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The effect of Ecosoil Compost Tea on growth, production and profitability of apple trees during the 2012 and 2013 production seasons

Abstract:

To quantify some of the benefits of Ecosoil's Compost Tea on apple trees, shoot growth and soil compaction measurements were done in the winter of 2011 and during the 2012 and 2013 seasons the effect on production and the amount of weevil damage on fruit in apple orchards were evaluated. Soil samples were also taken during 2013 and chemically analyzed. On the treated plots, the potential production areas were increased by 21%, production increased by an average of 21.3% during the 2012 and 2013 seasons. A Financial analysis was done to determine the impact on net farm income (NFI). In the calculations NBI increased by R14 428, or by 80%.

Method:

Orchards were selected on several farms of different apple cultivars and different ages within the Grabouw and Villiersdorp production areas. The number of years of Ecosoil Compost Tea applications varied between three to five seasons. The experimental layout was a split block design. One irrigation block within the orchard was treated and the other not, or several rows within the orchard were tapped off from Compost Tea treatments. Fifteen trees per treatment were randomly selected to be measured.

Treatment trees were treated with Ecosoil Compost Tea at a rate of 200 litres per hectare per month, as an additional application to the standard chemical and fertiliser programs used on the respective farms, from September to April . Control trees did not receive Ecosoil Compost Tea, but did receive the standard chemical and fertiliser programs.

For the assessment of tree growths in 2011, the selected trees were measured for stem circumference, number of shoots and length of shoots. On younger trees all the shoots were measured. On older trees, branches were randomly selected for shoot measurements and counts. The sums of the shoot growths were calculated as a means to determine the total potential production area. Additionally, soil penetrometer depth readings were taken to determine soil depth with compaction less than 300psi.

During the 2012 and 2013 seasons 15 trees on each of the 9 and 11 plots respectively were harvested, counted and the total fruit weight per tree were used to determine the average weight per fruit. Additionally, the stem diameter was recorded as well as the amount of fruits with weevil damage.

Analysis of Variance (ANOVA) was performed on all variables assessed using SAS statistical software version 9.2 (SAS Institute Inc., Cary, NC, USA). The Shapiro-Wilk test was performed to test for normality (Shapiro & Wilk, 1965). Student's-t least significant difference (LSD) was calculated at the 5% level to compare treatment means (Ott, 1998). A probability level of 5% was considered significant for all significance tests.

Results and Discussion:

Compost Tea microorganisms increased soil porosity, as illustrated by the soil penetrometer depth (Table 1), by 25.7 %. Less energy was therefore required for root growth in the soils, as compared to the more compacted control soils. The apple trees could therefore utilize more energy for shoot growth and production. On visual inspection more root growth were seen (data not shown) on plots treated with Ecosoil Compost Tea. The higher amount of root hairs illustrated the increased symbiotic plant-microbe interactions. It is commonly known that increased root growth will result in more shoot growth.

The number of shoots (Table 1), within the study, increased by 41.7% due to the Ecosoil Compost Tea treatments. This is due to more efficient bud break, which could have been as a result of higher nutrient reserve status and hormone levels within the trees. Beneficial soil microorganisms increase the nutrients available to plants due to their interactions with the plant roots (refer to Table 3). Similarly, these microorganisms can produce necessary plant hormones, or precursors for plant hormones. The number of shoots did not decrease the length of shoots significantly, but did increase the overall bearing area significantly by 21.1 %.

Table 1: Growth and soil depth measurements during 2011 season

	Treatments	Stem Diameter (cm)	Shoot Length (cm)	Number of Shoots	Length of all shoots (cm)	Soil depth Penetro-meter 300psi
2011	**Control**	25.18 a	27.99 a	21.84 a	712.65 a	27.23 a
	Compost Tea	24.79 a	25.18 a	30.95 b	862.76 b	34.24 b
	% difference	-1.5%	-10.0%	41.7%	21.1%	25.7%
	P Value	0.5765	0.4103	0.0185	0.0017	0.0030

Means in a column followed by the same letter are not significantly different at a 5% significant level

The harvesting assessments (Table 2) within the subsequent two seasons demonstrated that the increased growth of the trees did indeed increase the total amount of apples harvested per tree by 34.5% and 15% respectively compared to the control trees. The average increase over the two

seasons in number of apples per tree was 23.6%. There were no significant difference in the average weight per apple between the control and the treated orchards for both production seasons. A possible reason why the average fruit weight did not decrease with the higher number of fruit set is the larger "factory" of leaves and roots, as well as the beneficial impact of beneficial microbes regarding mineralization, fixation etc.

Table 2: Production and weevil damage measurements during the 2012 and 2013 seasons

Treatments		Stem Diameter (cm)	Total Weight Harvested per Tree (Kg)	Number of Fruit per Tree	Fruit Weight (g)	% of Fruit with Weevil Damage
2012	**Control**	28.98 a	28.02 a	215.83 a	143.91 a	10.56 a
	Compost Tea	29.99 a	37.94 b	290.37 b	146.86 a	6.54 b
	% difference	3.5%	35.4%	34.5%	2.0%	-38.1%
	P Value	0.0718	0.0190	0.0394	0.5046	0.0168
2013	**Control**	29.91 a	34.88 a	272.22 a	146.37 a	7.75 a
	Compost Tea	30.70 a	38.60 b	313.08 b	144.30 a	4.50 a
	% difference	2.6%	10.7%	15.0%	-1.4%	-41.9%
	P Value	0.1980	0.0303	0.0463	0.4686	0.0893
2012+2013	**Control**	29.49 a	31.79 a	246.84 a	145.26 a	9.02 a
	Compost Tea	30.38 b	38.30 b	302.86 b	145.45 a	5.42 b
	% difference	2.8%	21.3%	23.6%	0.6%	-39.9%
	P Value	0.0284	0.0020	0.0035	0.9391	0.0040

Means in a column followed by the same letter are not significantly different at a 5% significant level

Total weight per tree for 2012 and 2013 harvests were 35.4% and 10.7% more respectively for the Compost Tea treatments. The average increase in weight per tree over the two seasons was 21.3%. Weevil damage on fruit was significantly reduced by 39.9% over the two seasons. All fruit with weevil damage were counted, even those that could have passed as class 1 or 2. Weevil larvae overwinter in the soil and were predated by beneficial microorganisms present in Ecosoil's Compost Tea. This lowered the amount of adult weevils that caused damage to the fruit.

At the end of the 2013 soil samples were taken at four sites. The average chemical analysis appears

in Table 3. Microorganisms help with the mineralisation of minerals in the soil. With the larger crop in the treated plots it is conceivable that the mineral status would be lower due to greater demand for nutrients. However the mineral status was better here, underlining the importance of beneficial microorganisms even further. As can be seen, the Compost Tea also contributed to the amount of nitrogen available to the trees.

Table 3: Chemical Analysis

	Control	Compost Tea
pH (H_2O)	6.0	5.9
Plant available P (mg/kg)	29.3	34.0
Plant available K (mg/kg)	65.3	69.3
Trace Element (mg/kg) - Cu	4.2	4.2
Trace Element (mg/kg) - Zn	6.0	6.3
Trace Element (mg/kg) - Mn	4.2	5.0
Trace Element (mg/kg) - Fe	22.3	32.3
Potential Nitrogen Mineralisation (PMN) mg N/kg dry soil/wk	6.0	10.3

Additional Benefits:

Although not quantified, a significant improvement in color was observed on red apple cultivars during the past two seasons.

Woolly apple aphid and mildew were a huge problem on two of the sites during the 2013 season. Table 4 shows the percentage shoots infected by these pests and diseases. The Compost Tea treated trees had far less wooly apple aphid and mildew infections due to predation by beneficial micro-organisms and also due to increased systemic induced resistance.

Table 4: Percentage shoots infected with woolly apple aphid (WAA) and mildew

	Pink Lady		Early Red One	
	WAA	Mildew	WAA	Mildew
Control	20.3%	6.7%	25.5%	0.5%
Compost Tea	2.9%	2.8%	8.5%	0.0%

Financial Implications:

To determine the impact of Ecosoil Compost Tea on profitability average production and revenue figures from the Ceres and EGVV production areas (Table 5) were obtained from Hortgro. The pack-out percentages and production figures are an average of the 2011 and 2012 seasons and the income per class, the average farm gate income of the 2012 season. Production costs include

overhead costs. According to these figures the average net farm income (NFI) for apples was about R18000/ha. NFI does not include owner remuneration, interest on capital and land rent.

Table 5: Average production and income statistics for Ceres and EGVV for 2012 season

	Pack Out %	Ton/ha	R/Ton	Income/ha
Class 1	48	29.3	R 3 316	R 97 092
Class 2	18	11.0	R 2 052	R 22 531
Class 3	34	20.7	R 722	R 14 974
Gross Production Value (GPV)	100	61.0		R 134 598
Production Cost (PC)				R 116 640
Nett Farm Income (NFI)				**R 17 958**
NFI/PC				0.2

Ecosoil Compost Tea increased production in 2012 and 2013 by 35.4% and 10.7% respectively without adversely affecting fruit size. The average increase for the two seasons was 21.3% with a 99.8% confidence level. The 2013 season is widely regarded as an above-average production year and it can be expected that in average production years, like 2012, increased production differences can be expected. In order to determine the impact that Ecosoil Compost Tea will have on profitability, a more conservative 10% production increase was used. Table 6 shows the impact of this increase on NFI. Pack-out percentages were adjusted for the effect of Compost Tea on weevil damage. In the experimental data all fruit with weevil damage were counted, regardless if the damage would go through as class 1 or 2. For the purpose of the calculation it is assumed that 50% of weevil damage will have an economic impact and class 1 pack-out was increased with 1.2% and class 2 by 0.6% accordingly.

As mentioned earlier Compost Tea was applied from September to April at 200L/ha. Microbial nutrients were also additionally given with the first and last treatment. Production costs were increased to compensate for the cost of Ecosoil Compost Tea products, as well as additional labour, fuel, electricity, interest on capital and depreciation. Savings in fertilisation is not taken into account, but since growth is a determining factor in the calculation of fertilisation programs, it can be assumed that production costs will be reduced by lower fertiliser usage.

Table 6: Estimated profit with a 10% production increase and adjusted for weevil damage

	Pack Out %	Ton/ha	R/Ton	Income/ha
Class 1	49.2	33.0	R 3 316	R 109 472
Class 2	18.6	12.5	R 2 052	R 25 610
Class 3	32.2	21.6	R 722	R 15 600
Gross Production Value (GPV)	100.0	67.1		R 150 682
Increase in GPV				R 16 084
Increase in GPV due to 10% production increase				R 13 460
Increase in GPV due to less weevill damage				R 2 624
% Increase in GPV				12%
Production Cost (PC)				R 118 296
Nett Farm Income (NFI)				**R 32 386**
NFI/PC				0.3
Amount Nett Farm Income Increased				**R 14 428**
% NFI Increase				80%

As can be seen in Table 6, Ecosoil Compost Tea makes a significant difference in the profitability of farms. NFI in this calculation is increased with R14 428 or 80%. Additional benefits such as reduction in fertilisation, more productive lifetime of orchards, better color, less sunburn, better water retention, increased water infiltration, increased carbon sequestration, etc. were not even taken into account.

The importance of beneficial microbes in soil fertility and overall sustainability should not be underestimated. It has a significant impact on the profitability of farming enterprises. Ecosoil Compost Tea is a cost effective way to accomplish this.

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