

Project title The effects of biostimulants and plant health promoters in leafy salad crops under disease pressure

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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.

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.

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Grower Summary

Headline

- A number of biostimulant and plant health promoter products showed improved yield of marketable produce and reduced downy mildew symptoms in field grown lettuce.
- Phosphorus and potassium based products (Farm Fos and Orophite) produced comparable head quality to a three spray fungicide programme.
- Other products would require integration with fungicide sprays to produce heads of acceptable quality under high disease pressures.

Background and expected deliverables

The field grown salad and speciality produce industry increasingly utilises a range of products generally known as biostimulants or plant health promoters, including some biocontrol products. In most cases, the products do not have any claimed specific pesticide activity, and are not registered as pesticides, but are thought to act by enhancing plant growth and the plant's ability to withstand infection by disease, so that marketability is improved. Frequent applications are normally recommended, and final applications can be made close to harvest. Despite considerable uptake of health promoters, and the costs associated, there has been little experimental comparison of the benefits of different products. This project was undertaken to deliver a comparison of different types of available products, using lettuce and downy mildew as a test system and to establish the extent to which they improved produce quality compared to a standard fungicide programme. This would enable growers to judge the value of health promoters as part of their production protocols.

Summary of the project and main conclusions

Products with defined active ingredients were selected after discussion with the grower coordinator. These represented plant defence activators, plant nutrients or growth promoters and a biocontrol agent. Iceberg lettuces were raised in blocks, transplanted and then treated with the products, according to leaflet recommendations or advice from providers. A fungicide programme (Aliette, Manzate WG and Amistar, and Fubol Gold) was used as comparison. Downy mildew was introduced onto all plots by spraying a spore suspension at the six leaf stage. All the products used provided some benefits in terms of reduced disease and improved marketable yield compared to untreated plots, even though some improvements were relatively small. Only phosphorus and potassium based products were comparable to the fungicide programme, and the benefits observed were achieved with five applications compared to three for the fungicides.

Plant oil based products (orange, grapefruit, garlic, and coconut + citrus) gave partial reduction of downy mildew symptoms and some improvement in marketable yield. A protein based product - Pre-TECT containing harpin gave similar effects, with three applications, compared to the five or six used for the plant oil based products. Sanosorb a nutrient product containing humic acid was broadly similar in terms of disease reduction, but gave yield benefits closer to those seen with the phosphorus/potassium products. The biocontrol product, Sentry S, reduced disease symptoms, but only gave a very small improvement in marketable yield. Products are ranked in order of levels of downy mildew seen on inner leaves at harvest, with weight per marketable head in the summary table below.

Product ranking for downy mildew levels, with harvest weight/head

Product	Active Ingredient	Downy mildew (% area infected)	Weight (g) per marketable head
Untreated	-	26.7	644
Orosorb	Orange Oil	21.0	723
Biomax Forte	Citrus Coconut	20.0	713
Sentry S	<i>Bacillus subtilis</i>	20.0	670
Pre-tect	Harpin	19.3	731
Anthyllis	Garlic Oil	16.7	725
Biosept Crop Gold	Grapefruit Oil	16.0	690
Sanosorb	Humic acid	15.0	769
Orophite	Phosphorus acid + potash	9.7	775
Farm-Fos	Potassium phosphite	4.0	793
Fungicide programme:	Fosetyl-aluminum /mancozeb		
Aliette/Manzate WG	Azoxystrobin/mancozeb+	3.3	825
Amistar/Fubol Gold	metalaxyl-M		

2007 was very favourable for downy mildew development in lettuce, and products were under extreme disease pressure, with rapid development of symptoms. Under less pressure, the effects of health stimulants may be more marked and improvements in marketable yield correspondingly greater.

Financial benefits

This project has demonstrated that a range of available products, with defined active ingredients, do have benefits in terms of reducing disease and increasing quality. Applications may need to be frequent however, and the cost of this, together with product purchase, needs to be weighed against the benefits and costs of a standard fungicide programme. Under a severe test such as that produced by the 2007 season, it was clear that all products except the phosphorus/potassium ones would have to be integrated with fungicides to prevent serious crop losses.

Action points for growers

- Use phosphorus/potassium based products (eg Farm Fos and Orophite) to give benefits comparable to a standard fungicide programme, but frequent (every 5-7 days) applications are needed under high disease pressure.
- Use other health promoters, biostimulant products and biological agents as part of integrated programmes with fungicides unless disease pressure is very low.

Science Section

Introduction

Plant health promoters and biostimulants are used in leafy salad production as ways of achieving high quality and blemish free produce. Some products are registered as pesticides, and will control specific diseases. Others are not pesticides, though one of the potential benefits is that they affect plants in ways which enhance resistance to disease. Such products may be applied frequently, and close to harvest. Though there is a wide range of products available, there has been little or no comparison of their effectiveness under field conditions with “inoculum pressures” that might be experienced in favourable disease seasons. This project was undertaken to investigate the effectiveness of a range of biostimulant or health promoter products, using lettuce and downy mildew as the test system.

Materials and methods

Products for application were selected during the project proposal and discussed with the SPGA group. Selected materials represented the main types of product available, and are summarised in Table 1. A conventional fungicide programme (3 sprays, no block treatment) was included for comparison.

Block raised lettuce plants of the iceberg variety Robinson were transplanted on 10th May. Plots were 5.5 m long with 4 rows each of 22 plants, and there were 3 replicates of each treatment laid out in a randomised block design.

Each product was applied according to label recommendations or by advice from the supplier. Dates and rates of application are summarised in Table 2.

An isolate of downy mildew (BI 25) was increased in a growth room, and 100 ml of an aqueous suspension of 10⁴ spores ml⁻¹ applied to all plots on 28th June. Plants were irrigated at establishment and during any dry periods with overhead sprinklers in late afternoon.

Plants were assessed for % leaf area infected with downy mildew and plot greenness during the growing season, and then harvested on 23rd July and assessed again for disease, marketable weight, and ease of trimming

Table 1: Summary of commercial products used and product type

Product	Active ingredient	Type
Orosorb	Orange Oil	Plant enhancer
Anthyllis	Garlic Oil	Growth stimulant
Orophite	Phosphorus acid + potash	Foliar feed
Biomax Forte	Citrus Coconut	Phytoalexin stimulant
Sanosorb	Humic acid	Growth stimulant
Sentry S	<i>Bacillus subtilis</i>	Biological
Biosept Crop Gold	Grapefruit Oil	Flavanoid stimulant
Pre-tect	Harpin	Photosynthesis enhancer
Farm-Fos	Potassium phosphite	Plant nutrient
Fungicide programme: Aliette/Manzate WG + Amistar/Fubol Gold	Fosetyl-aluminum /mancozeb Azoxystrobin/mancozeb+metalaxyl-M	
Untreated	-	

Table 2: Summary of application dates and rates

Product	Date of application						Rate
Orosorb	20/6	27/6	4/7	11/7	19/7		500 ml /100 l water
Anthyllis	20/6	25/6	2/7	6/7	11/7	18/7	1 ml /100 ml water
Orophite	20/6	27/6	4/7	11/7	19/7		500 ml /100 l water
Biomax Forte	20/6	27/6	2/7	6/7	11/7	18/7	300 ml /ha in 1000 l water
Sanosorb	20/6	27/6	4/7	11/7	19/7		1 l /100 l water
Sentry S	20/6	25/6	2/7	6/7	11/7	17/7	12 l / ha
Biosept Crop Gold	20/6	27/6	4/7	11/7	19/7		4 ml / l water
Pre-tect	20/6	27/6	4/7				1 kg / ha
Farm-Fos	20/6	27/6	4/7	11/7	19/7		4 l / ha
Aliette	20/6						3 kg / ha
Manzate WG + Amistar	29/6						1.7 kg / ha and 1 l / ha
Fubol Gold	13/7						1.9 l / ha

Results and Discussion

After the wet conditions which persisted for much of June, downy mildew increased very rapidly in late June-early July and reached high levels on untreated plots. Some sprays were not applied as scheduled due to adverse weather, though none were more than +/-2 days from the planned timing. Though sprays were timed to avoid heavy rain, showery conditions after some sprays may have reduce the amount of product adhering to leaves.

All of the products tested reduced downy mildew compared to the untreated control, and increased marketable head weight. Most products enhanced overall plot greenness, even if only slightly. However, only two products, Farm Fos and Orophite, reduced disease to a level comparable to that of the conventional fungicide treated (Tables 3, 4 and 5, plot data for disease and yield in Appendix).

Table 3: Downy mildew levels on heads (% area infected, plot score)

Product	11/07/07	19/07/07		23/07/07	
	whole head	whole head	top of head	outer leaves	Inner leaves
Orosorb	28.3	43.3	18.3	30.0	21.0
Anthyllis	15.7	43.3	23.3	21.0	16.7
Orophite	17.3	21.7	5.0	11.0	9.7
Biomax Forte	18.3	43.3	23.3	16.3	20.0
Sanosorb	29.0	45.0	18.3	28.3	15.0
Sentry S	37.7	46.7	15.0	43.3	20.0
Biosept Crop Gold	25.0	35.0	13.3	22.7	16.0
Pre-tect	15.3	43.3	21.7	27.3	19.3
Farm-Fos	13.7	15.0	5.0	4.0	4.0
Fungicide programme	11.7	8.3	2.2	7.3	3.3
Untreated	25.7	60.0	33.3	37.0	26.7
LSD (p=0.05)	14.30	17.43	9.14	9.51	8.22

Table 4: Plot greenness, 0-5, 5 = most green, 19/07/07

Product	0-5 score
Orosorb	3.0
Anthyllis	3.0
Orophite	4.3
Biomax Forte	2.7
Sanosorb	3.0
Sentry S	2.7
Biosept Crop Gold	3.7
Pre-tect	3.0
Farm-Fos	4.7
Fungicide programme	5.0
Untreated	2.3
LSD (p=0.05)	1.13

Table 5: Harvest data 23/07/07

Product	Total weight marketable heads (kg)	Ease of trimming (1-5, 5=easy)	% marketable	Mean weight per marketable head (g)
Orosorb	6.6	3.0	45	723
Anthyllis	7.0	3.0	48	725
Orophite	7.5	4.0	48	775
Biomax Forte	6.2	2.0	43	713
Sanosorb	7.4	2.7	48	769
Sentry S	6.0	1.7	45	670
Biosept Crop Gold	7.1	2.7	52	690
Pre-tect	7.8	2.3	53	731
Farm-Fos	9.2	4.3	58	793
Fungicide programme	8.3	4.0	50	825
Untreated	5.1	1.3	40	644
LSD (p=0.05)	2.62	1.35	16.7	90.4

By the harvest date, plots had received 5 applications of most products, the exceptions being where labels recommended greater intervals between applications or fewer applications. Products were clearly differentiated between those containing phosphorus and/or potash and 'others'. From the 'others' group Biomax Forte (citrus and coconut) was one of the most effective in disease suppression by harvest. Pre-tect (harpin product), the other citrus oil containing products (Orosorb and Biosept), Sanosorb (humic acid) and garlic oil were also effective. The biological *Bacillus subtilis* preparation was less effective on outer leaves by harvest, though disease levels on inner leaves were still lower than the control. Biological products which require periods of multiplication on the leaf surface may have been particularly challenged by the wet season and highly favourable disease development conditions. Pre-tect and Sanosorb markedly increased yield compared to other products.

Conclusions

The results show that health promoters and biostimulants can contribute significantly to disease suppression and increasing marketable weights of produce. In some cases, they may be more effective if applied as part of an agrochemical disease control programme. However, given the extreme downy mildew pressure experienced in 2007, and the degree of disease suppression offered by most of the products tested, it is possible that in less favourable disease years, the products may be effective alone, and could be particularly valuable for organic systems. Farm Fos and Orophite suppressed downy mildew to almost the levels seen in the fungicide programme plots, and are therefore likely to be useful in most situations.

The effects seen were only achieved with multiple sprays, and frequent applications are advised in most product documentation. The costs of frequent application will need to be weighed against the benefits of using alternatives to agrochemicals in different situations. However, it was clear that biostimulants and health promoters did have benefits in the lettuce-downy mildew system examined here, and these may well extend to other host-pathogen combinations, as effects on plants are likely to be general, rather than specific effects on pathogens. Further work should focus on the benefits of products when integrated with fungicide programmes.

Technology transfer

Review of all salads research work at NIAB planned for meeting of Leafy Salads growers, October 2008. The results also to be presented in HDC News article.

Appendices

Plot data

Downy mildew % plant area infected 11/07/07 – whole plot score

Orosorb	30	30	25
Anthyllis	4	20	23
Orophite	14	26	12
Biomax Forte	28	16	11
Sanosorb	23	34	30
Sentry S	40	34	39
Biosept Crop Gold	25	28	22
Pre-tect	3	18	20
Farm-Fos	13	10	18
Fungicide programme	22	10	3
untreated	15	38	21

Downy mildew % plant area infected – whole plot score 19/07/07

Orosorb	45	40	45
Anthyllis	40	35	55
Orophite	30	15	20
Biomax Forte	50	45	35
Sanosorb	20	60	55
Sentry S	35	55	50
Biosept Crop Gold	25	45	35
Pre-tect	40	35	55
Farm-Fos	15	15	15
Fungicide programme	15	5	5
untreated	60	60	60

Downy mildew % plant area infected – top of heads/inner leaves 19/07/07

Orosorb	20	20	15
Anthyllis	15	20	35
Orophite	5	5	5
Biomax Forte	30	20	20
Sanosorb	10	25	20
Sentry S	10	20	15
Biosept Crop Gold	5	15	20
Pre-tect	15	20	30
Farm-Fos	5	5	5
Fungicide programme	5	1	1
untreated	30	30	40

Downy mildew % plant area infected 23/07/07 – outer leaves

Orosorb	40	15	35
Anthyllis	15	18	30

Orophite	15	8	10
Biomax Forte	6	18	25
Sanosorb	20	35	30
Sentry S	50	40	40
Biosept Crop Gold	30	18	20
Pre-tect	22	25	35
Farm-Fos	5	2	5
Fungicide programme	7	10	5
untreated	38	38	35

Downy mildew % plant area infected 23/07/07 – inner leaves

Orosorb	20	15	28
Anthyllis	12	18	20
Orophite	18	5	6
Biomax Forte	25	15	20
Sanosorb	7	20	18
Sentry S	20	20	20
Biosept Crop Gold	15	18	15
Pre-tect	15	15	28
Farm-Fos	5	5	2
Fungicide programme	3	5	2
untreated	25	25	30

Total marketable weight harvested per plot (kg) 23/07/07

Orosorb	9.65	4.44	5.84
Anthyllis	8.28	5.25	7.41
Orophite	8.31	8.69	5.6
Biomax Forte	5.21	7.15	6.18
Sanosorb	9.82	6.76	5.6
Sentry S	5.88	6.25	5.96
Biosept Crop Gold	7.19	7.22	6.95
Pre-tect	7.98	8.11	7.23
Farm-Fos	6.53	11.17	9.96
Fungicide programme	7.18	7.51	10.1
untreated	4.75	4.07	6.59

Weight per marketable head (g) 23/07/07

Orosorb	723	804	634
Anthyllis	726	753	750

Orophite	775	755	869
Biomax Forte	713	651	715
Sanosorb	769	755	751
Sentry S	670	653	694
Biosept Crop Gold	690	719	656
Pre-tect	731	725	811
Farm-Fos	793	816	796
Fungicide programme	825	798	834
untreated	644	594	678