Project title:	**Horticulture Strategic Centres for Field Vegetables: The effects of biostimulants in vining peas**
Project number:	FV 462
Project leader:	Jim Scrimshaw, PGRO
Report:	Annual report, June 2020
Previous report:	NA
Key staff:	Rob Glover Tom Jelden Lea Herold
Location of project:	Holbeach, Lincolnshire
Industry Representative:	Richard Fitzpatrick, HMC Peas,
Date project commenced:	01 March 2018

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The results and conclusions in this report are based on an investigation conducted over a one-year period. The conditions under which the experiments were carried out and the results have been reported in detail and with accuracy. However, because of the biological nature of the work it must be borne in mind that different circumstances and conditions could produce different results. Therefore, care must be taken with interpretation of the results, especially if they are used as the basis for commercial product recommendations.

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GROWER SUMMARY

Headline

None of the biostimulant applications had any statistically significant effects on crop emergence or chlorophyll content.
There were no statistically significant effects of any products on the incidence of pea downy mildew or root rot, although lower levels of downy mildew were recorded in plots containing three of the seed treatments.
Trials were not harvested due to high levels of bird damage and Fusarium foot rot.

Background

Yield potential is determined by environment, genetics and phenology versus yield loss and quality which is determined by abiotic and biotic stresses. Can a biostimulant produce a positive response to the effects of stress? The European biostimulants industry council (EBIC) defined biostimulants as follows: “Plant biostimulants contain substance(s) and/or micro-organisms whose function when applied to plants or the rhizosphere is to stimulate natural processes to enhance/benefit nutrient uptake, nutrient efficiency, tolerance to abiotic stress, and crop quality.” (Biostimulant, 2013).
Soil-borne disease management is a key priority for legume production and crop quality in the UK and Europe. New biological products may offer an opportunity to improve management of soil-borne diseases and the trials tested several biostimulants, biocontrol agents and nutritional products in field conditions.
Aphanomyces euteiches (root rot) and *Peronospora viciae* (downy mildew) are soil-borne diseases that cause major yield losses, uneven maturity and quality reduction in peas. They produce long-lasting resting spores which lead to a build-up of soil disease levels when legumes are grown regularly in rotations. Root rot is increasing in areas of the UK previously thought to be free of the disease and there are currently no chemical means of control. Current usage restrictions for plant protection products have led to difficulty controlling downy mildew in peas.
Previous work conducted by PGRO showed some positive effects when using biostimulant products and there has been increased grower demand for alternatives to replace pesticide losses. Two soil-applied products, five seed treatments, four foliar applied products and one combined soil and foliar treatment were selected to cover a range of application methods and ingredients.
These trials aimed to evaluate the effects of biostimulant products in peas; to assess the potential benefits they add to yield and disease tolerance; to identify trends that show which product(s) and application method(s) are best suited to each crop; and to improve decision making when using biostimulants in the field.

Summary

Two trials were established at Holbeach in Lincolnshire to evaluate the nutritional and biocontrol products (biostimulants).

Treatments were as follows:

	Product name	Rate	Mode of application	Ingredients
1	Untreated	_	_	_
2	TFP Pro Soil	1.0 l/ha	Soil application	Plant extracts, enzymes, minerals and metabolites
3	Serenade ASO	8.0 l/ha	Soil application	*Bacillius stubtilis*
4	Radiate	2.0 l/tonne	Seed treatment	Micronutrient blend
5	Start-uP	2.0 l/tonne	Seed treatment	Calcium, sulphur and zinc
6	Take Off ST	1.0 l/tonne	Seed treatment	Phosphite, manganese, zinc, biostimulant PGA
7	MultiMax GPA	200 ml/tonne	Seed treatment	Phosphite, manganese, zinc, biostimulant
8	KickOff	4.0 l/tonne	Seed treatment	Phosphorous, manganese, potassium, nitrogen, zinc, sulphate, amino acid
9	TFP Pro-Tect	1.0l/ha	Foliar application	Plant extracts, enzymes, minerals and metabolites
10	Zynergy + Na13	1.0 l/ha + 0.1% sp/v	Foliar application	Copper, zinc, sulphur
11	Foliar Tonic (Agrihit)	0.667 l/ha	Foliar application	Plant Extracts
12	Phorce	1.0 l/ha	Foliar application	NPK 03:38:15 (P as phosphite)
13	Prestop	250g/in 300 litres H2O	Foliar application	*Gliocladium catenulatum* J1446

At both sites the effects of the products on plant emergence (for soil and seed treatments) and chlorophyll content (all treatments) were evaluated. At one site the effects of the products on *P. viciae* (downy mildew) were evaluated and at the other site the effects on *A. euteiches* (root rot) were evaluated.

Financial Benefits

No current information available.

Action Points

There are no actions recommended as a result of these trials.

SCIENCE SECTION

Introduction

Materials and methods

Two trials were established in the Holbeach area, one at Fleet Hargate (OS reference TF 38622333) and the other at Holbeach Hurn (OS reference TF 41512950). The site at Holbeach Hurn had a history of downy mildew infection and the soil at Fleet Hargate was tested and shown to have *Aphanomyces euteiches* present. Soil type at both was predominantly silty clay loam. The trial was laid out in a randomised complete block design with four replications, each containing an untreated control. There were three product applications methods in four combinations. Seed, soil, foliar and a soil + foliar combination.

Table 1: Treatments applied at Holbeach Hurn and Fleet Hargate vining pea trials in 2019

Trt No	Product name	Rate	Application Method	Number of applications	Application Timing		
					T0	T1	T2
1	Untreated	–	–	–			
2	TFP Pro Soil	1.0 l/ha	Soil	1	pre drilling	–	–
3	Serenade ASO	8.0 l/ha	Soil	1	pre/post drilling	–	–
4	Radiate	2.0 l/tonne	Seed	1	seed	_	_
5	Start-uP	2.0 l/tonne	Seed	1	seed	_	_
6	Take Off ST	1.0 l/tonne	Seed	1	seed	_	_
7	MultiMax GPA	200 ml/tonne	Seed	1	seed	_	_
8	KickOff	4.0 l/tonne	Seed	1	seed	_	_
9	TFP Pro-Tect	1.0l/ha	Foliar	2	–	4-5 leaf pairs	21DALA
10	Zynergy + Na13	1.0 l/ha + 0.1% sp/v	Foliar	2	–	early flower	10-14DALA
11	Foliar Tonic (Agrihit)	0.667 l/ha	Foliar	2	–	early flower	10-14DALA
12	Phorce	1.0 l/ha	Foliar	2	–	2nd node	pre flowering
13	Prestop	250g/in 300 litres H2O	Soil + Foliar	2	pre-emergence	flower bud	

Table 2: Products and active ingredients tested in the trials at Holbeach Hurn and Fleet Hargate vining pea trials in 2019

Product	Ingredient(s)
TFP Pro Soil	Plant extracts, enzymes, minerals and metabolites
Serenade ASO	*Bacillius stubtilis*
Radiate	Micronutrient blend
Start-uP	Calcium, sulphur and zinc
Take Off ST	Phosphite, manganese, zinc, biostimulant PGA
MultiMax GPA	Phosphite, manganese, zinc, biostimulant
KickOff	Phosphorous, manganese, potassium, nitrogen, zinc, sulphate, amino acid
TFP Pro-Tect	Plant extracts, enzymes, minerals and metabolites
Zynergy	Copper, zinc, sulphur
Foliar Tonic	Plant Extracts
Phorce	NPK 03:38:15 (P as phosphite)
Prestop	*Gliocladium catenulatum* J1446

Spray applications were made using a handheld compressed air AZO plot sprayer, using flat fan LD110 nozzles, operating at 2 bar air pressure. All sprays were applied in 200 l water/ha except for treatment 13 which was applied in 300 l/ha water.
Seed treatments were applied using a Hege seed treating machine.

Holbeach Hurn trial diary:

The vining pea variety was Savannah. Target population was 100 plants/m^2 and these were planted at 25cm row spacings;
11th April 2019: The trial was drilled. Treatments 2, 3 and 13 were applied as spray applications;
30th April 2019: Treatment 12 was applied, and plant emergence was recorded by recording the number of plants per quadrat in three quadrats per plot;
13th May 2019: Treatment 9 was applied;
31st May 2019: The level of downy mildew was evaluated by recording percentage leaf area infection on 25 plants per plot (EPPO PP 1/65 (3));
6th June 2019: Treatment 9 was applied;
12th June 2019: Treatments 10, 11, 12 and 13 were applied;
26th June 2019: Treatments 10 and 11 were applied;

8th July 2019: Evaluation of chlorophyll content (mg/cm^2) was carried out using an atLEAF CHL PLUS chlorophyll meter.

Fleet Hargate

The vining pea variety was Savannah. Target population was 100 plants/m^2 and these were planted at 25cm row spacings;
7th May 2019: The trial was drilled. Treatments 2, 3 and 13 were applied as foliar sprays;
23rd May 2019: Plant emergence was recorded by recording the number of plants per quadrat in three quadrats per plot;
31st May 2019: Treatment 12 was applied;
12th June 2019: Treatment 9 was applied;
26th June 2019: Treatments 9, 10, 11, 12 and 13 were applied;
8th July 2019: Treatments 10 and 11 were applied;
15th July: Symptoms of foot rot were evaluated on 20 plants per plot, using below ground symptoms of root disease on a 0-5 scale, where 0 = no infection and 5 = total infection.
Severity of symptoms and results should be interpreted as follows:
Less than 2 – mildly infected with foot rot with low effect on yield;
3 and 4 – medium infection with foot rot and plants suffer from decreased ability to take up water and nutrients.
Greater than 4 are – heavily infected with foot rot, plant death possible and large reductions in yield can be expected.
Evaluation of chlorophyll content (mg/cm^2) was carried out using an atLEAF CHL PLUS chlorophyll meter.
Neither of the trials was harvested due to bird damage at Holbeach Hurn immediately prior to harvest, and excessive foot rot disease infection at Fleet Hargate. The commercial crop surrounding the trial at Fleet Hargate was also by-passed due to disease infection.

Data from both trials was analysed using Analysis of Variance in STAR® and ARM®.

Results

There were no significant differences in emergence between treatments at either site.

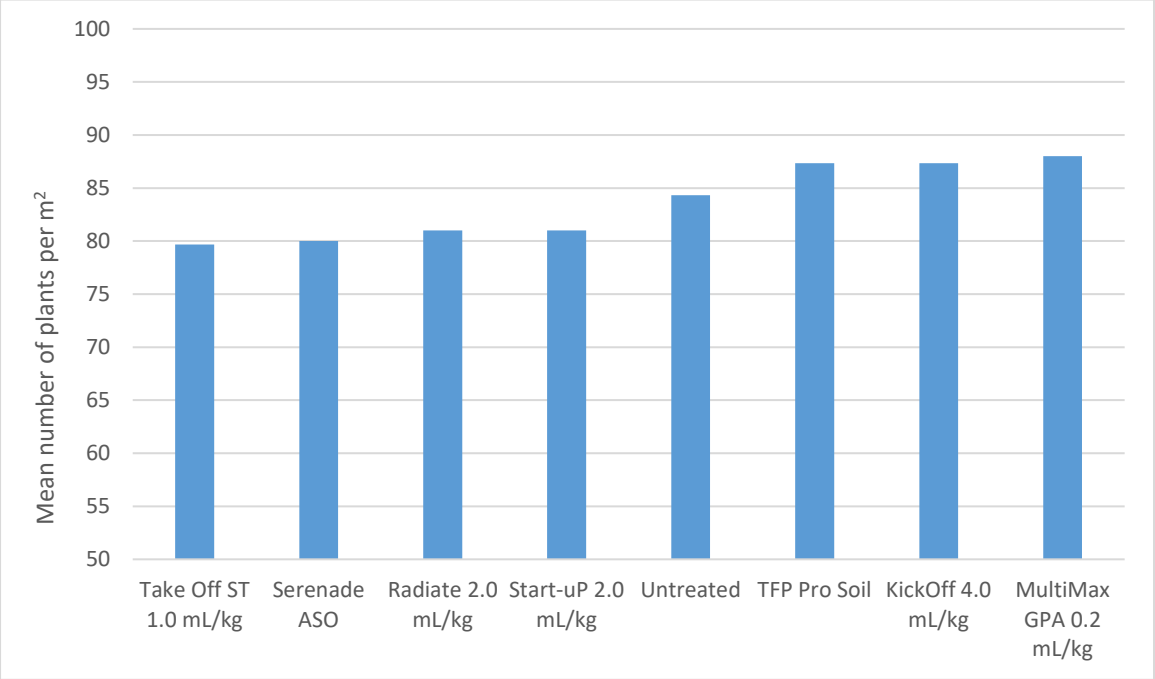

Figure 1: Mean number of seedlings emerged per treatment at Holbach Hurn recorded on 30th April 2019.

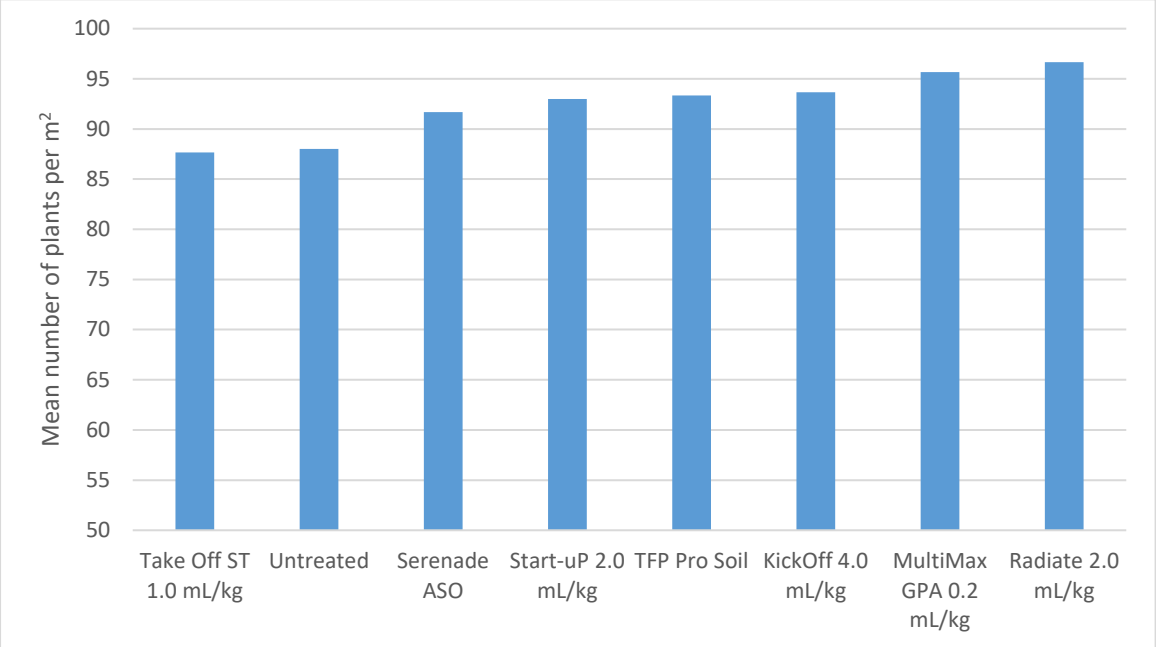

Figure 2: Mean number of seedlings emerged per treatment at Fleet Hargate recorded on 23rd May 2019.

Key for figures 3 to 6 inclusive:

Soil Seed Foliar Soil + Foliar

There were no statistically significant differences in chlorophyll content between treatments.

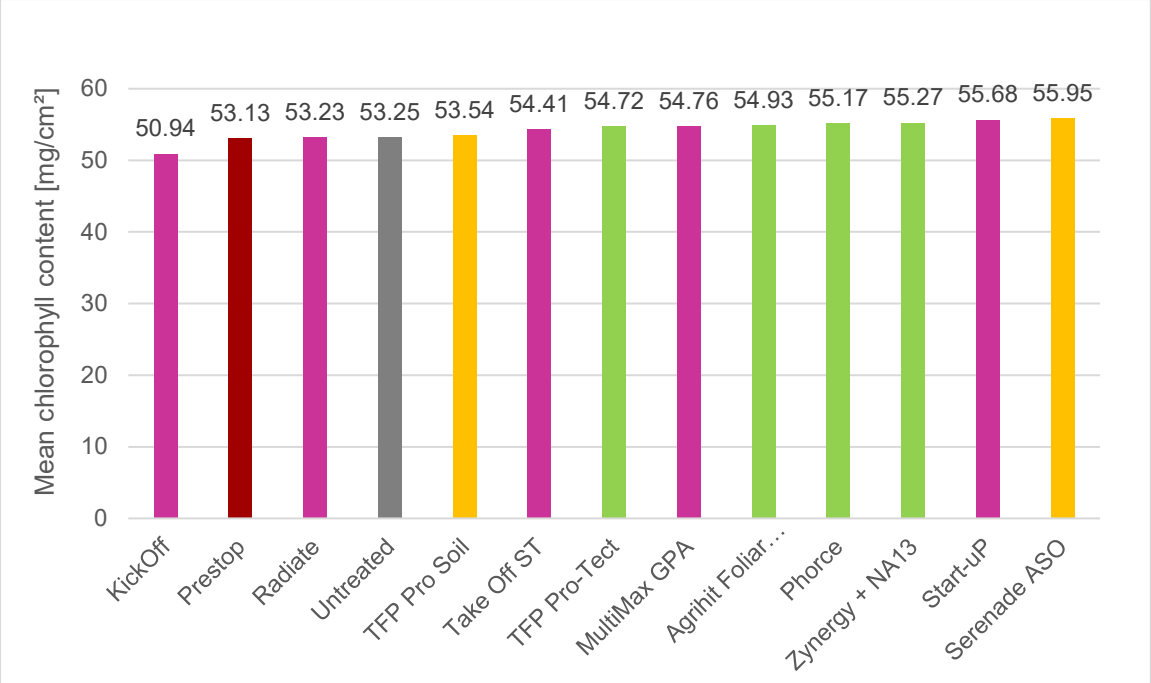

Figure 3: Mean chlorophyll content (mg/cm^2) per plant at Holbeach Hurn, measured on 10 plants per plot on 8th July 2019. SE = 1.51; P = 0.1225; CV% = 3.94.

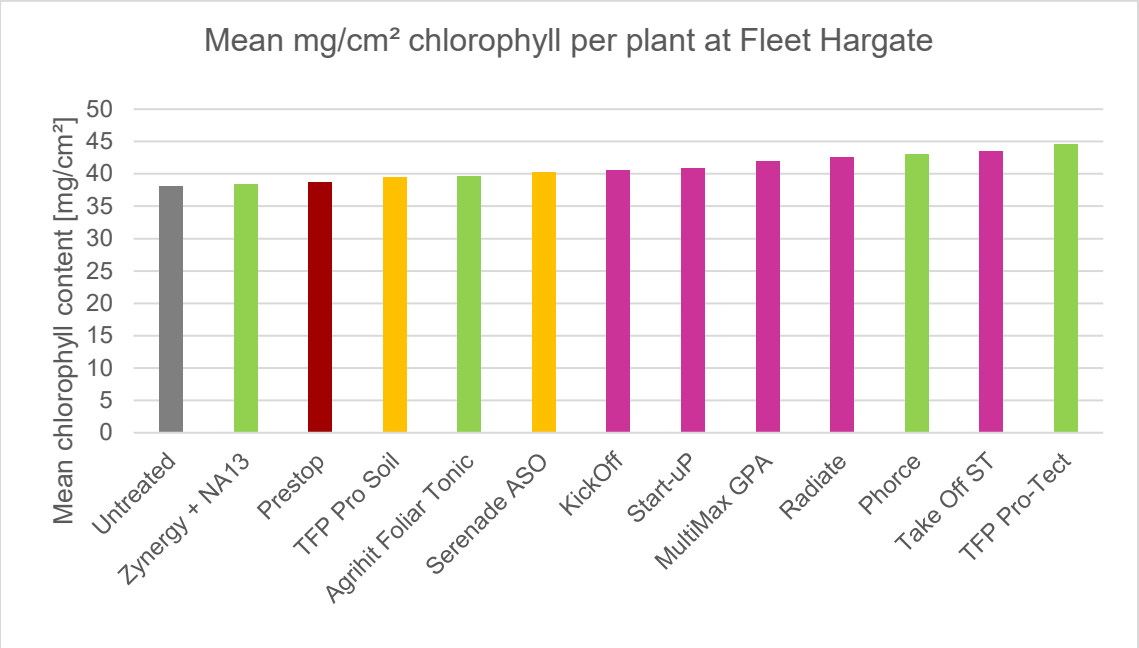

Figure 4: Mean chlorophyll content (mg/cm2) per plant at Fleet Hargate, measured on 10 plants/plot on 15th July 2019. SE = 3.26; P = 0.6334; CV% = 11.27.

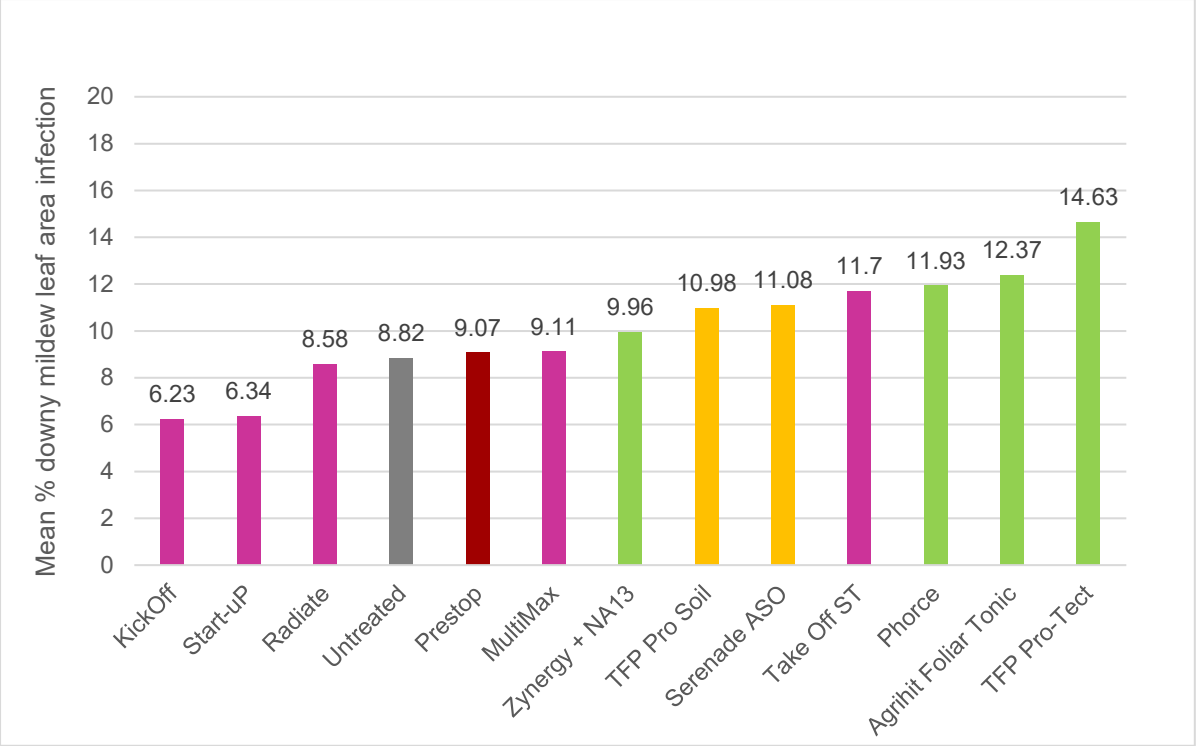

Figure 5: Mean percentage downy mildew infection per plant recorded on 25 plants/plot at Holbeach Hurn site on 31st May 2019. SE = 2.88; P = 0.2528; CV% = 40.54.

There were no statistically significant differences in downy mildew infection at Holbeach Hurn in 2019, although the plots that were treated with three of the seed treatments appeared to have lower levels of downy mildew and three out of the four foliar applications had highest downy mildew infection levels.

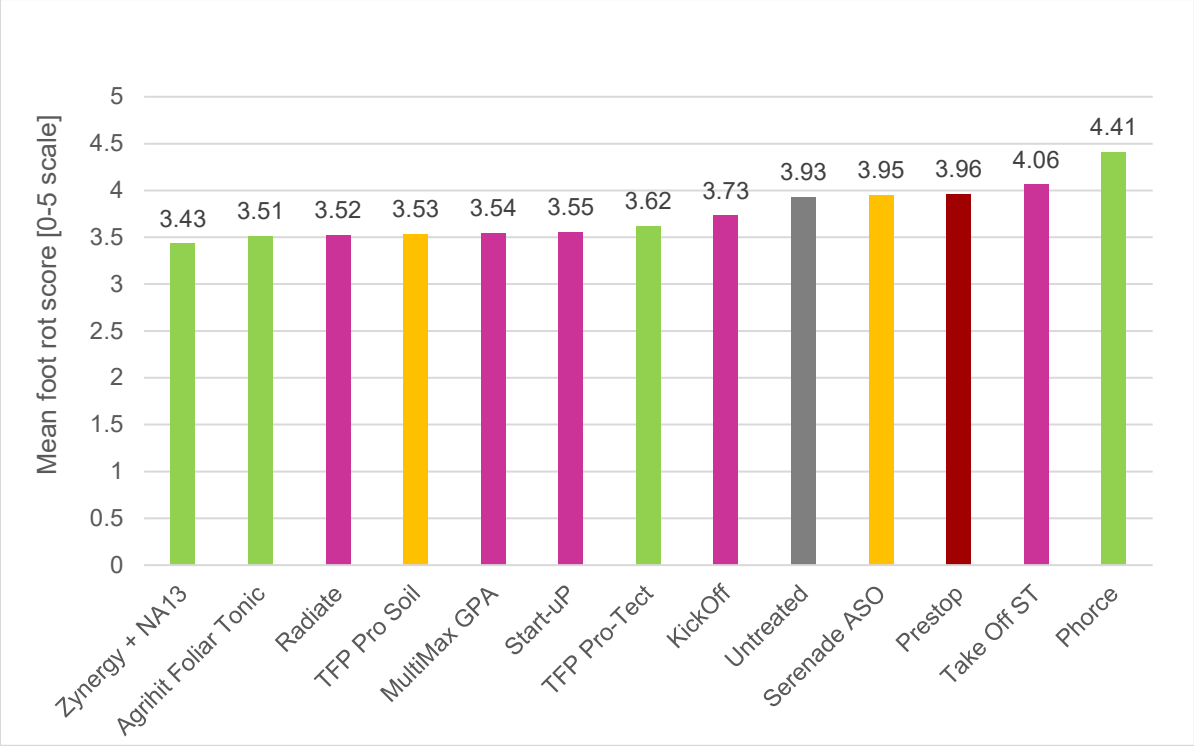

Figure 6: Mean foot rot score recorded on 25 plants/plot on 15th July 2019 at Fleet Hargate. Score 0-5 where 0 = no disease present, 5 = dead root. SE = 0.3082; P = 0.089; CV% = 11.63.

There were no statistically significant differences in foot rot incidence between treatments (Figure 6). Plants developed severe foot rot infection at Fleet Hargate (Figure 7), mainly caused by *Fusarium solani*. Under high disease pressure conditions fewer treatment differences were observed.

Figure 7: Significant plant loss caused by infection with *Fusarium solani* at Fleet Hargate in 2019.

As foot rot levels were so high and significant plant numbers had been lost from all plots harvesting was not carried out.

Discussion

There is considerable interest in the role that biostimulant and micronutrient products may play in crop production in the future. Improved crop health may help to reduce the susceptibility of crops to pests and diseases. With the frequent and rapid withdrawal of pesticides, addressing issues of plant health, performance and stress tolerance must be considered as part of the solution. Whether the products are manufactured from plant extracts, humic derivatives, inorganic salts, microbially sourced or seaweed extracts, responses in the field are inconsistent and affected by many environmental factors, which may not be easy to control or manage.

The products tested in 2019 trials were carefully selected over several years as potential solutions for crop yield variability and stress tolerance, based on conversations with manufacturers and preliminary evidence in legume and other crops. However, further information and data are required to determine whether the cost-benefit is sufficient to justify on-farm use.

These trials have produced inconsistent results, and this may be a common message from other independent trials in various crops. Field trials are essential to evaluate the efficacy of such products, but results may be less predictable than when carried out in protected trials (glasshouse or polytunnel) due to environmental variability.

Products such as these need to deliver enough benefit to justify their use. However, small benefits may be enough in some situations, particularly in high value crops such as vining peas.

Conclusions

It is not possible to make recommendations based on the results from trials carried out in 2019 as there were no statistically significant differences in plant emergence, chlorophyll content or plant health (indicated by disease infection).

Knowledge and Technology Transfer

PGRO/ Syngenta Road Shows 2020 (presentation and discussion) – discussion of the importance of biostimulant products for crop management, including disease management – Jim Scrimshaw;
Dengie Peas Agronomy Training 2020 (presentation and discussion) – Jim Scrimshaw;
Swaythorpe Growers Technical Update February 2020 (presentation and discussion) – Jim Scrimshaw;

References

Biostimulant Coalition (2013). What are biostimulants?
http://www.biostimulantcoalition.org/about/

Appendix A

Meteorological data

Holbeach – Moulton ISPALDIN12

	Temperature			Humidity			Precip. Accum.
DATE	High	Avg	Low	High	Avg	Low	Sum
04/01/2019	13.8 C	7.1 C	2.2 C	86 %	71 %	48 %	0.00 mm
04/02/2019	8.9 C	4.7 C	1.2 C	91 %	85 %	69 %	5.59 mm
04/03/2019	10.2 C	5.2 C	0.7 C	93 %	79 %	57 %	0.25 mm
04/04/2019	10.9 C	5.2 C	-0.4 C	92 %	76 %	52 %	0.00 mm
04/05/2019	14.3 C	9.5 C	4.2 C	83 %	60 %	37 %	0.00 mm
04/06/2019	11.1 C	7.2 C	3.2 C	92 %	81 %	67 %	0.00 mm
04/07/2019	11.1 C	8.6 C	7.3 C	94 %	91 %	85 %	0.76 mm
04/08/2019	15.2 C	10.1 C	6.0 C	95 %	85 %	66 %	0.00 mm
04/09/2019	10.6 C	8.0 C	5.3 C	92 %	77 %	64 %	0.00 mm
04/10/2019	10.4 C	6.7 C	3.7 C	78 %	66 %	54 %	0.00 mm
04/11/2019	10.1 C	5.7 C	2.3 C	78 %	64 %	49 %	0.00 mm
04/12/2019	10.9 C	5.1 C	0.1 C	86 %	69 %	47 %	0.00 mm
4/13/2019	9.5 C	4.7 C	-0.2 C	84 %	67 %	45 %	0.00 mm
4/14/2019	8.7 C	5.1 C	0.3 C	81 %	67 %	51 %	0.00 mm
4/15/2019	13.7 C	7.9 C	2.4 C	90 %	72 %	49 %	0.00 mm
4/16/2019	14.5 C	9.3 C	4.9 C	91 %	79 %	61 %	0.00 mm
4/17/2019	17.0 C	10.7 C	4.5 C	93 %	79 %	64 %	0.00 mm
4/18/2019	18.3 C	11.5 C	5.5 C	95 %	79 %	57 %	0.00 mm
4/19/2019	18.9 C	12.2 C	5.9 C	91 %	73 %	47 %	0.00 mm
4/20/2019	21.1 C	11.1 C	4.1 C	94 %	77 %	46 %	0.00 mm
4/21/2019	24.1 C	13.1 C	3.6 C	94 %	66 %	28 %	0.25 mm
4/22/2019	24.9 C	14.5 C	3.5 C	86 %	59 %	24 %	0.00 mm
4/23/2019	17.7 C	12.5 C	8.5 C	87 %	74 %	57 %	0.00 mm
4/24/2019	21.4 C	12.9 C	6.4 C	92 %	73 %	49 %	0.00 mm
4/25/2019	17.5 C	12.2 C	7.5 C	87 %	69 %	44 %	0.00 mm
4/26/2019	17.7 C	11.5 C	3.9 C	90 %	68 %	42 %	0.00 mm
4/27/2019	9.9 C	8.4 C	6.8 C	86 %	75 %	64 %	0.76 mm
4/28/2019	12.8 C	8.8 C	5.7 C	87 %	79 %	60 %	0.51 mm
4/29/2019	14.2 C	8.8 C	4.6 C	94 %	83 %	62 %	0.25 mm
4/30/2019	15.6 C	9.6 C	3.5 C	92 %	77 %	52 %	0.00 mm
	Temperature			Humidity			Precip. Accum.
DATE	High	Avg	Low	High	Avg	Low	Sum
05/01/2019	19.1 C	11.7 C	3.6 C	92 %	75 %	46 %	5.08 mm
05/02/2019	16.1 C	11.3 C	8.0 C	91 %	79 %	57 %	12.95 mm
05/03/2019	9.0 C	7.5 C	5.4 C	91 %	85 %	76 %	0.25 mm
05/04/2019	10.1 C	6.4 C	2.1 C	85 %	75 %	62 %	1.27 mm
05/05/2019	12.3 C	7.7 C	3.6 C	86 %	67 %	44 %	0.00 mm
05/06/2019	11.6 C	8.2 C	4.2 C	84 %	70 %	49 %	0.25 mm
05/07/2019	15.3 C	9.1 C	5.6 C	89 %	74 %	40 %	0.51 mm

05/08/2019	11.6 C	9.4 C	7.5 C	92 %	87 %	82 %	13.72 mm
05/09/2019	10.4 C	8.6 C	7.3 C	90 %	87 %	80 %	0.25 mm
05/10/2019	12.8 C	8.6 C	6.0 C	91 %	85 %	67 %	3.56 mm
05/11/2019	14.8 C	10.4 C	7.1 C	92 %	77 %	54 %	0.51 mm
05/12/2019	17.0 C	10.8 C	3.3 C	91 %	67 %	35 %	0.00 mm
5/13/2019	19.1 C	10.5 C	2.7 C	89 %	68 %	41 %	0.00 mm
5/14/2019	20.5 C	12.4 C	4.4 C	86 %	63 %	42 %	0.00 mm
5/15/2019	17.9 C	11.6 C	5.1 C	85 %	66 %	41 %	0.00 mm
5/16/2019	18.6 C	11.5 C	5.8 C	88 %	70 %	33 %	0.00 mm
5/17/2019	15.8 C	11.8 C	9.7 C	88 %	79 %	62 %	0.51 mm
5/18/2019	15.5 C	12.0 C	9.9 C	92 %	88 %	75 %	4.32 mm
5/19/2019	19.7 C	12.7 C	7.4 C	96 %	81 %	52 %	0.25 mm
5/20/2019	20.2 C	14.0 C	10.1 C	89 %	75 %	48 %	0.00 mm
5/21/2019	20.3 C	13.6 C	7.6 C	89 %	69 %	38 %	0.00 mm
5/22/2019	19.9 C	13.9 C	7.8 C	79 %	59 %	36 %	0.00 mm
5/23/2019	21.9 C	15.2 C	8.4 C	84 %	60 %	33 %	0.00 mm
5/24/2019	22.5 C	16.0 C	9.2 C	83 %	61 %	37 %	0.00 mm
5/25/2019	21.3 C	16.2 C	10.9 C	85 %	63 %	40 %	0.00 mm
5/26/2019	19.1 C	16.1 C	10.6 C	81 %	71 %	49 %	0.51 mm
5/27/2019	16.8 C	12.4 C	8.7 C	83 %	71 %	53 %	2.29 mm
5/28/2019	16.4 C	11.6 C	9.0 C	89 %	80 %	58 %	5.84 mm
5/29/2019	16.3 C	11.3 C	6.0 C	95 %	83 %	57 %	1.52 mm
5/30/2019	22.3 C	17.6 C	13.6 C	94 %	76 %	59 %	0.51 mm
5/31/2019	21.1 C	16.5 C	11.7 C	85 %	72 %	56 %	0.00 mm

	Temperature			Humidity			Precip. Accum.
DATE	High	Avg	Low	High	Avg	Low	Sum
06/01/2019	25.0 C	18.8 C	11.6 C	90 %	67 %	44 %	0.00 mm
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06/07/2019	17.9 C	12.8 C	6.7 C	89 %	78 %	56 %	4.32 mm
06/08/2019	13.0 C	11.6 C	8.9 C	93 %	85 %	71 %	3.30 mm
06/09/2019	19.2 C	13.2 C	6.7 C	90 %	71 %	43 %	0.51 mm
06/10/2019	12.2 C	10.9 C	9.8 C	91 %	88 %	78 %	25.91 mm
06/11/2019	11.1 C	10.4 C	9.7 C	96 %	95 %	92 %	53.09 mm
06/12/2019	14.8 C	11.8 C	9.9 C	98 %	94 %	84 %	16.76 mm
6/13/2019	13.2 C	11.5 C	10.3 C	96 %	94 %	92 %	23.62 mm
6/14/2019	18.2 C	13.6 C	10.6 C	96 %	85 %	62 %	2.03 mm
6/15/2019	19.1 C	13.3 C	8.2 C	92 %	80 %	59 %	2.79 mm
6/16/2019	20.2 C	14.3 C	8.7 C	92 %	80 %	59 %	4.32 mm
6/17/2019	20.4 C	16.2 C	12.1 C	86 %	70 %	54 %	0.00 mm
6/18/2019	19.8 C	15.3 C	10.1 C	90 %	79 %	60 %	4.83 mm
6/19/2019	18.8 C	15.9 C	13.3 C	93 %	85 %	71 %	1.52 mm
6/20/2019	18.5 C	15.2 C	11.9 C	83 %	69 %	53 %	0.00 mm

6/21/2019	20.1 C	14.6 C	8.0 C	83 %	64 %	44 %	0.00 mm
6/22/2019	23.1 C	15.8 C	9.8 C	89 %	71 %	42 %	0.00 mm
6/23/2019	20.9 C	15.1 C	10.1 C	89 %	82 %	69 %	0.00 mm
6/24/2019	24.4 C	19.5 C	14.2 C	92 %	83 %	70 %	0.00 mm
6/25/2019	19.2 C	15.7 C	14.4 C	92 %	91 %	87 %	4.06 mm
6/26/2019	16.1 C	14.2 C	12.2 C	91 %	83 %	76 %	0.00 mm
6/27/2019	17.9 C	14.1 C	10.8 C	86 %	77 %	67 %	0.00 mm
6/28/2019	20.2 C	16.2 C	12.6 C	85 %	76 %	67 %	0.00 mm
6/29/2019	30.4 C	21.4 C	10.9 C	92 %	70 %	43 %	0.00 mm
6/30/2019	23.3 C	19.1 C	14.1 C	82 %	64 %	46 %	0.00 mm