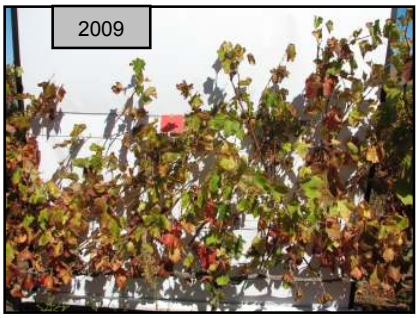

Final Report December 2011

Evaluating HiYield Plus™ on wine grapes for the 2009 season

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Abstract

Promising results in decreasing the disease incidence as well as amount of damage were obtained on a trial in the Durbanville area. The Shiraz cultivar was used in a block trial to test the concept of using elicitors to manage disease incidence and limit the degree of damage to the crop. HiYield Plus™ at a rate of 8ℓ ha^{-1} was applied a month after fruit set and sprayed every three weeks for an additional 3 applications.

When comparing treatments to the control, a yield increase of 0.538t ha^{-1} (NS) was obtained from HiYield Plus™, without a change in wine quality. Decreases in curly leaf virus incidence of 31%

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(P<0.01) and disease damage rates of rates 39% (P<0.01) were however observed between the HiYield Plus™ treatment and the control. The OMNIBOOST-K formulated with phosphites also produced statistically significant reductions in curly leaf virus incidence and damage. Nutrient foliars without elicitors gave a measure of control on disease damage and incidence. The level of control shown by the elicitor containing foliars was however superior to the ordinary foliars

Recommendations

- Test the product for a second season in another region.
- Determine if fungal sprays could be reduced.
- What is the economic impact of fewer sprays and increased yield?
- What is the impact of the fewer sprays on the Cu-levels in the saps?

Introduction

Since man began cultivating crops he has had to contend with managing pests and diseases which if left un-checked can cause reduced yields and crop failures. Today's farmers have a number of strategies they can employ ranging from chemical controls to products which are less toxic to the environment. HiYield Plus™, a 6:5:14* (N:P:K)-product with trace elements to combat stress at crucial times and elicitors (salicylic acid in this case) that activate plants' natural defence systems to combat fungal- and bacterial infections was developed to increase crop vitality and its ability to fight disease. A trial to evaluate the effect that elicitors have on crop production was implemented in the Durbanville district of the Cape to compare elicitor products, HiYield Plus™ and OMNIBOOST-K formulated with phosphites, to formulations without the elicitor ingredient.

The vineyard on which the product was tested was so infected with curly leaf virus that it was intended to be replanted after the 2009 trials. In spite of the diseases, we still managed to increase the yield of the diseased vines by more than 0.500t ha^{-1} applying HiYield Plus™.

* Note that the old formulation was used to conduct this trial; the new formulation is 5:4:11.

Trial Details

TRIAL NO : Grapes-Health Foliars-MK-2009-11

TITLE : Evaluating HiYield Plus™ on wine grapes for the 2009 season.

OBJECTIVES : To determine if curly leaf virus can be diminished.

CROP : Wine grapes (Shiraz at Nitida).

TRIAL DESIGN : Randomised Complete Block Design (4 X 8).

TREATMENT LIST :

1. Control.
2. HiYield Plus™ at 8ℓ ha^{-1}.
3. HiYield™ at 8ℓ ha^{-1}.
4. OMNIBOOST-K™ enriched with Phosphite at 5kg ha^{-1}.

Trial layout :

3	4	2	2	2	4	2	3
2	1	4	1	3	3	4	1
4	3	1	3	4	1	1	2
1	2	3	4	1	2	3	4

Application : Treatment applications started 2 weeks after fruit set and were repeated every 21 days until 2 weeks before harvest

Treatment	1st spray (1 month after fruit set) - Notes on application	2nd spray	3rd spray	4th spray	Application volume water ℓ/ha
Control	Control	N/A	N/A		N/A
HiYield Plus™	8/12/2009	21/12/2009	11/1/2010	28/1/2010	700 (but as leaves increase spray @ 1000ℓ ha^{-1} from Jan. 2010)
HiYield™	8/12/2009	21/12/2009	11/1/2010	28/1/2010	700 (but as leaves increase spray @ 1000ℓ ha^{-1} from Jan. 2010)
OMNIBOOST-K™ + Phosphite	8/12/2009	21/12/2009	11/1/2010	28/1/2010	700 (but as leaves increase spray @ 1000ℓ ha^{-1} from Jan. 2010)

Note on Applications :

- The first applications were implemented 1 month after fruit set because of the colder weather and thus a slower start to the season and not two weeks after fruit set as would be the standard practice.

Assessments :

Action & Parameter	Methods	Timing	Dates
Soil	1 composite topsoil (0 – 20cm) as well as 1 subsoil (20 – 40cm) sample was taken randomly across the trial – 18 sub samples combined	N / A	30 Nov. 2009
Disease rating	General impression of harvested vine was noted in terms of the rate of incidence of leaf curling as well as the % damage being caused by this disease.	Three weeks post harvest	12 April 2010
Yield	Harvested and recorded per strip using portable load cells	At harvesting	Shiraz – 23 Mar. 2010
Quality of wine – brix and pH	Fruit samples per strip were taken to the local lab to test wine quality	At harvesting	Shiraz – 23 Mar. 2010

Site Details :

District	Farm Name	Cultivar	Vines per ha
Durbanville	Nitida	Shiraz	2469

Statistical Analysis :

- The data was analysed statistically with ANOVA and Two sample T-Tests at a 95% significance level using the NCSS 2001 statistical program.

Results and Discussion

Yield Summary:

Legend for interpretation of significant differences

Effect	P < 0.10	P < 0.05
Positive		
Negative		
Significant		

Table 1 ANOVA results of treatments on yield, brix and disease comparisons of wine grapes

	Block Effect					Treatment Effect				
	Degrees of Freedom	Sum of Squares	Mean Square	F-ratio	Prob.-level	Degrees of Freedom	Sum of Squares	Mean Square	F-ratio	Prob.-level
Harvested Yield (t/ha)	7	23.360	3.337	0.707	0.6665	3	3.585	1.195	0.253	0.8582
Brix %	7	4.932	0.705	0.499	0.8245	3	0.973	0.324	0.230	0.8745

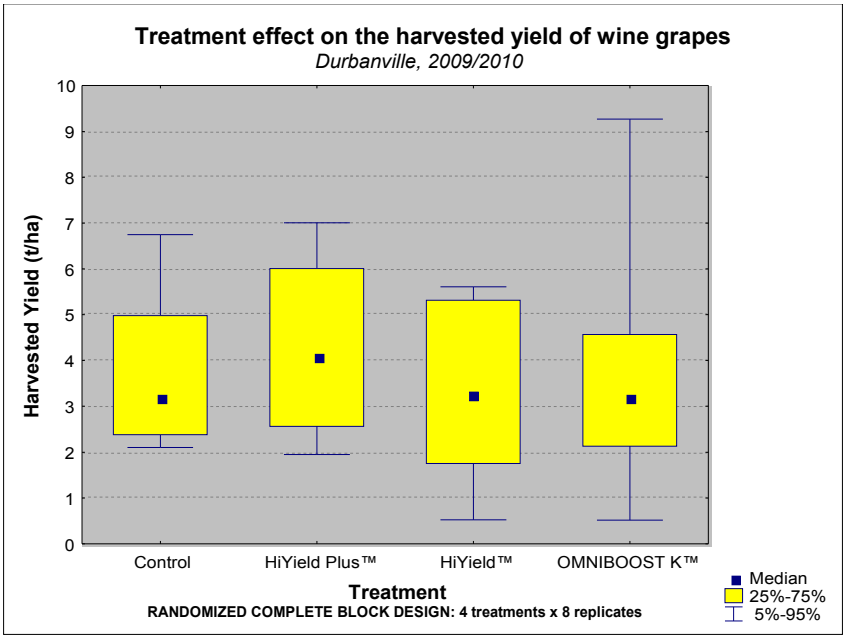


Figure 1 Yields of wine grapes treated with different health foliars at Nitida.

Yield analyses:

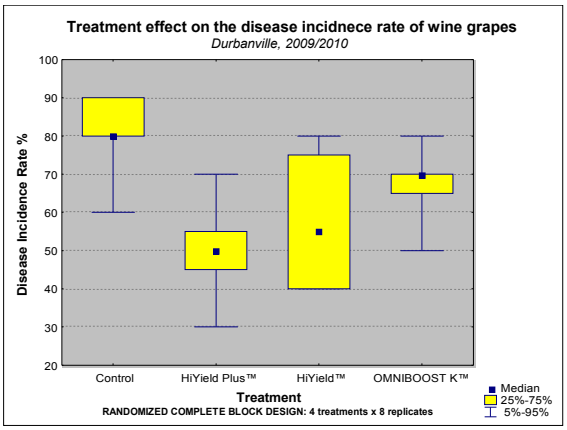
- No statistically significant yield increase was observed – see Table 1.

- The HiYield Plus™ treatment had the highest yield of 4.279t ha^{-1}.
- A yield increase of 0.538t ha^{-1} (14.4%) was observed between the HiYield Plus™ treatment (4.279t ha^{-1}) and the control (3.741t ha^{-1}) – see Addendum A.
- Even with this increase in yield the disease has spread too far for the vine to recover and it's not economically viable to keep this block of vineyard.
- The healthy vines yielded 4.040t ha^{-1} more than the control – see Addendum A.

- This increase in yield did not affect the wine quality in any way – no significant differences in the brix% were seen – see Table 1.
  - The average brix% was 21.947%.

Disease analyses:

In general, the block was severely infected with curly leaf virus and was about to be taken out by the producer. The disease observations focused on this virus only and information below reflects visual observations of harvested vines.



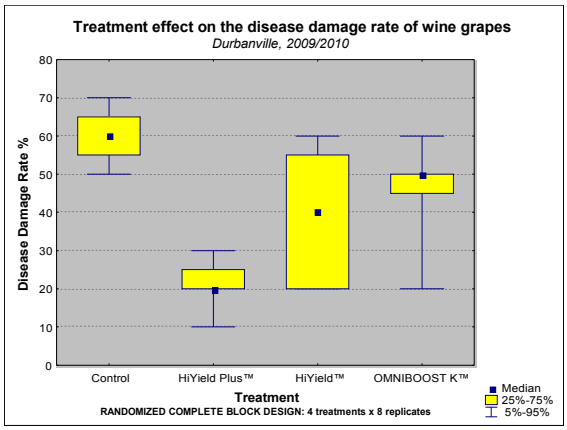


Figure 2 Curly leaf virus incidence and damage on wine grapes treated with different health foliars at Nitida.

- Strong statistically significant decreases in curly leaf virus incidence rates of 31% ($P < 0.01$) were observed between the HiYield Plus™ treatment and the control – see Table 2 above as well as Tables 3 & 4 in Addendum G.
  - Decreases in disease incidence rates varied between 31% and 14%.

- The incidence of curly leaf virus amongst control vines was significantly higher than all treatments; HiYield Plus™ ($P<0.01$), HiYield™ ($P<0.01$) & OMNIBOOST-K™ + Phosphite ($P=0.04$). OMNIBOOST-K™ + Phosphite was not as effective at controlling the disease as HiYield Plus™ ($P<0.01$).
- There were no difference between the performance of HiYield Plus™ and ordinary HiYield™ even at the 80% confidence level.
- The lesser curly leaf virus incidence and damage rates of the HiYield Plus™ treatment corresponded with the increased yield of this treatment. Thus the healthier vines yielded a higher average yield.

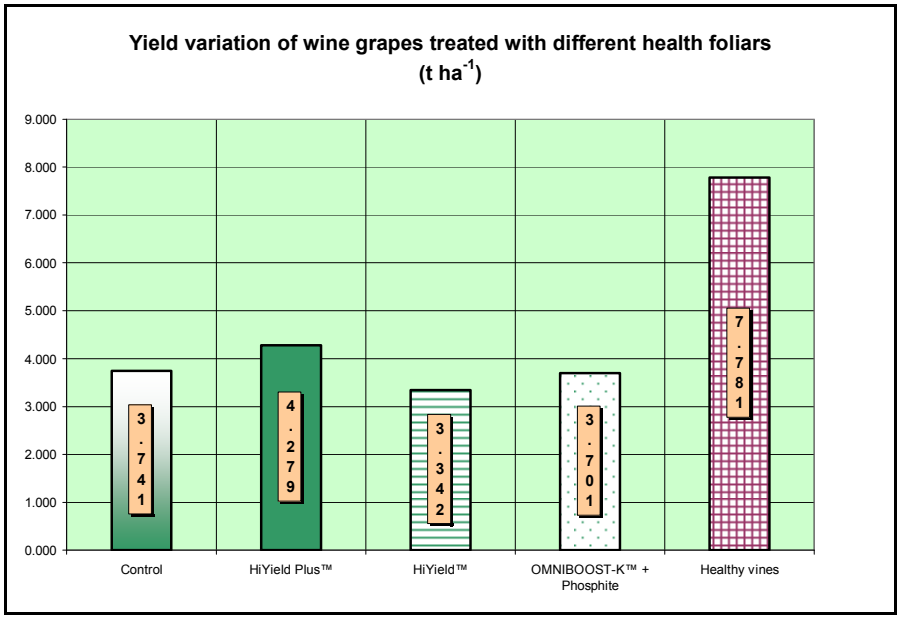
- All the treatments had significantly less disease damage than the control ($P<0.05$).
- HiYield Plus™ showed the greatest reduction in damage from disease, reducing the damage by 39% ($P<0.01$) as compared to the control – see Table 2 above as well as Tables 3 & 4 in Addendum G.
    - Decreases in disease damage rates varied between 39% and 14%.
    - The degree of disease damage of the control was significantly higher than HiYield Plus™ ($P<0.01$), HiYield™ ($P<0.01$) & OMNIBOOST-K™ + Phosphite ($P=0.02$), and HiYield Plus™ was significantly lower than HiYield™ ($P<0.01$) & OMNIBOOST-K™ + Phosphite ($P<0.01$).

Conclusion

- HiYield Plus™ at a rate of 8ℓ ha^{-1} decreased the curly leaf virus incidence rates by 31% ($P<0.01$) and the disease damage rates by 39% ($P<0.01$).
- Nutrient foliars without elicitors gave a measure of control on disease damage and incidence. The level of control shown by the elicitor containing foliars was however superior to the ordinary foliars.
- In this trial the disease control shown by salicylic acid was superior to that of phosphite though rates may need to be optimised for the phosphite application.
- No yield increases were obtained and wine quality was not affected negatively in any way.
- The lack of yield response was possibly because the vines were heavily infected with curly leaf virus and responses may be more pronounced on blocks with different disease profiles.

Addendum A – Yield Data

Farm code	Cultivar	Sample number	Treatment	Repeat	Row	Column	Total harvested (kg)	Total yield (t/ha)
ND	Shiraz	1.1	1	1	8	4	2.156	5.323
ND	Shiraz	1.2	1	2	7	2	0.971	2.397
ND	Shiraz	1.3	1	3	6	3	1.147	2.832
ND	Shiraz	1.4	1	4	5	2	0.851	2.101
ND	Shiraz	1.5	1	5	4	4	0.958	2.365
ND	Shiraz	1.6	1	6	3	3	1.429	3.528
ND	Shiraz	1.7	1	7	2	3	2.732	6.745
ND	Shiraz	1.8	1	8	1	2	1.878	4.637
ND	Shiraz	2.1	2	1	8	2	0.899	2.220
ND	Shiraz	2.2	2	2	7	4	0.790	1.951
ND	Shiraz	2.3	2	3	6	1	2.362	5.832
ND	Shiraz	2.4	2	4	5	1	1.884	4.652
ND	Shiraz	2.5	2	5	4	1	1.414	3.491
ND	Shiraz	2.6	2	6	3	4	2.837	7.005
ND	Shiraz	2.7	2	7	2	1	1.175	2.901
ND	Shiraz	2.8	2	8	1	3	2.505	6.185
ND	Shiraz	3.1	3	1	8	1	0.213	0.526
ND	Shiraz	3.2	3	2	7	3	1.104	2.726
ND	Shiraz	3.3	3	3	6	4	0.315	0.778
ND	Shiraz	3.4	3	4	5	3	2.197	5.424
ND	Shiraz	3.5	3	5	4	2	2.110	5.210
ND	Shiraz	3.6	3	6	3	2	1.469	3.627
ND	Shiraz	3.7	3	7	2	4	1.151	2.842
ND	Shiraz	3.8	3	8	1	1	2.270	5.605
ND	Shiraz	4.1	4	1	8	3	2.032	5.017
ND	Shiraz	4.2	4	2	7	1	1.668	4.118
ND	Shiraz	4.3	4	3	6	2	0.666	1.644
ND	Shiraz	4.4	4	4	5	4	1.062	2.622
ND	Shiraz	4.5	4	5	4	3	3.754	9.269
ND	Shiraz	4.6	4	6	3	1	1.268	3.131
ND	Shiraz	4.7	4	7	2	2	0.209	0.516
ND	Shiraz	4.8	4	8	1	4	1.333	3.291

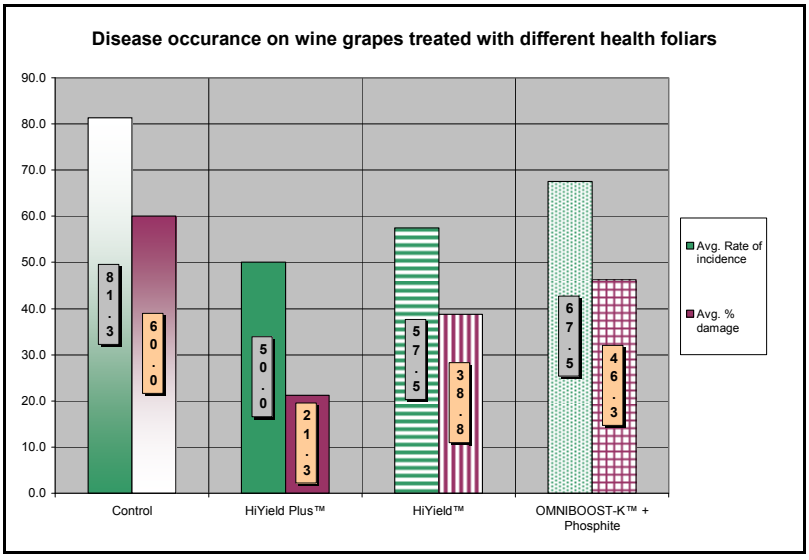


Addendum B – Disease Data

Table 2 Fisher's LSD for mean comparisons between treatment effects on disease comparisons of wine grapes

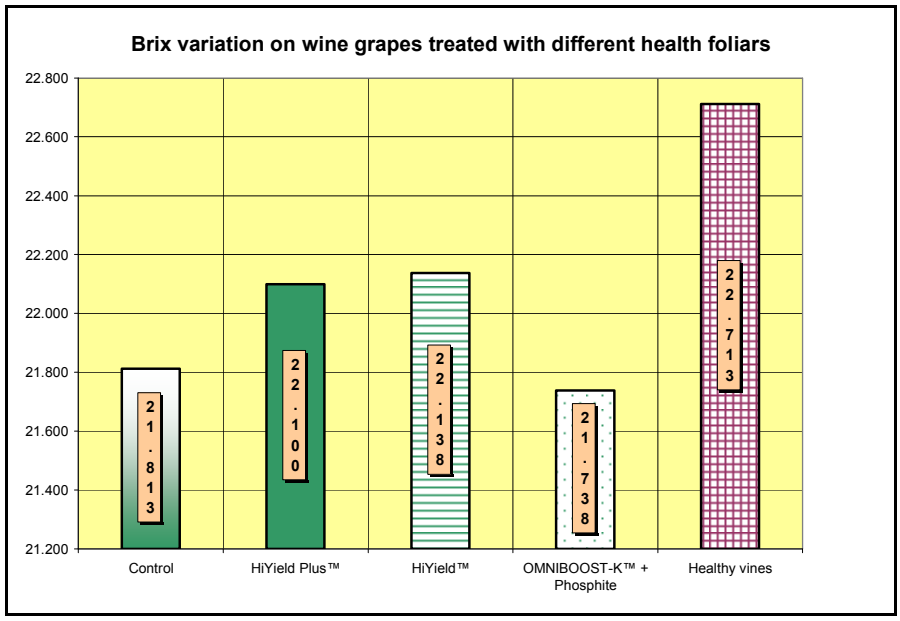
	α = 0.05	α = 0.2
Disease Incidence Rate %	12.716%	8.091%
Disease Damage Rate %	11.036%	7.022%

Farm code	Cultivar	Sample number	Treatment	Repeat	Row	Column	Rate of incidence	% damage
ND	Shiraz	1.1	1	1	8	4	90.000	70.000
ND	Shiraz	1.2	1	2	7	2	80.000	60.000
ND	Shiraz	1.3	1	3	6	3	80.000	60.000
ND	Shiraz	1.4	1	4	5	2	80.000	60.000
ND	Shiraz	1.5	1	5	4	4	90.000	70.000
ND	Shiraz	1.6	1	6	3	3	90.000	60.000
ND	Shiraz	1.7	1	7	2	3	60.000	50.000
ND	Shiraz	1.8	1	8	1	2	80.000	50.000
ND	Shiraz	2.1	2	1	8	2	30.000	10.000
ND	Shiraz	2.2	2	2	7	4	50.000	20.000
ND	Shiraz	2.3	2	3	6	1	50.000	20.000
ND	Shiraz	2.4	2	4	5	1	50.000	20.000
ND	Shiraz	2.5	2	5	4	1	40.000	20.000
ND	Shiraz	2.6	2	6	3	4	70.000	30.000
ND	Shiraz	2.7	2	7	2	1	50.000	20.000
ND	Shiraz	2.8	2	8	1	3	60.000	30.000
ND	Shiraz	3.1	3	1	8	1	80.000	60.000
ND	Shiraz	3.2	3	2	7	3	80.000	60.000
ND	Shiraz	3.3	3	3	6	4	40.000	20.000
ND	Shiraz	3.4	3	4	5	3	40.000	30.000
ND	Shiraz	3.5	3	5	4	2	50.000	50.000
ND	Shiraz	3.6	3	6	3	2	70.000	50.000
ND	Shiraz	3.7	3	7	2	4	60.000	20.000
ND	Shiraz	3.8	3	8	1	1	40.000	20.000
ND	Shiraz	4.1	4	1	8	3	80.000	60.000
ND	Shiraz	4.2	4	2	7	1	70.000	50.000
ND	Shiraz	4.3	4	3	6	2	60.000	40.000
ND	Shiraz	4.4	4	4	5	4	70.000	50.000
ND	Shiraz	4.5	4	5	4	3	70.000	50.000
ND	Shiraz	4.6	4	6	3	1	70.000	50.000
ND	Shiraz	4.7	4	7	2	2	70.000	50.000
ND	Shiraz	4.8	4	8	1	4	50.000	20.000



Addendum C – Brix Data

Farm code	Cultivar	Sample number	Treatment	Repeat	Row	Column	Brix
ND	Shiraz	1.1	1	1	8	4	21.700
ND	Shiraz	1.2	1	2	7	2	20.800
ND	Shiraz	1.3	1	3	6	3	21.700
ND	Shiraz	1.4	1	4	5	2	22.000
ND	Shiraz	1.5	1	5	4	4	24.000
ND	Shiraz	1.6	1	6	3	3	21.600
ND	Shiraz	1.7	1	7	2	3	21.700
ND	Shiraz	1.8	1	8	1	2	21.000
ND	Shiraz	2.1	2	1	8	2	21.700
ND	Shiraz	2.2	2	2	7	4	25.000
ND	Shiraz	2.3	2	3	6	1	22.000
ND	Shiraz	2.4	2	4	5	1	21.000
ND	Shiraz	2.5	2	5	4	1	22.200
ND	Shiraz	2.6	2	6	3	4	20.500
ND	Shiraz	2.7	2	7	2	1	21.500
ND	Shiraz	2.8	2	8	1	3	22.900
ND	Shiraz	3.1	3	1	8	1	23.800
ND	Shiraz	3.2	3	2	7	3	21.000
ND	Shiraz	3.3	3	3	6	4	23.000
ND	Shiraz	3.4	3	4	5	3	22.000
ND	Shiraz	3.5	3	5	4	2	22.400
ND	Shiraz	3.6	3	6	3	2	23.400
ND	Shiraz	3.7	3	7	2	4	21.500
ND	Shiraz	3.8	3	8	1	1	20.000
ND	Shiraz	4.1	4	1	8	3	21.400
ND	Shiraz	4.2	4	2	7	1	22.900
ND	Shiraz	4.3	4	3	6	2	22.000
ND	Shiraz	4.4	4	4	5	4	20.700
ND	Shiraz	4.5	4	5	4	3	21.200
ND	Shiraz	4.6	4	6	3	1	21.900
ND	Shiraz	4.7	4	7	2	2	22.200
ND	Shiraz	4.8	4	8	1	4	21.600



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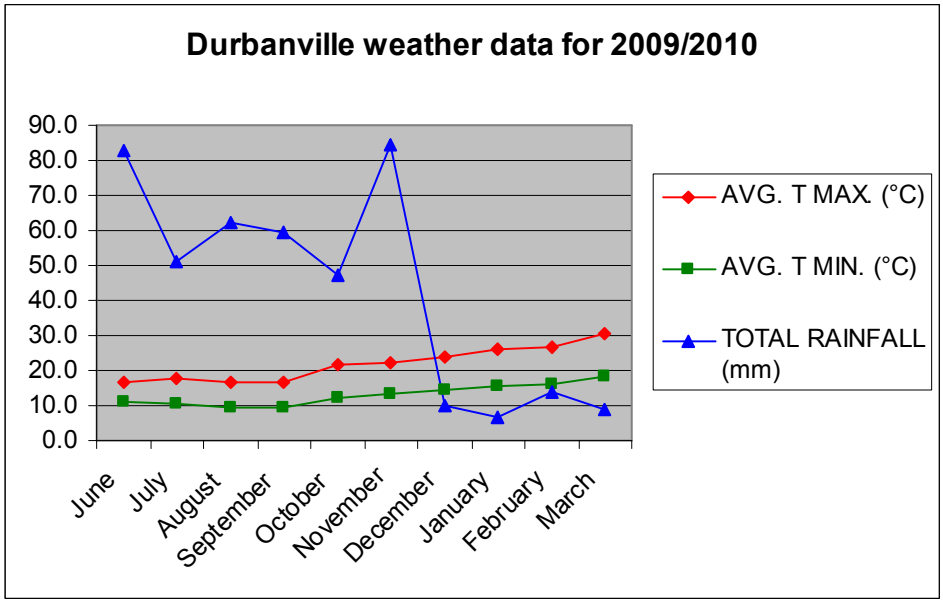
Addendum D – Weather Data

MONTH	AVG. T MAX. (°C)	AVG. T MIN. (°C)	TOTAL RAINFALL (mm)
June	16.8	11.4	83.1
July	17.7	10.6	51.3
August	16.9	9.6	62.0
September	16.6	9.7	59.7
October	21.7	12.3	47.2
November	22.2	13.4	84.6
December	24.0	14.3	9.9
January	25.9	15.7	6.6
February	26.6	16.3	13.7
March	30.7	18.5	9.1



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Addendum E – Water Data

Treatment	pH	mS cm^{-1}	ppm	Watersource
HiYield Plus™	7.00	6.08	4170	Spraycarts fill-up point
HiYield™	7.30	5.84	4000	
OMNIBOOST-K™ + Phosphite	5.20	No reading	4630	
Water used	7.00	1.45	990	

Note: Used the same fill-up point every time, thus readings not taken with follow-up sprays

Content % / Product	N	P	K	S	Mg	B	Mo	Zn	Cu	Mn	Fe	Plant elicitors	Other
HiYield™*	6	5	14		0.01	0.01	0.01	0.02	0.02	0.02	0.02		
HiYield Plus™*	6	5	14		0.01	0.01	0.01	0.02	0.02	0.02	0.02	Salicylic acid	Sea weed
OMNIBOOST-K™ + Phosphite	7.1	16	7.4	8	3.7	0.041	0.079	0.18	0.12	0.13	0.13		Phosphite

* The old formulation of the product was used in the trial; the new formulation is 5:4:11.

Addendum F – Soil Data

Topsoil

Farm code	Cultivar	Sample number	Treatment	Soil depth	Bulk density	pH (KCl)	Exchangeable acidity	Acid saturation	S (%)	P (mg/kg)	K (mg/kg)	Ca (mg/kg)	Mg (mg/kg)
ND	Shiraz	HEALT1	Healthy	Topsoil	1156	5.28	NVT	NVT	33.3	44	141	1030	227
ND	Shiraz	PRESP1	Trial site	Topsoil	1229	4.99	NVT	NVT	133.2	36	126	538	144

Na (mg/kg)	ECEC (pH 7) cmol(+)/kg	Ca / Mg	Mg / K	(Ca + Mg) / K	Sand %	Slik %	Klei %	Organic C %	Zn (mg/kg)	Mn (mg/kg)	Fe (mg/kg)	Cu (mg/kg)	B (mg/kg)
30.0	7.5	2.8	5.2	19.4	63	21	16	1.69	2.20	2.00	72.70	0.70	0.56
32.0	4.3	2.3	3.7	12.0	65	19	16	0.97	1.50	1.76	31.60	0.60	0.53

Subsoil

Farm code	Cultivar	Sample number	Treatment	Soil depth	Bulk density	pH (KCl)	Exchangeable acidity	Acid saturation	S (%)	P (mg/kg)	K (mg/kg)	Ca (mg/kg)	Mg (mg/kg)
ND	Shiraz	HEALT1	Healthy	Subsoil	1049	4.91	NVT	NVT	44.4	54	65	975	89
ND	Shiraz	PRESP1	Trial site	Subsoil	1140	4.63	NVT	NVT	66.6	32	59	499	68

Na (mg/kg)	ECEC (pH 7) cmol(+)/kg	Ca / Mg	Mg / K	(Ca + Mg) / K	Sand %	Slik %	Klei %	Organic C %	Zn (mg/kg)	Mn (mg/kg)	Fe (mg/kg)	Cu (mg/kg)	B (mg/kg)
30.0	5.9	6.7	4.4	33.7	59	23	18	1.45	0.60	1.85	55.50	0.40	0.43
36.0	3.4	4.5	3.7	20.2	65	15	20	0.69	0.60	1.85	36.80	0.30	0.38

Addendum G – Stats Data

Table 3 Mean differences of the disease incidence between treatments

	Treatment	HiYield Plus™	HiYield™	OMNIBOOST-K™ + Phosphite
Treatment	**Mean**	50.00	57.50	67.50
Control	81.25	31.25*	23.75*	13.75*
OMNIBOOST-K™ + Phosphite	67.50	17.50*	10.00	
HiYield™	57.50	7.50		

**Significance difference at 95%*

Table 4 Mean differences of the disease damage between treatments

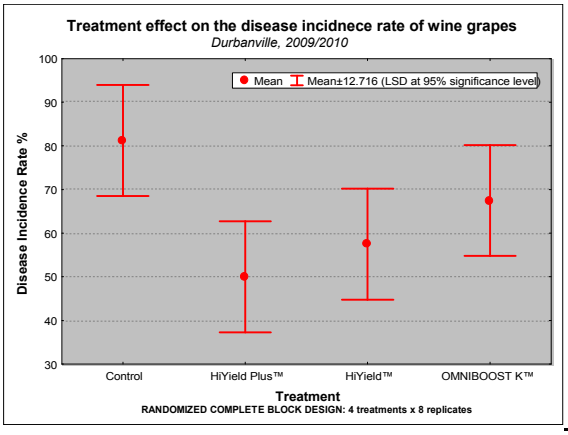
	Treatment	HiYield Plus™	HiYield™	OMNIBOOST-K™ + Phosphite
Treatment	**Mean**	21.25	38.75	46.25
Control	60.00	38.75*	21.25*	13.75*
OMNIBOOST-K™ + Phosphite	46.25	25.00*	7.50	
HiYield™	38.75	17.50*		

**Significance difference at 95%*

Table 5 Comparison of all analyzed parameters' CV between the control and the treatments

		Yield (t ha^{-1})	Brix (%)	Disease incidence (%)	Disease rate (%)
Control	Avg.	4	22	81	60
	CV%	44.7	4.4	12.2	12.6
HiYield Plus™	Avg.	4	22	50	21
	CV%	44.9	6.3	23.9	30.2
HiYield™	Avg.	3	22	58	39
	CV%	60.0	3.0	30.5	46.7
OMNIBOOST-K™ + Phosphite	Avg.	4	22	68	46
	CV%	71.4	3.1	13.1	25.7

*the science of growing



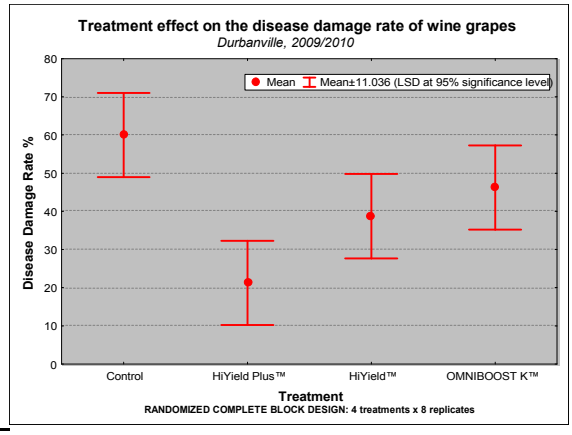


Figure 3 Means of disease incidence and damage on wine grapes treated with different health foliars at Nitida.

Rate of incidence

Descriptive Statistics Section

Variable	Count	Mean	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean
Treatment=1	8	81.25	9.910312	3.503824	72.96478	89.53522
Treatment=2	8	50	11.95229	4.225771	40.00764	59.99236

Note: T-alpha (Treatment=1) = 2.3646, T-alpha (Treatment=2) = 2.3646

Confidence-Limits of Difference Section

Variance Assumption	DF	Mean Difference	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean
Equal	14	31.25	10.97888	5.489438	19.47633	43.02367
Unequal	13.54	31.25	15.52647	5.489438	19.43833	43.06166

Note: T-alpha (Equal) = 2.1448, T-alpha (Unequal) = 2.1517

Equal-Variance T-Test Section

Alternative Hypothesis	T-Value	Prob Level	Decision (5%)	Power (Alpha=.05)	Power (Alpha=.01)
Difference <> 0	5.6928	0.000056	Reject Ho	0.999535	0.991811
Difference < 0	5.6928	0.999972	Accept Ho	0.000000	0.000000
Difference > 0	5.6928	0.000028	Reject Ho	0.999912	0.997254

Difference: (Treatment=1)-(Treatment=2)

Descriptive Statistics Section

Variable	Count	Mean	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean
Treatment=1	8	81.25	9.910312	3.503824	72.96478	89.53522
Treatment=3	8	57.5	17.52549	6.196197	42.84832	72.15168

Note: T-alpha (Treatment=1) = 2.3646, T-alpha (Treatment=3) = 2.3646

Confidence-Limits of Difference Section

Variance Assumption	DF	Mean Difference	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean
Equal	14	23.75	14.23652	7.118261	8.482848	39.01715
Unequal	11.06	23.75	20.13348	7.118261	8.093426	39.40657

Note: T-alpha (Equal) = 2.1448, T-alpha (Unequal) = 2.1995

Equal-Variance T-Test Section

Alternative Hypothesis	T-Value	Prob Level	Decision (5%)	Power (Alpha=.05)	Power (Alpha=.01)
Difference <> 0	3.3365	0.004894	Reject Ho	0.872971	0.641855
Difference < 0	3.3365	0.997553	Accept Ho	0.000001	0.000000
Difference > 0	3.3365	0.002447	Reject Ho	0.936268	0.752434

Difference: (Treatment=1)-(Treatment=3)

Descriptive Statistics Section

Variable	Count	Mean	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean
Treatment=1	8	81.25	9.910312	3.503824	72.96478	89.53522
Treatment=4	8	67.5	8.864053	3.133916	60.08947	74.91053

Note: T-alpha (Treatment=1) = 2.3646, T-alpha (Treatment=4) = 2.3646

Confidence-Limits of Difference Section

Variance Assumption	DF	Mean Difference	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean
Equal	14	13.75	9.401748	4.700874	3.667629	23.83237
Unequal	13.83	13.75	13.29608	4.700874	3.655938	23.84406

Note: T-alpha (Equal) = 2.1448, T-alpha (Unequal) = 2.1473

Equal-Variance T-Test Section

Alternative Hypothesis	T-Value	Prob Level	Decision (5%)	Power (Alpha=.05)	Power (Alpha=.01)
Difference <> 0	2.9250	0.011081	Reject Ho	0.776350	0.501795
Difference < 0	2.9250	0.994460	Accept Ho	0.000005	0.000000
Difference > 0	2.9250	0.005540	Reject Ho	0.871692	0.623199

Difference: (Treatment=1)-(Treatment=4)

Descriptive Statistics Section

Variable	Count	Mean	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean
Treatment=2	8	50	11.95229	4.225771	40.00764	59.99236
Treatment=4	8	67.5	8.864053	3.133916	60.08947	74.91053

Note: T-alpha (Treatment=2) = 2.3646, T-alpha (Treatment=4) = 2.3646

Confidence-Limits of Difference Section

Variance Assumption	DF	Mean Difference	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean
Equal	14	-17.5	10.52209	5.261043	-28.78382	-6.216186
Unequal	12.91	-17.5	14.88048	5.261043	-28.8737	-6.126302

Note: T-alpha (Equal) = 2.1448, T-alpha (Unequal) = 2.1619

Equal-Variance T-Test Section

Alternative Hypothesis	T-Value	Prob Level	Decision (5%)	Power (Alpha=.05)	Power (Alpha=.01)
Difference <> 0	-3.3263	0.004994	Reject Ho	0.871007	0.638547
Difference < 0	-3.3263	0.002497	Reject Ho	0.935059	0.749555
Difference > 0	-3.3263	0.997503	Accept Ho	0.000001	0.000000

Difference: (Treatment=2)-(Treatment=4)

Descriptive Statistics Section

Variable	Count	Mean	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean
Treatment=3	8	57.5	17.52549	6.196197	42.84832	72.15168
Treatment=4	8	67.5	8.864053	3.133916	60.08947	74.91053

Note: T-alpha (Treatment=3) = 2.3646, T-alpha (Treatment=4) = 2.3646

Confidence-Limits of Difference Section

Variance Assumption	DF	Mean Difference	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean
Equal	14	-10	13.8873	6.943651	-24.89265	4.89265
Unequal	10.36	-10	19.63961	6.943651	-25.39858	5.398578

Note: T-alpha (Equal) = 2.1448, T-alpha (Unequal) = 2.2176

Equal-Variance T-Test Section

Alternative Hypothesis	T-Value	Prob Level	Decision (5%)	Power (Alpha=.05)	Power (Alpha=.01)
Difference <> 0	-1.4402	0.171808	Accept Ho	0.268882	0.097043
Difference < 0	-1.4402	0.085904	Accept Ho	0.391860	0.153533
Difference > 0	-1.4402	0.914096	Accept Ho	0.001268	0.000136

Difference: (Treatment=3)-(Treatment=4)

Rate of damage

Descriptive Statistics Section

Variable	Count	Mean	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean
Treatment=1	8	60	7.559289	2.672612	53.68027	66.31973
Treatment=2	8	21.25	6.4087	2.265817	15.89219	26.60781

Note: T-alpha (Treatment=1) = 2.3646, T-alpha (Treatment=2) = 2.3646

Confidence-Limits of Difference Section

Variance Assumption	DF	Mean Difference	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean
Equal	14	38.75	7.007649	3.503824	31.23504	46.26496
Unequal	13.63	38.75	9.910312	3.503824	31.21612	46.28388

Note: T-alpha (Equal) = 2.1448, T-alpha (Unequal) = 2.1502

Equal-Variance T-Test Section

Alternative Hypothesis	T-Value	Prob Level	Decision (5%)	Power (Alpha=.05)	Power (Alpha=.01)
Difference <> 0	11.0593	0.000000	Reject Ho	1.000000	1.000000
Difference < 0	11.0593	1.000000	Accept Ho	0.000000	0.000000
Difference > 0	11.0593	0.000000	Reject Ho	1.000000	1.000000

Difference: (Treatment=1)-(Treatment=2)

Descriptive Statistics Section

Variable	Count	Mean	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean
Treatment=1	8	60	7.559289	2.672612	53.68027	66.31973
Treatment=3	8	38.75	18.07722	6.391261	23.63707	53.86293

Note: T-alpha (Treatment=1) = 2.3646, T-alpha (Treatment=3) = 2.3646

Confidence-Limits of Difference Section

Variance Assumption	DF	Mean Difference	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean
Equal	14	21.25	13.85512	6.927559	6.391864	36.10814
Unequal	9.38	21.25	19.5941	6.927559	5.673918	36.82608

Note: T-alpha (Equal) = 2.1448, T-alpha (Unequal) = 2.2484

Equal-Variance T-Test Section

Alternative Hypothesis	T-Value	Prob Level	Decision (5%)	Power (Alpha=.05)	Power (Alpha=.01)
Difference <> 0	3.0675	0.008355	Reject Ho	0.813739	0.551272
Difference < 0	3.0675	0.995822	Accept Ho	0.000002	0.000000
Difference > 0	3.0675	0.004178	Reject Ho	0.897851	0.670569

Difference: (Treatment=1)-(Treatment=3)

Descriptive Statistics Section

Variable	Count	Mean	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean
Treatment=1	8	60	7.559289	2.672612	53.68027	66.31973
Treatment=4	8	46.25	11.87735	4.199277	36.32029	56.17971

Note: T-alpha (Treatment=1) = 2.3646, T-alpha (Treatment=4) = 2.3646

Confidence-Limits of Difference Section

Variance Assumption	DF	Mean Difference	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean
Equal	14	13.75	9.955257	4.977629	3.074049	24.42595
Unequal	11.87	13.75	14.07886	4.977629	2.891653	24.60835

Note: T-alpha (Equal) = 2.1448, T-alpha (Unequal) = 2.1814

Equal-Variance T-Test Section

Alternative Hypothesis	T-Value	Prob Level	Decision (5%)	Power (Alpha=.05)	Power (Alpha=.01)
Difference <> 0	2.7624	0.015270	Reject Ho	0.728859	0.445270
Difference < 0	2.7624	0.992365	Accept Ho	0.000009	0.000001
Difference > 0	2.7624	0.007635	Reject Ho	0.836533	0.566762

Difference: (Treatment=1)-(Treatment=4)

Descriptive Statistics Section

Variable	Count	Mean	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean
Treatment=2	8	21.25	6.4087	2.265817	15.89219	26.60781
Treatment=3	8	38.75	18.07722	6.391261	23.63707	53.86293

Note: T-alpha (Treatment=2) = 2.3646, T-alpha (Treatment=3) = 2.3646

Confidence-Limits of Difference Section

Variance Assumption	DF	Mean Difference	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean
Equal	14	-17.5	13.56203	6.781013	-32.04383	-2.956173
Unequal	8.73	-17.5	19.1796	6.781013	-32.91173	-2.08827

Note: T-alpha (Equal) = 2.1448, T-alpha (Unequal) = 2.2728

Equal-Variance T-Test Section

Alternative Hypothesis	T-Value	Prob Level	Decision (5%)	Power (Alpha=.05)	Power (Alpha=.01)
Difference <> 0	-2.5807	0.021778	Reject Ho	0.670442	0.383414
Difference < 0	-2.5807	0.010889	Reject Ho	0.790493	0.502079
Difference > 0	-2.5807	0.989111	Accept Ho	0.000020	0.000001

Difference: (Treatment=2)-(Treatment=3)

Descriptive Statistics Section

Variable	Count	Mean	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean
Treatment=2	8	21.25	6.4087	2.265817	15.89219	26.60781
Treatment=4	8	46.25	11.87735	4.199277	36.32029	56.17971

Note: T-alpha (Treatment=2) = 2.3646, T-alpha (Treatment=4) = 2.3646

Confidence-Limits of Difference Section

Variance Assumption	DF	Mean Difference	Standard Deviation	Standard Error	95% LCL of Mean	95% UCL of Mean
Equal	14	-25	9.543135	4.771567	-35.23399	-14.76601
Unequal	10.76	-25	13.49603	4.771567	-35.53111	-14.46889

Note: T-alpha (Equal) = 2.1448, T-alpha (Unequal) = 2.2071

Equal-Variance T-Test Section

Alternative Hypothesis	T-Value	Prob Level	Decision (5%)	Power (Alpha=.05)	Power (Alpha=.01)
Difference <> 0	-5.2394	0.000125	Reject Ho	0.998101	0.977825
Difference < 0	-5.2394	0.000063	Reject Ho	0.999554	0.991237
Difference > 0	-5.2394	0.999937	Accept Ho	0.000000	0.000000

Difference: (Treatment=2)-(Treatment=4)

Acknowledgement: Thank you to Tanya Singh for the disease ratings and the Numerical Support for verifying the Statistical Analysis and for their assistance in producing several graphs.