How does the technology work? Rhizobium are a bacteria that live and thrive in symbiosis in root nodules produced by the plant. These nodules house the bacteria responsible for fixing the atmospheric nitrogen and makes it available for the plant.

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PTAGTIV.COM/en/rhizobium

Nodule formation & nitrogen fixation

The bacteria start the "invasion process" by penetrating the root-hair wall and enter the plant cells. This primes a gene within the plant that initiates the root nodulation. Within these nodules, the rhizobium differentiate into a non-motile form, which go to work fixing the raw atmospheric nitrogen (N_2) into plant accessible ammonium. They achieve this by producing nitrogenase enzyme, which starts the conversion process, consuming a great deal of energy. Maximum N-fixation is reached when the plant is sufficiently nodulated.

Ammonium absorption / exchange of services

After the nodule formation, the plant converts the ammonium into amino acids which are exported throughout the plant. At this point, the plant releases the simple sugars and O_2 to the rhizobium bacteria, fulfilling its end of the bargain.

This last step is important, as the presence of free oxygen can stop nitrogen fixation, preventing ammonium (NH_3) synthesis and transfer to the plant. Fortunately, the rhizobium take the oxygen and bind it using a protein called leghemoglobin (was first discovered in legumes and is very similar to the hemoglobin found in human blood). Like blood, leghemoglobins appear red in the nodules, due to the presence of iron molecules.

Legume plants are known to have a lower phosphorus use efficiency. This is a problem, because the process of nitrogen fixation is very energy-intensive for pulse and soybean plants. For this reason, they consume more phosphorus (P) than other plants.

The increased demand can be alleviated thanks to another symbiotic association, the mycorrhizal symbiosis. Mycorrhizae are symbiotic fungi that colonize the roots of most plants, and dramatically improve the plant's ability to absorb phosphorus. The plant will photosynthesize 51%[C] more and grow faster, and the rhizobium will fix more nitrogen if more phosphorus is available. For this reason, having a healthy mycorrhizal association is of particular benefit to pulses and soybeans.

What modulates / influences nodulation?

- Successful infection depends on the competitiveness, specificity, infectivity and effectiveness of the rhizobia.[D]
- Infection rate & effectiveness of rhizobia are influenced by soil low N status and is a necessary requisite to trigger symbiosis.[E]
- Successful infection requires the bacteria to actively colonize root-hair tips (motility) and reach the Quorum sensing of the rhizobium.[F]
- N fixation relies on a cascade of effector molecules – events in multi-steps series of reactions and depend on effector availability, concentration and localization, synchronization, host specificity and environmental factors.

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PREMIER TECH

THE TRIPARTITE SYMBIOSIS
HELPS YOU GET BIGGER YIELD

How can the tripartite symbiosis improve crop productivity?

Each phase of the plant growth requires a lot of nutrients and energy to obtain higher yield. *"* […] *the tripartite interactions between legumes, AMF* [Arbuscular Mycorrhizal Fungi] *and rhizobia cause increases in legume productivity, and the N:P:C supply ratio as influenced by the tripartite symbiotic associations plays a fundamental role in controlling the legume's photosynthetic rate and biomass productivity."* [A]

How do the technologies work? Mycorrhizae develop a network that explores the soil and accesses more nutrients and water to transfer to the plant; rhizobium fixes nitrogen and makes it available to the plant. By working together, they influence positively the plant for increased yield.

Help feed the plant

N and P are major nutrients for the plant. *"Tripartite associations of host plants with both rhizobia and AMF* [Arbuscular Mycorrhizal Fungi] *benefit the host plant by increased P uptake through the mycorrhizal association balancing the high input of N through rhizobial N-fixation."* [A] In addition, mycorrhizae reach more water and nutrients needed by legumes such as B, Ca, Cu, Fe, K, Mn, Mo and Zn, key components for energy production.

Higher photosynthesis

When used in combination, mycorrhizae and rhizobium increase the photosynthetic rate by 51%[B]. *"The rate of photosynthesis increased substantially more than the C* [Carbon] *costs of the rhizobial and AM* [Arbuscular Mycorrhizal] *symbioses."* [B] The total increased sugar production by the plant far outweighs the cost to "house" the partners.

Better productivity

Better nutrient use efficiency and bigger biomass result in higher yield from each legume plant (harvest index). For example, *"*[…] *it has been found that pea plants coinoculated with Rhizobium leguminosarum and AMF* [Arbuscular Mycorrhizal Fungi] *has shown best results regarding plant height, plant dry mass, nodule fresh weight, number of seeds, seed weight, seed yield, number of root nodules, number of pods per plant, average pod weight and pod length* […]*."* [C]

A Koele et al. 2014. VFRC Report 2014/1, pp. 1-57.
B Kaschuk et al. 2009. Soil Biol. Biochem. 41:1233-1244.
C Shinde et al. 2016. Int. J. Bioassays. 5:4954-4957.

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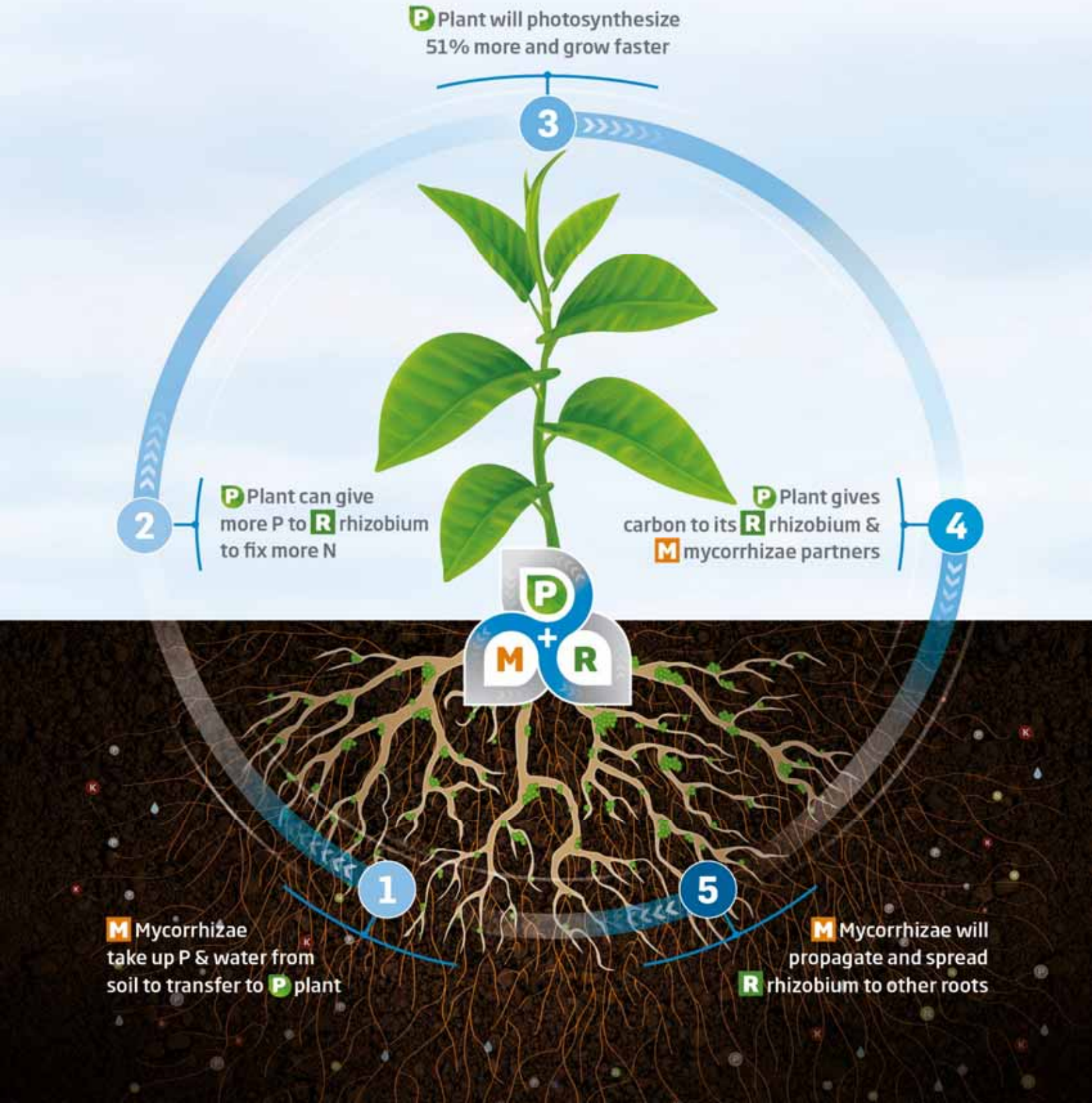
TRIPARTITE SYMBIOSIS

BIOLOGICAL INTERACTIONS BETWEEN MYCORRHIZAE, RHIZOBIUM AND PLANTS

By enhancing root system growth and creating a network of filaments, mycorrhizae help plants to uptake more nutrients, such as phosphorus, and increase the nodulation process for the rhizobium.



THE CANOLA ROTATION INOCULANT

HELPS YOU COUNTER REDUCED YIELD AFTER CANOLA

What affects your soil biology?

Many crop practices (tillage, fallow land, flooding and crop rotation) contribute to decreasing the beneficial biology, such as mycorrhizal fungi population, in your agricultural soils. For example, it is well known that crops following *Brassicaceae* plants (canola and mustard), in a rotation generally tend to demonstrate reduced yield, compared to results when seeded after another crop. It can largely be explained by the relationship (or lack of relationship) between *Brassicaceae* and beneficial microorganisms, such as mycorrhizae[A]. Canola roots exude a toxic compound that reduces populations of those beneficial microorganisms in the soil. Furthermore, the "absence of a mycorrhizal host plant during the fallow period decreases mycorrhizal colonization potential for the succeeding crop and results in P deficiency symptoms in plants that are mycorrhizal dependent, such as corn, soybean, sunflower, and cotton." [B]

A. Gavito, M. E., Miller M. H., 1998. Changes in mycorrhizal development in maize induced by crop management practices. Plant Soil. 198: 185-192.

B. Ellis, J. R., 1998. Plant Nutrition. Post Flood Syndrome and Vesicular-Arbuscular Mycorrhizal Fungi. J. Prod. Agric., Vol. 11, no.2: 200-204.

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D. Jones, C. E. 2009. Mycorrhizal fungi - powerhouse of the soil. Evergreen Farming 8:4-5.

E. Grant, C. A. et al. 2001. The importance of early season phosphorus nutrition. Canadian Journal of Plant Science. 211-224.

Reach more nutrients and water

Sufficient nutrient and water uptake is critical for effective plant growth and ultimately to maximize your yield potential, especially for low mobility nutrients such as P and Zn.[C] By adding a mycorrhizal inoculant, the plant develops a secondary root system (mycorrhizal hyphae) allowing it a larger soil contact surface and thus better to access to nutrients and water. "The absorptive area of mycorrhizal hyphae is approximately 10 times more efficient than that of root hairs and about 100 times more efficient than that of roots." [D]

Ensure early P uptake

"Phosphorus plays a critical role in energy reactions in the plant [such as photosynthesis. Phosphorus is also a key component in building blocs for plant.] Deficits can influence essentially all energy requiring processes in plant metabolism. Phosphorus stress early in the growing season can restrict crop growth, which can carry through to reduce final crop yield." [E] Mycorrhizae make soil phosphorus (P) more available to the plant, and actively absorb and transfer it via the mycorrhizal filament network (hyphae) directly to the root.

Increase your yield potential

By introducing mycorrhizal inoculant close to the seed at seeding, you get the association working early with the full benefits of increased nutrient and water uptake when plants need them. Therefore, get more out of the fertilizer you have already invested into the crop.

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PREMIER TECH

IGNITE™

WHEN IDEAS IGNITE SCIENCE

Making a difference, is Premier Tech. Our scientists, engineers, sales and marketing specialists are always testing and working on new biologicals. In 2019, one of them, *Serendipita indica*, "showed great potential to bring added value for growers to important crops such as Canola, and our teams worked to ensure its viability and performance up to the day that seed goes into the ground" says Dr. Trepanier, scientific expert director at Premier Tech Growers and Consumers. This inoculant collaborates with Canola to IGNITE transcription of plant genes related to nutrient absorption and stress tolerance.

2.5 bu/ac*

(total of 12 replicated trial sites)

* Statistically different vs untreated.

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AGTIV® highly effective inoculants make a difference in the field by pushing crops' yield potential and increasing growers' net returns. Lead the way with Premier Tech's expertise for AGTIVated acres.

	ACTIVE INGREDIENT	ORGANIC	APPLICATION MODE: GRANULAR IN-FURROW	APPLICATION MODE: MIXING WITH SEEDS	APPLICATION MODE: LIQUID IN-FURROW	APPLICATION MODE: LIQUID ON SEED	FORMULATION
PULSES (peas, lentils & faba beans)							
AGTIV® PULSES • Powder **F:** Powder (peat) **S:** 4.7 kg (10.3 lb) pail **C:** Peas & faba beans: **16 ha (40 acres)** – Lentils: **24 ha (60 acres)**	M	R	✓		●			
AGTIV® PULSES • Granular **F:** Granules (peat) **S:** 18.2 kg (40 lb) bag – 364 kg (800 lb) tote bag **C:** Peas, lentils & faba beans: Bag: **4 ha (10 acres)** – Tote bag: **80 ha (200 acres)**	M	R	✓	●				
AGTIV® RHIZO • Granular for PULSES **F:** Granules (peat) **S:** 18.2 kg (40 lb) bag – 364 kg (800 lb) tote bag **C:** Peas, lentils & faba beans: Bag: **4 ha (10 acres)** – Tote bag: **80 ha (200 acres)**		R	✓	●				
AGTIV® RHIZO • Liquid for PULSES ✪ **F:** Liquid **S:** 8 L (8 kg) bag-in-box **C:** Peas, lentils & faba beans: **32 ha (80 acres)** or **6530 kg of seeds (240 bu)**	C	R	✓			●	●	
AGTIV® ON SEED™ — RHIZO • Powder for PULSES **F:** Powder (peat) **S:** 4.7 kg (10.3 lb) pail **C:** Peas & faba beans: **16 ha (40 acres)** – Lentils: **24 ha (60 acres)**		R	✓		●			
SOYBEAN							
AGTIV® SOYBEAN • Powder **F:** Powder (peat) **S:** 4.7 kg (10.3 lb) pail **C:** Soybean: **16 ha (40 acres)**	M	R	✓		●			
AGTIV® SOYBEAN • Granular **F:** Granules (peat) **S:** 18.2 kg (40 lb) bag – 364 kg (800 lb) tote bag **C:** Soybean: Bag: **4 ha (10 acres)** – Tote bag: **80 ha (200 acres)**	M	R	*	●				
AGTIV® BRADY • Granular for SOYBEAN **F:** Granules (peat) **S:** 18.2 kg (40 lb) bag – 364 kg (800 lb) tote bag **C:** Soybean: Bag: **4 ha (10 acres)** – Tote bag: **80 ha (200 acres)**		R	*	●				
AGTIV® BRADY • Liquid for SOYBEAN ✪ **F:** Liquid **S:** 8 L (8 kg) bag-in-box **C:** Soybean: **16 ha (40 acres)** or **5680 kg of seeds (250 units)**	C	R	✓			●	●	
AGTIV® BB COMBO • Liquid for SOYBEAN ✪ **F:** Liquid **S:** 8 L (8 kg) (*Bradyrhizobium*) bag-in-box - 300 ml (*Bacillus*) bottle **C:** Soybean: **16 ha (40 acres)** or **5680 kg of seeds (250 units)**	B	R	✓			●	●	
CANOLA							
AGTIV® IGNITE • L for Brassicaceae **F:** Liquid **S:** 11 L (11 kg) bag-in-box **C:** Canola: **454 kg (1000 lb) of seeds**	S						●	
CHICKPEA							
AGTIV® CHICKPEA • Powder **F:** Powder (peat) **S:** 4.7 kg (10.3 lb) pail **C:** Chickpea: **16 ha (40 acres)**	M	R	✓		●			
AGTIV® CHICKPEA • Granular **F:** Granules (peat) **S:** 18.2 kg (40 lb) bag – 364 kg (800 lb) tote bag **C:** Chickpea: Bag: **3.2 ha (8 acres)** – Tote bag: **64 ha (160 acres)**	M	R	✓	●				
FORAGES							
AGTIV® FORAGES • Powder **F:** Powder (diatomaceous earth) **S:** 1.6 kg (3.5 lb) pail **C:** Alfalfa, mix forages & grass: **8 ha (20 acres)**	M		*		●			

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	ACTIVE INGREDIENT		ORGANIC	APPLICATION MODE						FORMULATION
				IN-FURROW	SEED-PIECE TREATMENT AT THE WAREHOUSE	MIXING WITH SEEDS	INCORPORATION INTO GROWING MEDIA	TRANSPLANTING	SEED TREATMENT	
FIELD CROPS (dry beans, cereals & flax)										
AGTIV® FIELD CROPS – ○ • Powder **F:** Powder (peat) **S:** Case of 4 x 800 g (4 x 1.75 lb) pails **C:** Dry beans, cereals & flax: **32 ha (80 acres)** per case Alfalfa, mix forages & grass: **16 ha (40 acres)** per case	M		✓			●				
AGTIV® FIELD CROPS • Powder **F:** Powder (diatomaceous earth) **S:** 2 kg (4.4 lb) pail **C:** Dry beans, cereals & flax: **16 ha (40 acres)**	M		*			●				
AGTIV® FIELD CROPS • Granular **F:** Granules (zeolite) **S:** 18.2 kg (40 lb) bag – 364 kg (800 lb) tote bag **C:** Dry beans, cereals & flax: Bag: **3.2 ha (8 acres)** – Tote bag: **64 ha (160 acres)**	M		✓	●						
AGTIV® FIELD CROPS • Liquid **F:** Liquid (spores in suspension) **S:** Case of 2 x 950 ml (2 x 32 fl. oz) bottles **C:** Beans, cereals & flax: **16 ha (40 acres)** per case	M	C	✓	●						
POTATO										
AGTIV® POTATO • Liquid **F:** Liquid (spores in suspension) **S:** Case of 2 x 950 ml (2 x 32 fl. oz) bottles **C:** Potato: **8 ha (20 acres)** per case	M		✓	●	●					
GREEN PEAS										
AGTIV® SPECIALTY CROPS — PEA • Powder **F:** Powder (peat) **S:** 2.4 kg (5.3 lb) pail **C:** Green peas: **8 ha (20 acres)**	M	R	✓			●				
SPECIALTY CROPS										
AGTIV® SPECIALTY CROPS • Powder **F:** Powder (diatomaceous earth) **S:** Case of 4 x 500 g (4 x 1.1 lb) pails **C:** Vegetables, berries & garlic	M		**			●	●	●		
AGTIV® SPECIALTY CROPS • Granular **F:** Granules (peat) **S:** 10 kg (22 lb) pail **C:** Vegetables, herbs, berries & fruit trees	M		✓	●			●	●		
AGTIV® ON SEED™ **F:** Treated seeds **C:** Vegetables and fruits Ask your representative for more details.	M	B	*						●	

See last page for complete product recommendations.

F: Formulation
S: Size
C: Crop/ Coverage

ACTIVE INGREDIENTS:

M MYCORRHIZAE PTB297 Technology

R RHIZOBIUM PTB160 Technology (pulses) PTB162 Technology (soybean) *Mesorhizobium ciceri* (chickpea)

B BACILLUS PTB180 Technology

S SERENDIPITA PTB299 Technology (Brassicaceae)

N New product

C Combo available

● Eligible with AGTIV® Extender

ORGANIC:

✓ For organic use

* Non eligible for organic use. Contact us for more details.

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TOOLS

Premier Tech offers technical support for product application, field demonstration, equipment and input compatibility, and promotes educational agronomic knowledge.

- NEW ON SEED™ packages for Pulses, Soybean and Canola
- Labels, SDS, organic certificates
- Application videos, charts and rate calculators

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- Pesticide compatibility lists
- Liquid fertilizer compatibility lists

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- Efficacy report
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EQUIPMENT & PROGRAMS

To ensure performance through efficient and precise application of its inoculants, Premier Tech recommends the use of approved equipment, supported by pay-back programs on selected AGTIV® products.

LIQUID

EQUIPMENT PROGRAM

The **AGTIV® Liquid Injection Kit**, integrating a Dosatron® Injection System, is easy to install on your existing in-furrow application system, it operates off the main solution flow for precise application of AGTIV® liquid products.

RETAILER FRIDGE PROGRAM

Premier Tech recommends to its retailer network the purchase of a fridge that can effectively store AGTIV® liquid products. Contact your representative to learn more.

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POWDER

Premier Tech has a list of recommended applicators to use with AGTIV® powder products. Ask your representative to learn more about the applicators and the pay-back program offered.

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AVERAGE YIELD INCREASE BY CROP

See all results at PTAGTIV.COM/en/results

LENTILS

2.7 bu/ac

AVERAGE YIELD INCREASE
64 sites over 12 years, Canada
10.1%

PEAS

3.6 bu/ac

AVERAGE YIELD INCREASE
22 sites over 10 years, Canada
6.3%

SOYBEAN

3.4 bu/ac

AVERAGE YIELD INCREASE
87 sites over 8 years, Canada and Europe
7.7%

DRY BEANS

252 lb/ac

AVERAGE YIELD INCREASE
12 sites over 5 years, Canada
9%

CHICKPEA

1.5 bu/ac

AVERAGE YIELD INCREASE
2 sites over 1 year, Canada
4%

DURUM WHEAT

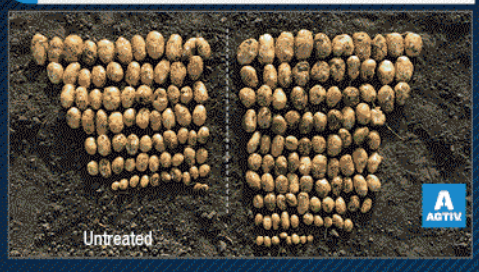
3.8 bu/ac

AVERAGE YIELD INCREASE
12 sites over 7 years, North America
6.5%

POTATO

31.6 cwt/ac

AVERAGE YIELD INCREASE
1172 sites over 11 years, North America and Europe
10%



BARLEY

7.3 bu/ac

AVERAGE YIELD INCREASE
28 sites over 6 years, Canada and Europe
10.5%

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