Project title:	Vegetable crops: Development of a screening programme for plant growth enhancement products.
Project number:	FV394
Project leader:	Pat Croft, STCRF
Report:	Final report, March 2012
Previous report:	None
Key staff:	Mr Neil Fuller Dr Luke Tilley
Location of project:	STCRF, Cawood, Selby N. Yorkshire YO8 3TZ
Industry Representative:	Martin Evans
Date project commenced:	March 2011
Date project completed (or expected completion date):	March 2012

DISCLAIMER

AHDB, operating through its HDC division seeks to ensure that the information contained within this document is accurate at the time of printing. No warranty is given in respect thereof and, to the maximum extent permitted by law the Agriculture and Horticulture Development Board accepts no liability for loss, damage or injury howsoever caused (including that caused by negligence) or suffered directly or indirectly in relation to information and opinions contained in or omitted from this document.

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.

PLEASE NOTE: The HDC, whilst reporting the results of this independent work, does not advocate or promote the use of the products reviewed in this study for crop protection. It is important to note that:

a) The trials reported in this study are not specifically designed regulatory trials to support a product claim and they have not been through any regulatory scrutiny to assess consistency, level of control and appropriate dose of the products.
b) It is important for growers to remember that before using any product for plant protection purposes always check whether the product is currently approved for the intended use and situation.

AUTHENTICATION

We declare that this work was done under our supervision according to the procedures described herein and that the report represents a true and accurate record of the results obtained.

Dr. Pat Croft
Project Leader
STCRF

Signature ..... Date .....

Dr. Luke Tilley
STCRF

Signature ..... Date .....

Report authorised by:

[Name]
[Position]
[Organisation]

Signature ..... Date .....

[Name]
[Position]
[Organisation]

Signature ..... Date .....

CONTENTS

GROWER SUMMARY

Headlines

- The screening of 12 amino acid, micronutrient and phosphate/phosphite products on three crops established that some of the products improved yield and reduced levels of Botrytis in lettuce.

- There were improvements on crop yield for many products in comparison to the control, but there was no statistical reliability in many of the results.

Background

Vegetable growers are faced with increased demand for UK-grown produce in an arena of reduced pesticide availability, increased fertiliser costs, pressure to reduce greenhouse emissions, demands to improve productivity and quality whilst protecting the environment and improving biodiversity. High yields require the management and optimisation of all resources, including N, P, K and micronutrient availability. This project focused on screening plant enhancers (non- NPK macro and micronutrient products).

These products claim to be meeting growers' demands for better yields and crop quality at reduced inputs and costs. Plant enhancers are often categorised as 'snake oils' because of the similarity of their claims but variability in their results. However, it is known that micronutrients are increasingly being identified as crucial to crop productivity and quality (Marschner, 1995). This means that plant enhancers may have an important role to play in crop and yield improvement.

There is currently no formal screening of these products to provide even a qualitative review of plant enhancers for the benefit of growers. A programme of work to address this deficiency would allow growers to identify effective products, as well as inconsistent and ineffective ones.

The aim is to provide a service to the UK horticultural sector that uses recent science, known expertise and grower consultations to equip vegetable growers with better-informed options for crop improvement using plant enhancers.

This project will serve as a starting point to investigate the plant enhancers found to be most successful on a wider soil types and more vegetable crops.

Summary of the results and main conclusions

- Tables 1 to 3 below summarise the recorded effects of the different treatments for each of the three crops (lettuce, carrots and peas). The tables provide a simple comparison of the treatments (NPK and treatment) to the control (NPK only), indicating where the treatments gave a better performance than the control (>) or not (x). The table also indicates were these differences are significant after statistical analysis ($p<0.05$) (+).

- Significant treatment effects were recorded on lettuce, where increases in weight and reductions in Botrytis levels were recorded at harvest.

- In carrots and peas some treatments did improve measurements in comparison to the control plots, but there were no statistically valid improvements.

- It is not possible to determine if the lack of statistical evidence is due to the high variability that is inherent with the products, or if indeed the treatments had not provided additional benefits. It is also possible that the extreme dry conditions experienced for much of the crops (except for the lettuce which was irrigated) may have hindered some of the activity that some of the microbial products may have otherwise produced.

Tables 1-3. Mean measurements per sample per plot. Summarising means for each crop and comparing treatment means to the control mean (x = means are not different, > = treatment better than the control (but not statistically significant), + = treatment statistically better than the control ($p<0.05$)) .

Table 1. Lettuce

	Treatments	Means per plot (20 plants per plot) Weight (g)	No. with *Botrytis*	No. with *Sclerotinia*	No. with tip burn
1	Control (NPK only)	*	*	*	*
2	InCA	>	+	>	>
3	Wormcast Pro	>	+	X	>
4	Omex BioStarter	>	>	>	>
5	Omex Bio Plus	>	+	>	>
6	PLC Colonize AG	X	+	>	>
7	PHC Complete Plus	X	>	>	X
8	TTL Plus	X	+	>	X
9	Serenade	+	+	>	>
10	HYT b	>	+	>	>
11	HYTb + a + c	>	+	>	>
12	Phos Star	+	+	>	>

Table 2. Peas

	Treatments	Means per sample (2 x 0.5m) Numbers of pods	Stem length	Pod weights	Nodule score
1	Control (NPK only)	*	*	*	*
2	InCA	>	>	>	>
3	Wormcast Pro	>	>	X	X
4	Omex BioStarter	>	X	>	>
5	Omex Bio Plus	>	>	>	>
6	PLC Colonize AG	>	X	>	X
7	PHC Complete Plus	X	>	X	X
8	TTL Plus	>	X	>	X
9	Serenade	>	X	>	X
10	HYT b	X	x	>	X
11	HYTb + a + c	>	>	>	>
12	Phos Star	>	>	>	X

Table 3. Carrots

	Treatments	Means per sample (60 carrots) Cavity spot score	Carrot root fly score	Diameter	Length
1	Control (NPK only)	*	*	*	*
2	InCA	>	X	X	X
3	Wormcast Pro	X	X	X	X
4	Omex BioStarter	X	>	X	X
5	Omex Bio Plus	>	X	>	>
6	PLC Colonize AG	>	>	X	X
7	PHC Complete Plus	>	X	X	X
8	TTL Plus	>	X	X	X
9	Serenade	>	X	X	X
10	HYT b	X	>	>	>
11	HYTb + a + c	X	>	X	X
12	Phos Star	X	X	X	X

Lettuce (Frisco)

Yield:

Lettuce treated with Serenade and Phos-Star had significantly heavier lettuce at harvest than the control plots.

The mean numbers of plants with tip burn were recorded at harvest. Treatments that produced lower levels of tip burn were, Inca, Wormcast, Biomex, Biomex plus, Colonise, Serenade, HYT b and HYT a+b and Phos Star, but these differences were not statistically significant.

The percentage of marketable lettuce at harvest was recorded. Phos-Star gave the highest percentage (96%) but this higher level was not significant when compared to the standard NPK treated plots.

Disease:

All treatments produced lower levels of *Botrytis cinerea* than the control plots and this difference was significant for InCA, Wormcast, Biomex Plus, Colonise, TTL, Serenade, HYT b, HYT a + b, Phos-star

All treatments (Except for Wormcast) produced lower levels of *Sclerotinia sclerotiorum* than the standard control at harvest. However none of the differences were statistically significant because of the high variability around the averages for each treatment. Unlike Botrytis,

Sclerotinia was much more clustered in its distribution, which would increase the variability within the data.

Peas (Ambassador)

Yield:

The weight and numbers of pods were recorded. The results showed that several treatments produced higher numbers of pods in comparison to the NPK treated control plots, (InCa, Wormcast, Bioex, Biomex Plus, Colonise, TTL, Serenade, HYT b, HYT a + b, and Phos-Star). However there was high variability around the average weight and numbers for some treatments and this may have resulted in the recorded differences not being statistically significant.

The stem length (per plant) and stem length with pod numbers (per sample plot) were recorded. Although some treatments increased stem length, again differences were not significant. There was no correlation between stem length and pod number

Nodule formation was given a score (out of 10). Biomex Plus, HYT a+b, provided a larger score for nodule formation. But again, there is a large variability in the data. Phos Star scored very low on the nodule score but this product would not be expected to improve this aspect of crop agronomy.

Disease:

Scores were given to powdery mildew in pods sampled; disease levels were too low to determine any treatment effect.

Carrots (Nairobi)

Yield:

The measurements of carrot diameter and length gave no significantof effect of treatment. There was no statistically significant effect of treatment on weight at harvest.

Disease/Pest:

Overall levels of cavity spot were very low during the trial, making treatment comparisons invalid. The dry weather conditions experienced at the start of the crop will have contributed to the low cavity spot levels.

There was also no apparent effect on carrot root fly damage, but again in the trial, levels of damage were relatively low, making treatment comparison difficult to determine.

Further trials should consider increasing numbers of replicates.

Future trials may test products under different environmental conditions. Testing products under less arid conditions, as experienced in the present trial, may provide clearer improvements in terms of product efficacy. Therefore consider irrigating crops if dry spring/summer.

Financial Benefits

The recent government report: The Future of Food and Farming: Challenges and choices for global sustainability, indicates a need for sustainable intensification of production technologies. This will result in pressures from consumers and retailers regarding crop inputs such as pesticides and fertilisers (Foresight, 2011). It is possible that micronutrients may provide sustainable methods of maintaining, or even increasing, yield and quality. It is important for the horticultural industry to begin to understand the growing body of evidence on micronutrient nutrition and that the increasing list of plant enhancement products is tested for their potential benefits on different crops.

Action Points

There are no action points at this stage as further work is required to increase the number of replicates.

PLEASE NOTE: **The HDC, whilst reporting the results of this independent work, does not advocate or promote the use of the products reviewed in this study for crop protection. It is important to note that:**

c) The trials reported in this study are not specifically designed regulatory trials to support a product claim and they have not been through any regulatory scrutiny to assess consistency, level of control and appropriate dose of the products.

d) It is important for growers to remember that before using any product for plant protection purposes always check whether the product is currently approved for the intended use and situation.

SCIENCE SECTION

Introduction

There are increasing pressures on growers to produce larger yields for less cost and with fewer inputs. As a consequence growers are faced with an increasing list of yield enhancing products that have a range of claims varying from increased yield with reduced nitrogen to maintaining yield using lower traditional inputs. These products claim to be meeting growers' needs for better yields and crop quality at reduced costs and inputs. The products exploit old and recent information on non-N, P, K macro- nutrients (e.g. magnesium, sulphur and calcium) and micronutrients (copper, manganese, boron, molybdenum).

There is currently no screening programme for these products to provide information on the efficacy of plant growth enhancers. This project aims to act as a first step towards understanding the role that these products can play towards helping growers achieve increased yield and better quality crops.

Materials and methods

All work conducted for the project was undertaken at STCRF.

Lettuces were propagated at STCRF before being transplanted, the peas and carrot plots were directly drilled.

Crop Diaries

Table 4. PEAS 'Ambassador'

Date	Action
Apr	Field J: Applied P + K to trial area (166Kg/Ha).
25 May	Harrowed and rolled land. Marked out trial area.
26 May	Drilled Ambassador @ 1 seed/cm with Oyjard Drill. 4 rows/1.83m bed @ 37.5cm.
27 May	Applied herbicide Cirrus @ 0.2 l/200 l water/ha. (V windy).
13 Jun	Applied all micronutrient treatments @ 3 true leaves. **Spray 1.**
20 Jun	Covered trial area with 17g/m2 fleece to stop pigeon damage.
28 Jun	Removed cover. Applied micronutrient treatments**. Spray 2.**
28 Jun	Applied Dovetail @ 1.5 l/400 l/ha for aphid.
10 Jul	No observable differences in crop vigour/colour. Flowering commencing.
12 Jul	Applied micronutrient treatments. **Spray 3.**
28 Jul	Applied micronutrient treatments. **Spray 4.**
8 Aug	Root nodule assessment.
9 Aug	Harvested 2 middle rows x 0.5 m long. Recorded number of pods and weight.
10 Aug	Picked 100 pods at random from plots 1-12. Shelled. Peas sent to Lancrop for nutrient analysis

Table 5. CARROTS 'Nairobi'

Date	Action
Apr	Applied P and K to trial area in Field J.
25 May	Marked out trial area.
	Applied Nitrogen @ 100 kg/ha. Harrowed and rolled seedbed.
	Drilled Nairobi @ 150-180 seeds/m2. 4 rows/1.83m bed @ 37.5cm.
29 May	Applied herbicide. Linuron @ 1.2 l/200 l water/ha.
20 Jun	Applied micronutrient treatments @ 2nd true leaf. **Spray 1.**
24 Jun	Carrots hand weeded.
28 Jun	Applied Dovetail @ 1.5 l/400 l/ha water for aphid (some visible).
5 Jul	Applied micronutrient treatments. **Spray 2.**
10 Jul	No apparent differences in crop colour or vigour to date.
19 Jul	Applied micronutrient treatments. **Spray 3.**
11 Aug	Applied micronutrient treatments. **Spray 4.**
Sep	Harvested 60 carrots from middle of each plot and assessed.

Table 6. LETTUCE 'Frisco'

Date	Action
Apr	Applied P and K to trial area Field J.
Jun	Lettuce cv Frisco sown into blocks.
28 Jun	Applied micronutrient treatments to run-off as a pre-planting drench. **Spray 1.**
29 Jun	Applied Nitrogen @ 100 kg/ha. Harrowed and rolled trial area.
	Marked out 4 rows/1.83 m bed @ 37.5 cm x 30 cm within rows.
1 Jul	Planted lettuce. Irrigated 15 mm.
3 Jul	Irrigated 15 mm.
12 Jul	Applied micronutrient treatments. **Spray 2.**
28 Jul	Applied micronutrient treatments. **Spray 3.**
29 Jul	Applied Nitrogen top-dressing @ 100 kg/ha. Irrigated 15mm.
11 Aug	Applied micronutrient treatments. **Spray 4.**
Aug	Harvested.

Treatment Application

Treatments were applied to the three crops using an Oxford Precision Sprayer at 2 bar pressure.

Table 7. Treatments and rates

	Product	Rate	Volume in 4 Litres of Water	Application
A	Commercial NPK (Control)			**4x at 14 day intervals**
B	InCa	1L/Ha	19.4ml	**4x at 14 day intervals**
C	Wormcast Pro-Tea	10L/Ha	195ml	**4x at 14 day intervals**
D	Omex Biomex Starter	0.5L/Ha	9.7ml	**4x at 14 day intervals**
E	Omex Biomex Plus	2.5L /Ha	48.7ml	**4x at 14 day intervals**
F	PHC Colonize AG	2 KG /Ha	38.6g	**4x at 14 day intervals**
G	PHC Complete Plus	2 KG /Ha	38.6g	**4x at 14 day intervals**
H	TTL Plus	4 L/Ha	78.5ml	**4x at 14 day intervals**
I	Serenade	10 L/Ha	195ml	**4x at 14 day intervals**
J	HYTb	2 L/Ha	40ml	**4x at 14 day intervals**
K	HYTb + HYTa + HYTc	2L/Ha HYTb 2L/Ha HYTb mixed with 2 KG/Ha of HYTc	A=40ml B=40ml C=40g	**4x at 14 day intervals**
L	**Phos-star PO3-PO4**	**1 Litre per Hectare**	**19.4ml**	**4x at 14 day intervals**

Each of the 12 treatments (including commercial NPK) were replicated four times. The plots measured 9 metres in length and 1.8 metres in width. Treatments were applied at 200l/Ha.

Yield Assessments:

Each individual crop received different assessments.

Lettuce: At harvest each plant was assessed for weight, tip burn and rated as either marketable or non-marketable.

Peas: Peas were assessed for root nodulation, stem length, and number and weight of pods.

Carrots: At harvest 60 carrots per plot were taken from middle rows and were scored for diameter, length and weight.

Disease assessments:

Lettuce: At harvest 20 lettuces were removed from the centre two rows of each plot and assessed for *Botrytis cinerea* and *Sclerotinia sclerotiorum*.

Peas: Peas were assessed for powdery mildew from pods sampled from two middle rows x 0.5 m long.

Carrots: In addition to above assessments, harvested carrots were scored for carrot root fly damage and cavity spot.

Data Analysis

Analysis was done using ANOVA, Data sets with percentages were transformed with Angular transformations. Means were compared using LSD's at the 5% level of significance.

Results and Discussion

Yield assessments

Lettuce (Frisco)

Below are the data for measurements taken from the lettuce crop at harvest.

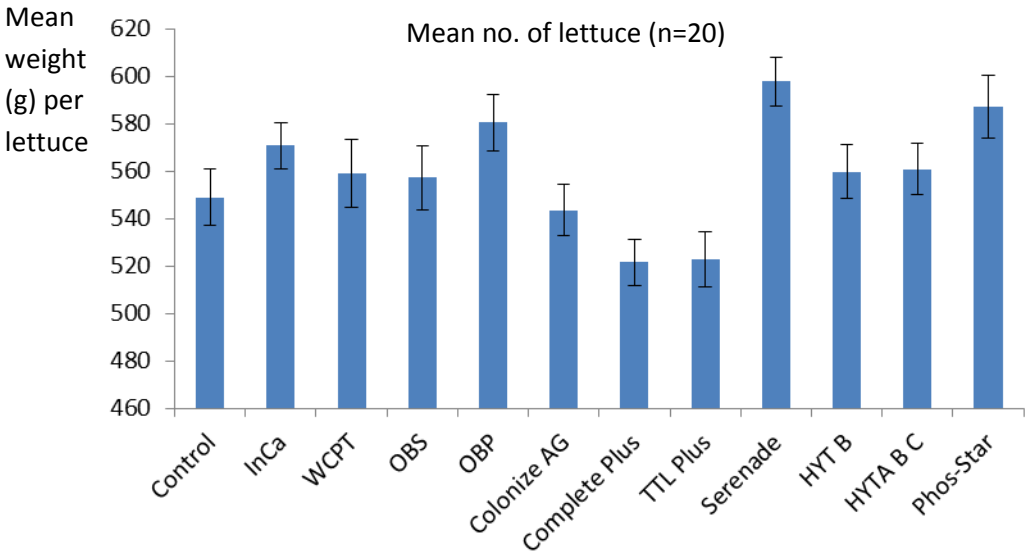

Figure 1. Mean (±SE) weight (g) of lettuce per sample plot at harvest

Figure 1 gives the mean weights of lettuce at harvest. There was a significant difference recorded in the weights of the treatments ($p<0.001$). Lettuce treated with Serenade and Phos-Star had significantly heavier lettuce than the control plots.

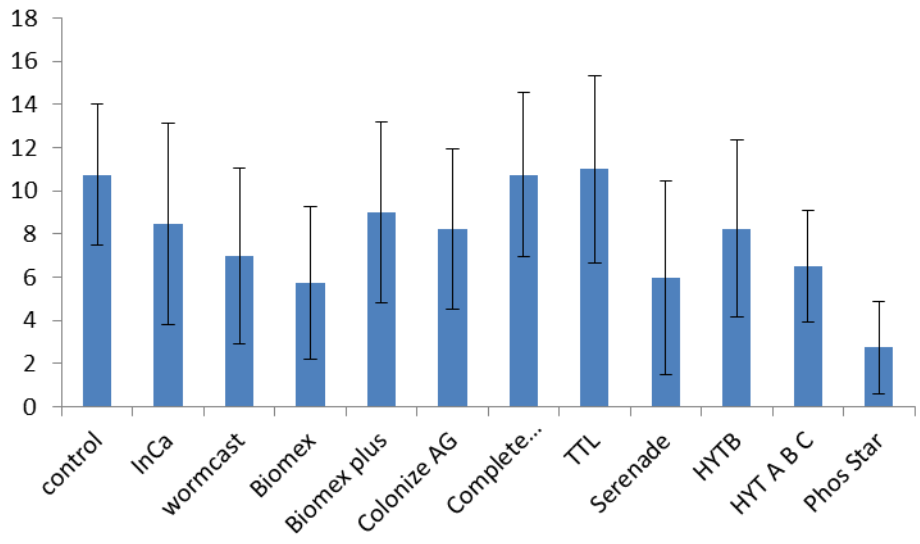

Figure 2. Mean (±SE) number of plants per plot (20 sample) with tip burn

Figure 2 provides the mean numbers of plants per plot with tip burn, recorded at harvest. Treatments that produced lower levels of tip burn were, Inca, Wormcast, Biomex, Biomex plus, Colonise, Serenade, HYT b and HYT abc and Phos-Star, but these differences were not significant at the 5% level.

Figure 3 presents the percentage of marketable lettuce at harvest. Phos-Star gave the highest percentage (96%) but this higher level was not statistically significant when compared to the standard NPK.

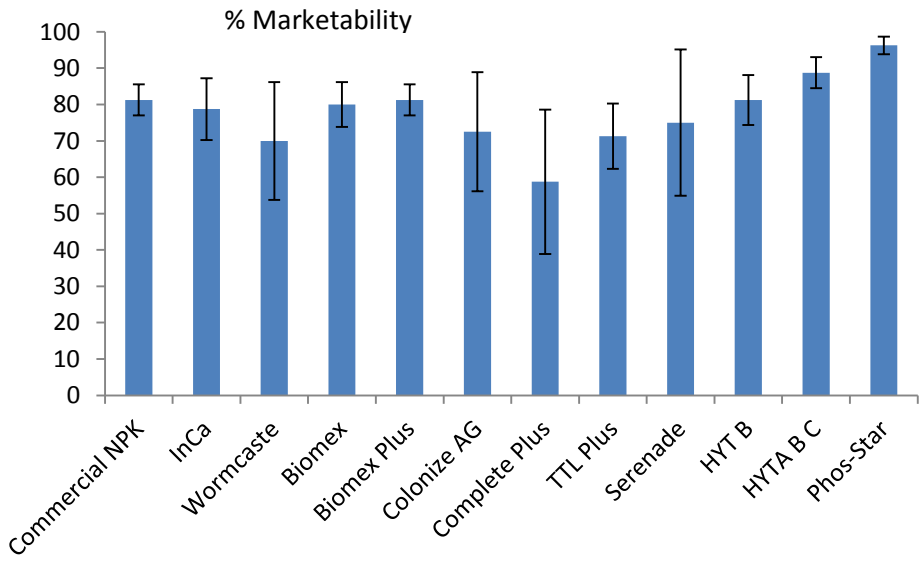

Figure 3. Percentage marketability of lettuce per sample

Disease assessments

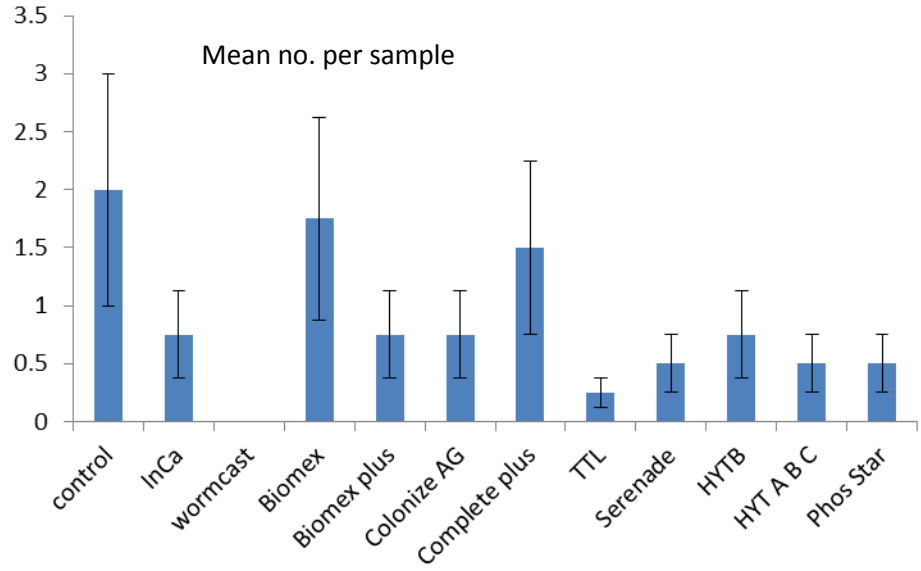

Figure 4. Mean (±SE) number of lettuce with *Botrytis cinerea* per replicate plot at harvest

Figure 4. Shows that all treatments that recorded lower levels of *Botrytis cinerea* than the control plots and this difference was statistically significant at the 5% level for InCA, Wormcast, Biomex Plus, Colonise, TTL, Serenade, HYT b, HYT abc and Phos-star.

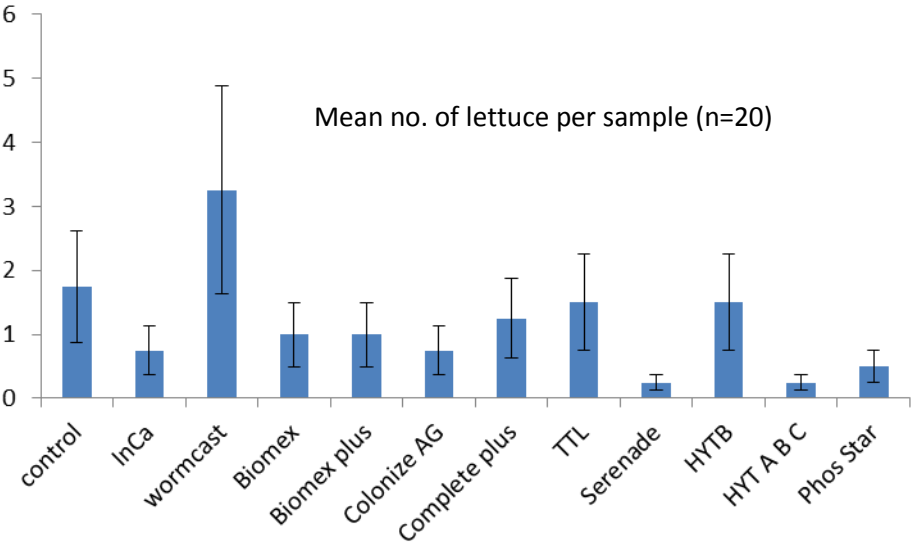

Figure 5. Mean (±SE) number lettuce with *Sclerotinia sclerotiorum* per sample plot at harvest.

Figure 5 shows that all treatments (Except for Wormcast) produced lower levels of *Sclerotinia sclerotiorum* than the standard control at harvest. However none of the differences were significant because of the highly variable treatment means (indicated by the

large Stand Error (SE) bars). Unlike *B. cinerea*, *S. sclerotiorum* was much more clustered in its distribution, thereby increasing the variability of the resulting data.

Peas (Ambassador)

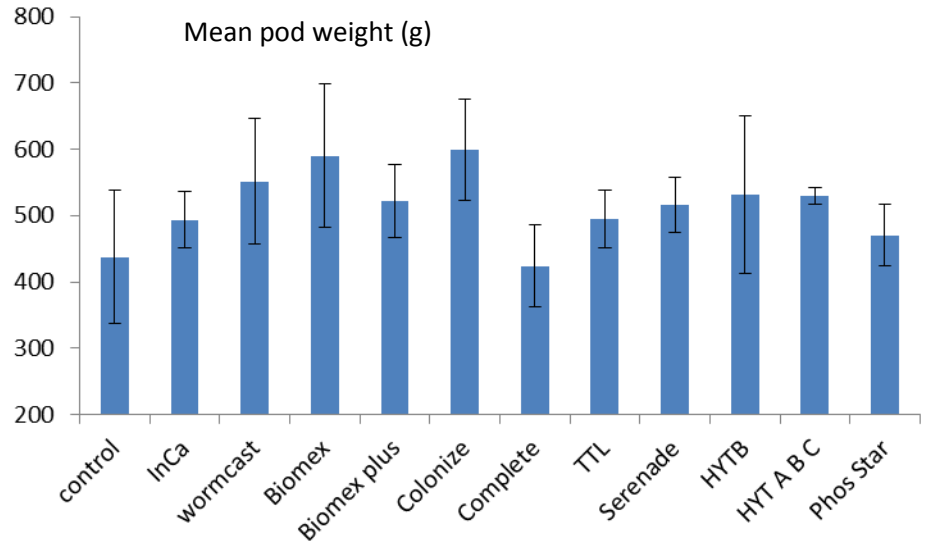

Figure 6. Mean weight (±SE) of pods per sample (2 x 0.5m inner rows)

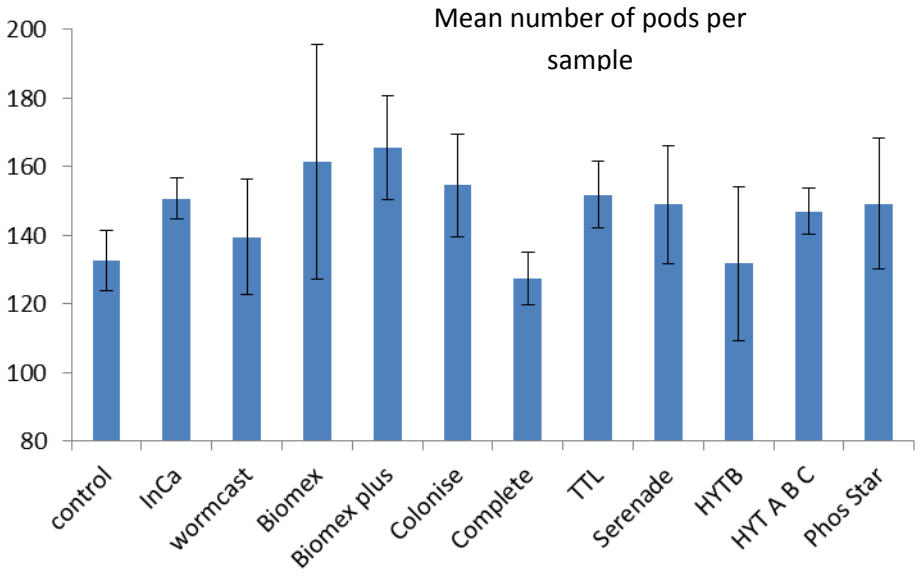

Figure 7. Effect of treatment on the mean numbers of pods (±SE).

The weight and numbers of pods are given in Figures 6 and 7. The results show that several treatments produced larger numbers of pods in comparison to the control (InCa, Wormcast,

Bioex, Biomex Plus, Colonise, TTL, Serenade, HYT b, HYT a b c, and Phos-Star). However these results should be taken with a degree of caution because there were high levels of variability between plot means for some treatments.

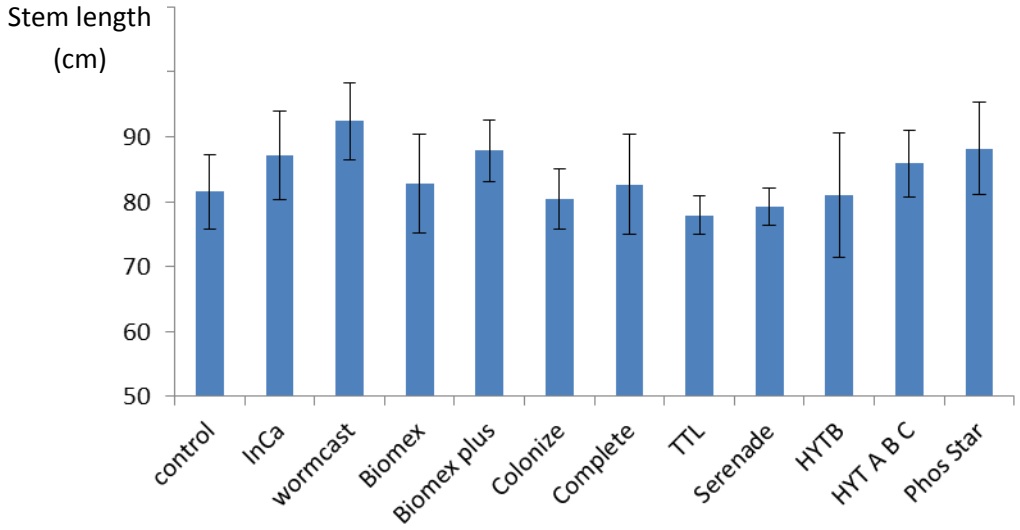

Figure 8 Mean (±SE) stem length per sample plot (two rows of 0.5m sample)

Figures 8 and 9 show the mean stem length (per plant) and stem length with pod numbers (per sample plot). Although some treatments increased stem length, again differences were not significant. There was no significant correlation between stem length and pod number (Figure 9).

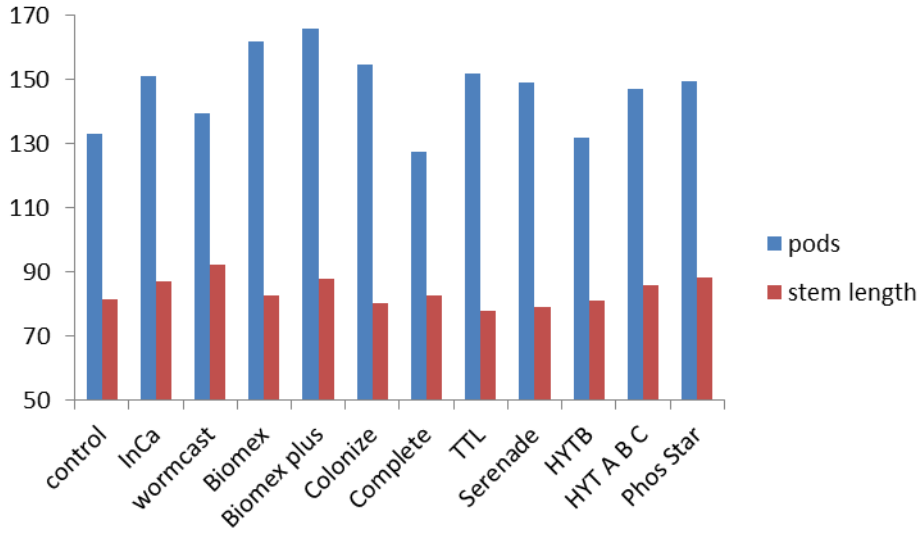

Figure 9. Mean stem length (cm) per plant and numbers of pods (per sample plot)

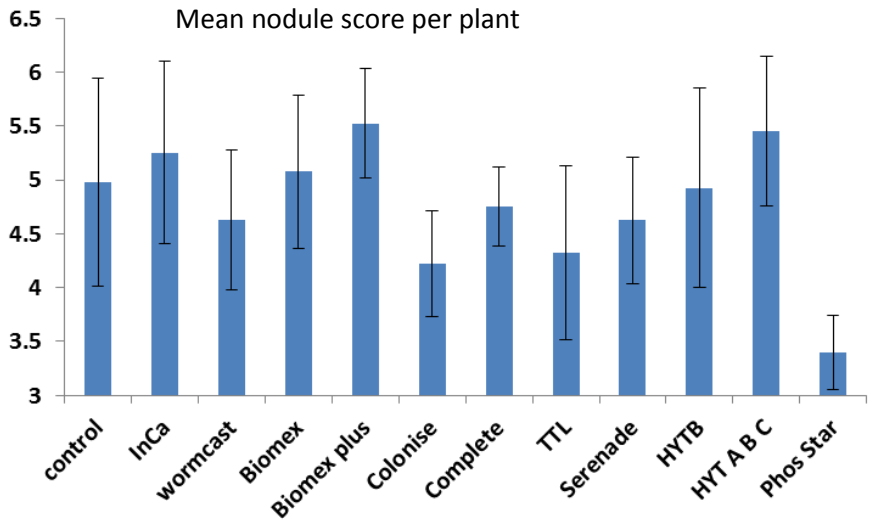

Figure 10. Mean (±SE) nodule score (0-10) per pea plant

Nodule formation was scored on a scale of 0 – 10 per plant. Biomex Plus, HYT abc, provided a larger score for nodule formation. But again, there was a large variability in the data preventing statistical significance being established for these treatments. Phos Star scored very low for nodule formation but then this product would not be expected to improve this aspect of plant performance.

Carrots (Nairobi)

Yield Asesments:

The measurements of carrot diameter and length gave no significant effect of treatment. Figure 11 shows the mean weight per sample plot. Overall there is no apparent effect of treatment on carrot weight.

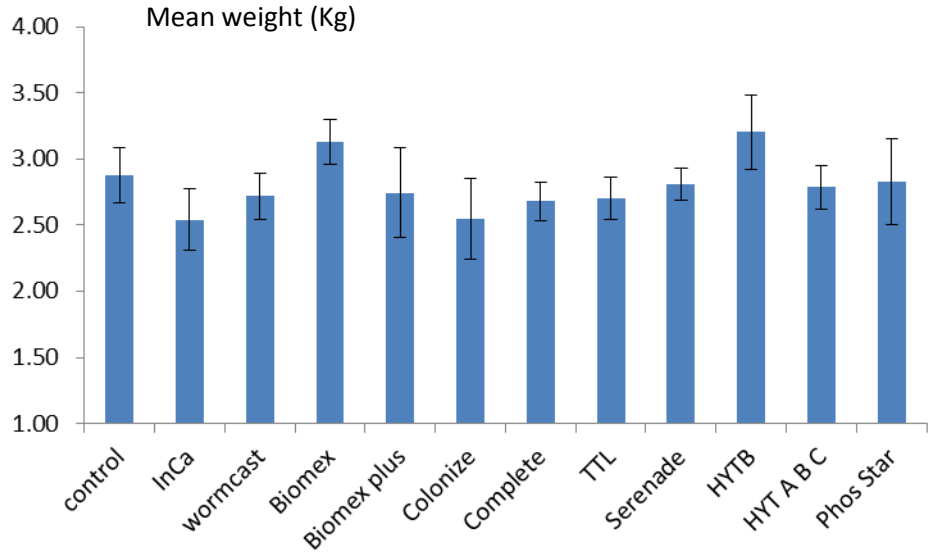

Figure 11. Mean carrot weight per sample plot

Disease Assessments:

Cavity spot in carrot samples (60 carrots from middle rows per plot) was scored on a scale of 0-5, with 5 being the highest level of damage.

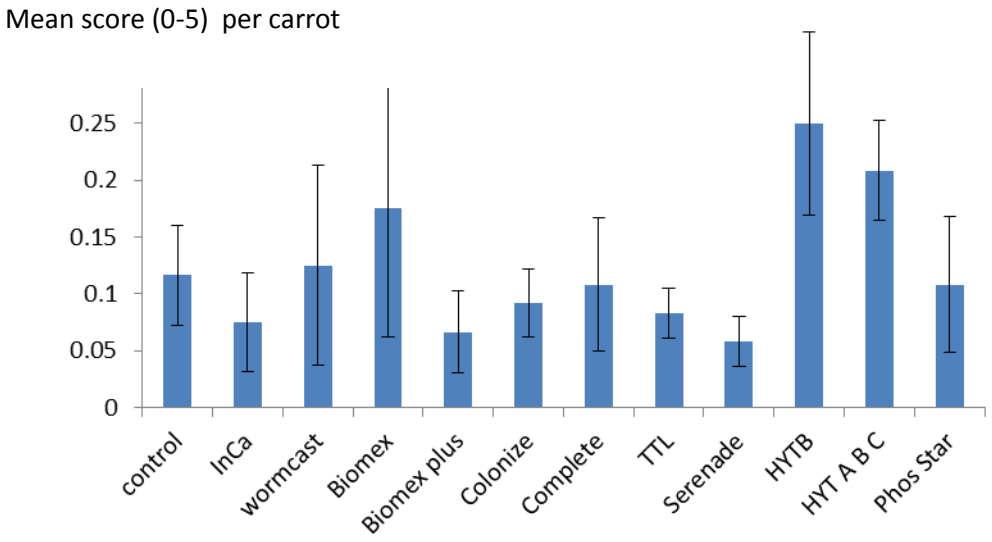

Figure 12. Mean (±SE) cavity spot score per carrot

The results in Figure 12 show that overall levels of cavity spot were very low during the trial, making treatment comparisons invalid. The dry weather conditions experienced at the start of the crop may have contributed to the low cavity spot levels.

There is no apparent effect on carrot root fly damage (0-5 score) (Figure 13), but again during the trial, levels of damage were relatively low, making treatment comparison difficult.

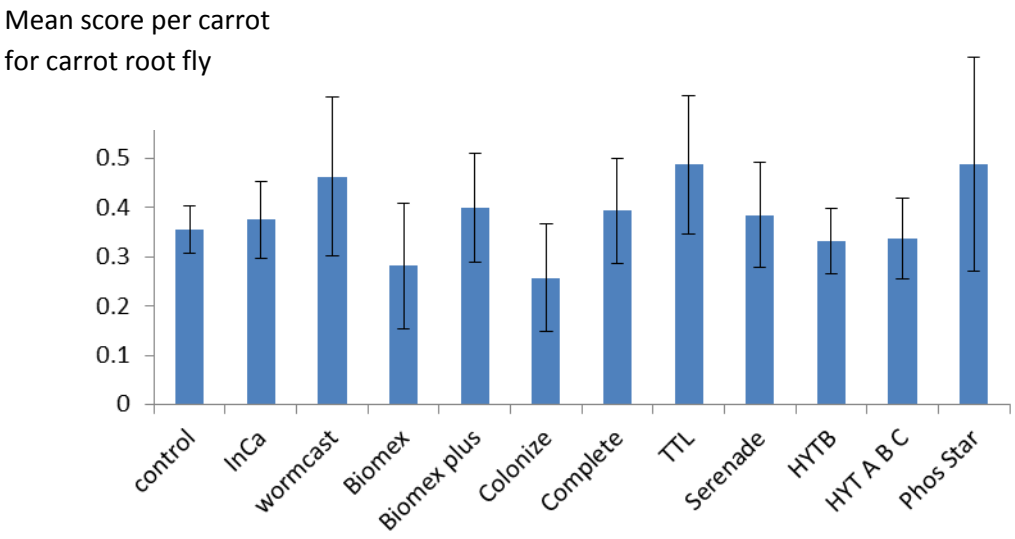

Figure 13. Mean (±SE) score for carrot root fly damage per carrot

Conclusions

Yield Assessments:

Lettuce

- Lettuce treated with Serenade and Phos-Star had significantly heavier head weights at harvest than the control plots.
- Treatments that produced lower levels of tip burn were, Inca, Wormcast, Biomex, Biomex plus, Colonise, Serenade, HYT b and HYT abc and Phos-Star, but these differences were not statistically significant.
- Phos-Star gave the highest percentage marketable (96%) but this higher level was not significant when compared to the standard NPK treated plots.

Peas

- The results showed that several treatments produced larger numbers of pods in comparison to the NPK treated control plots, (InCa, Wormcast, Bioex, Biomex Plus, Colonise, TTL, Serenade, HYT b, HYT abc, and Phos-Star). However there was high variability around the average weight and numbers for some treatments and this may have resulted in the recorded differences not being statistically significant.
- Several treatments increased stem length in comparison to the control (InCa, Wormcast, Biomex Plus, HYTabc and Phos-Star), but the differences were not significant. There was no correlation between stem length and pod number

- Biomex Plus and HYT abc provided a larger score for nodule formation. But again, there results are variable.

Carrots

- There was no significance between treatments for carrot root diameter and length.
- There was no statistically significant effect of treatment on carrot root weight at harvest.

General Comments

- The most significant results on yield were obtained for the lettuce crop. During the trial lettuce was the only crop irrigated. It is possible the dry spring conditions observed in the carrot and pea crops in the early part of the season may have resulted in reduced efficacy in the micronutrient based products.
- The first year of the trial demonstrates trends in yields across the three crops, where several treatments increased yields in comparison to the control. However as these trends were not statistically significant, it is not possible to determine if the observed differences were truly valid.

Disease Assessments:

Lettuce:

- All treatments produced lower levels of *Botrytis cinerea* than the control plots and this difference was significant for InCA, Wormcast, Biomex Plus, Colonise, TTL, Serenade, HYT b, HYT a + b and Phos-star.
- All treatments (Except for Wormcast) produced lower levels of *Sclerotinia sclerotiorum* than the standard control at harvest. However none of the differences were statistically significant because of the high variability in plot means for each treatment. Unlike Botrytis, *Sclerotinia* infection was much more clustered in its distribution, which would naturally increase the variability within the data.

Peas

- Sampled pods were scored for powdery mildew infection but disease levels were too low to determine any treatment effect.

Carrots

- Overall levels of cavity spot were very low during the trial, making treatment comparisons invalid. The dry weather conditions experienced at the start of the season may have contributed to the low cavity spot levels.
- There was no apparent effect on carrot root fly damage, but again levels of damage were relatively low making treatment comparisons difficult to determine.

Future work

Further trials should have an increased numbers of replicates to reduce treatment variability.

Testing products in a wetter season may provide clearer improvements in terms of product efficacy.

Appendix

	%N	%P	%K	%Ca	%Mg	Mn ppm	B ppm	Zn ppm	Fe ppm	Cu ppm	Mb ppm	%S
Control	4.39	0.50	1.29	0.10	0.16	13.0	11.3	53.3	99	9.2	2.01	0.16
InCa	4.26	0.48	1.32	0.13	0.18	13.9	13.0	52.0	100	9.0	2.17	0.16
Wormcast	4.22	0.48	1.23	0.11	0.17	13.6	12.2	53.0	95	9.3	2.05	0.14
Biomex Starter	4.3	0.50	1.30	0.09	0.17	14.1	12.4	47.8	93	9.4	1.92	0.14
Biomex Plus	4.34	0.54	1.36	0.10	0.17	13.5	11.9	57.5	102	9.7	2.37	0.15
Colonize AG	3.69	0.42	1.29	0.14	0.19	14.0	13.7	47.5	105	9.3	2.08	0.16
Complete Plus	4.16	0.46	1.29	0.13	0.17	14.3	13.2	48.5	102	9.0	1.96	0.16
TTL Plus	4.41	0.51	1.34	0.11	0.16	13.3	12.5	52.6	100	9.0	2.31	0.17
Serenade	4.20	0.47	1.15	0.09	0.15	12.1	9.5	47.4	89	9.4	2.02	0.14
HYTb	4.29	0.50	1.26	0.13	0.16	13.1	11.4	58.0	115	10.9	2.36	0.15
HYT abc	3.91	0.42	1.20	0.12	0.17	13.5	12.8	48.0	89	8.6	2.01	0.14
Phos-star	4.21	0.45	1.26	0.10	0.16	13.4	11.7	46.9	98	8.7	2.02	0.15