Field Trial Results for EnOrmus Bud

Conducted on Rustenberg Wine Estate Summer 2018 / 2019



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1. Introduction

This report details the results of field trials that were conducted on the historic Rustenberg Wine Estate in Ida's Valley, Stellenbosch over the summer of 2018 /19. The results clearly show that EnOrmus Bud (a product of EnOrmus CC) not only increases plant volume but also plant health when compare to four control subblocks not treated with EnOrmus Bud.

The satellite picture below shows block HH01 on Rustenberg Estate, planted with Merlot wine grapes in full production, with five subblocks clearly marked. This block contains 22 277 vines in total.



An examination of the yield of these subblocks (in tons per hectare) over the last ten years reveals interesting information, as evident in the graph below. The subblocks tend to move mostly parallel showing the impact of macro conditions that affect this block over time. Notable is the steep decline in block 2 in 2013, which is the most variable of all sub-blocks.



Graph 1: Historical yield data

Further examination of the data underlying the above graph shows that subblocks B and E showed the greatest yield increase over this summer of 2018/2019 – 5.82 and 5.61 tons per hectare yield increase respectively compared to the previous year.

	Tons per hectare										
Sub -											Gain per HA
Block	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	(2018-2019)
Α	5.65	6.94	5.44	3.15	5.66	5.92	5.33	4.64	2.62	5.82	3.20
В	10.82	11.40	10.46	3.21	11.48	10.57	9.94	9.64	6.80	12.62	5.82
С	8.22	12.24	9.88	12.98	8.20	11.35	10.16	8.91	9.18	12.51	3.34
D	8.88	10.19	7.45	10.77	8.03	9.23	8.09	9.18	7.81	11.26	3.45
E	11.73	10.55	9.89	13.49	9.07	10.89	7.84	7.26	4.96	10.57	5.61

Table 1: Historical yield data and yield increase in 2018/2019.

While this sets the scene for the analysis, it is not comprehensive by itself and needs further statistical analysis to reach significant conclusions.

2. Methodology

To assess whether or not EnOrmus Bud improves plant growth and health, an experimental design was set up on the Merlot block. The 22 277 vines were divided into five subblocks for different treatments.

										Treatment Group
Sub - Block	No. of vines	AgriO (L/ha)	Tr1 ml/ha	Tr2 (L/ha)	Tr3 (L/ha)	Tr4 (ml/ha)	Tr5 (L/ha)	Tr6 (kg/ha)	enOrmus Bud (L/ha)	
Α	3909	0	200		1	200	2	5		Control
В	5031	10	200							Control
С	3702	0	200	2	1		2	5		Control
D	5628	0	200	2			2	5		Control
E	4007	0	200						10	Experimental

Table 2: Treatments used on all subblocks

Table 2 shows the experimental design setup, aiming to demonstrate the efficacy of EnOrmus Bud treated subblock E. The four other blocks (A, B, C and D) serve as control groups to ensure sufficient replication. Note the large sample sizes which lend themselves to statistical robustness.

3. Application

EnOrmus Bud was applied according to specification as a soil drench at the start of the season, on 21 September 2018, at an application rate of 10 litres of EnOrmus Bud per hectare. This was followed by a leaf spray before the budding stage, early in December 2018, at an application rate of 2 litres of EnOrmus Bud per hectare.

4. Data collection

Using a state of the art infra-red camera equipped drone, the complete block was photographed and analysed on 22 February 2019.

The image analysis was conducted by Aerobotics, South Africa's leading independent agricultural image processing company, using Artificial Intelligence technology.

5. Metrics used

The drone data is extremely useful in analysing large samples which would be arduous and inefficient to do manually, and provides robust data for statistical analysis, also eliminating human error in data collection. This ensures that the data is of the highest quality.

Metric	Description
Area	Area that the vine covers
Volume	Volume of the vine
Height	Height of the vine
NDVI	Normalized difference vegetation index. Overall, NDVI is a standardized way to measure healthy vegetation. High NDVI values signify healthier vegetation

Volume serves as a proxy for yield - data for which exists at a block level but not at the individual vine level.

6. Data analysis

Results by sub-block

The results of the five subblocks on these metrics are shown below.

The data can be seen on Table 3 below, which indicates that subblock E had the highest NDVI by some margin. Subblock A showed the greatest Volume, followed by subblock E.

Graph 2: Results by sub-block

Sub - Block	Area	Volume	Height	NDVI
А	1.195	1.069	1.300	0.631
В	0.982	0.862	1.309	0.643
C	0.898	0.593	1.020	0.649
D	1.058	0.866	1.205	0.632
E	1.024	0.985	1.298	0.694
Average	1.032	0.877	1.231	0.648

Table 3: Drone results on key metrics by sub-block

These results indicate that the vines that were treated with EnOrmus Bud were the healthiest, as measured by NDVI.

The acid test for agricultural statistics is an ANOVA test, and this follows below.

7. ANOVA Test

ANOVA was conducted on the EnOrmus Bud (subblock E) to compare this treatment with the control groups subblocks A to D).

ANOVA requires equal sample sizes to be computed. The EnOrmus Bud subblock contains 4007 vines, so to calculate the ANOVA, we needed an equal number of control vines. To extract an equal sample size, we used a systematic random sample of the remaining control vines (n=18 270), using a k interval of 4.

Hypothesis

The null hypothesis is that there is no statistical difference in plant volume or health between EnOrmus Bud (subblock E) and the control subblocks (A to D).

The alternate hypothesis is that there is a statistical difference between the EnOrmus Bud experimental subblock on plant volume and health compared to the other subblocks.

Results

	Volume	Height	NDVI
NO enOrmus Bud	0.83467	1.19942	0.63869
enOrmus Bud	0.98547	1.29849	0.69447
Difference %	118%	108%	109%

Table 4: Results of Experiment



The ANOVA table is shown below:

Anova: Two-Factor With Replicati	on					
		h ai aht	a du i	Tatal		
SUIVIIVIARY	volume	neight	Πάνι	TOLAI		
NO enormus	1000	4000	1000	42040		
Count	4006	4006	4006	12018		
Sum	3343.684	4804.886	2558.577	10707.15		
Average	0.834669	1.199422	0.638686	0.890926		
Variance	0.075847	0.045392	0.005189	0.096126		
eNormus						
Count	4006	4006	4006	12018		
Sum	3947.803	5201.752	2782.027	11931.58		
Average	0.985473	1.29849	0.694465	0.992809		
Variance	0.111371	0.044457	0.003933	0.114084		
Tatal						
	0010	0040	0042			
Count	8012	8012	8012			
Sum	7291.487	10006.64	5340.604			
Average	0.910071	1.248956	0.666576			
Variance	0.099283	0.047373	0.005338			
ANOVA						
Source of Variation	SS	df	MS	F	P-value	F crit
Sample	62.37483	1	62.37483	1307.702	7E-279	3.841846
Columns	1370.854	2	685.4271	14370.13	0	2.996106
Interaction	9.067054	2	4.533527	95.04641	0	2.996106
Within	1146.184	24030	0.047698			
Total	2588.48	24035				

Table 5: ANOVA Table comparing enOrmus Bud to control group.

8. Conclusions

1. From the sample the results indicate that there is a significant difference considering the two groups of plants i.e. those treated with EnOrmous Bud and those not treated with EnOrmus Bud (as shown by sample results in the ANOVA).

2. There is a significant difference when only considering the different plant measurements namely volume, height and ndvi (as shown on column results in the ANOVA).

3. When considering plants treated with EnOrmous Bud and those that are not and its relationship to the plant measurements, there is a significant difference in favour of the EnOrmus Bud treated plants (as shown by the results from Interaction in the ANOVA table).

The alternate hypothesis is upheld. This means that there is a statistical difference between vines treated with EnOrmus Bud and those in the control group that were not.

The conclusion than is that treating plants with EnOrmus Bud will produce healthy plants based on the ANOVA and as well as shown on the graph of average volume, height and nvdi.

The authors therefore confirm the following claim confidently: EnOrmus Bud provides bigger, healthier plants!

9. Supporting experimental work on Walnut trees

From autumn 2016 an experiment was conducted of the farm Elandshoek near Aliwal North, to compare EnOrmus Bud treated and untreated subblocks on mature walnut orchards. The aim was to improve the growth rate and yield of the +- 5 000 walnuts trees that were established on Elandshoek over the previous +- ten years.

Measurements were taken of trunk thickness and shoot tip growth over the following two growth seasons, and harvest data is currently being taken after the third growth season after applying EnOrmus Bud over three seasons, autumn and spring, at an application rate of 10 litres per hectare through soil drenches.

The summarised results after two years of treatment (three applications) are as follows for trunk thickness:

Elandshoek Trunk Circu	mference	Measuren	nents Ma	y 2018		
Block	Block	1 A & B	Block	2 A & B	Block 2 C	
Treatment	Treated 05/18	Untreated 05/18	Treated 05/18	Untreated 05/18	Treated 05/18	Untreated 05/18
Total cm	3 692.7	3 618.8	1 749.5	1 873.5	920.9	968.7
Number of trees	88	91	39	38	22	26
Average	42.0	39.8	44.9	49.3	41.9	37.3
Prev year 2016/17	36.5	34.7	40.7	46.3	38.1	34.0
Average growth cm last year	5.5	5.1	4.2	3.0	3.8	3.3
% Advantage last year	7.8		38.5		15.4	
Baseline Sept 2016	34.0	32.5	38.0	43.6	35.8	32.2
Average growth cm 2 years	8.0	7.3	6.9	5.7	6.1	5.1
% Advantage two years	9.6		20.3		19.8	

Trees in treated subblocks for mature trees in the top blocks gained consistently more in trunk circumference compared to untreated subblocks on a year-to-year basis and over the two year period. The advantage was 7.8, 38.5 and 15.4 percent for the past year, and in total for the two year period 9.6, 20.3 and 19.8 percent for the three top blocks.

It can safely be stated that the increase in trunk circumference of treated over non-treated subblocks was consistent and significant for the individual years and the total over both years, for all three blocks of mature trees.

The summarised results after two years of treatment (three applications) are as follows for shoot tip growth:

Elandshoek Shoot Tip Growth Measurements May 2018									
Variable	Block 1	A & B	Block 2	A & B	Block 2 C				
	Treated	Untreated	Treated	Untreated	Treated	Untreated			
	05/18	05/18	05/18	05/18	05/18	05/18			
Total cm	3 953.5	3 945.0	1 638.0	1 540.0	916.0	1 023.0			
Number of trees	88	91	39	38	22	26			
Average cm	44.9	43.4	42.0	40.5	41.6	39.3			
Prev year 2016/17	60.2	43.2	40.9	33.8	34.8	44.5			
% Advantage this year	3.6		3.6		5.8				
Total growth 2 years	105.1	86.6	82.9	74.3	76.4	83.8			
% Advantage two years	21.5		11.5		-8.8				

In blocks 1A&B and 2A&B the treated subblocks outperformed the untreated subblocks, but in block 2C the untreated subblock outperformed the treated subblock. Nonetheless, the advantage on averages in centimeter growth of tip growth was 19.7 cm in favour of treated subblocks, and on average percentage the advantage of treated subblocks was 24.2 percent on mature trees measuring shoot tip growth.

These results on mature walnuts trees are a further indication that the application of EnOrmus Bud indeed result in enhanced growth in both trunk thickness and shoot tip growth.

