The effect of compost addition on soil fertility and grapevine performance

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Introduction & Aim

The maintenance of high-quality soil is essential for environmental and vineyard health. Studies have shown that using organic food waste in farming practices leads to reduced environmental impacts with improved soil structure, nutrient status, water-holding capacity, and fertility (Gaiotti et al., 2017; Nguyen et al., 2013; Pinamonti 1998). However, data on the impacts on grapevine performance remain inconsistent (Mugnai et al., 2012), highlighting the need for further research. This project aimed to investigate the effects of 'Repurpose It Viticulture Compost' on grapevine performance and soil fertility.

Methods

Repurpose It Viticulture Compost was tested on Melbourne Polytechnic's Growling Frog vineyard during the 2023-2024 growing season. A randomised block design was applied to four treatments, each consisting of ten, mature Shiraz vines: control, compost, fertiliser, and compost plus fertiliser. Compost was applied to the soil adjacent to each vine over a 1 m^2 area at a height of 10 cm to cover the vine rootzone. Composite soil samples at a depth of 15 cm were taken of the soil pre- and post-treatment and sent to Nutrient Advantage for testing. The fertiliser used in this study was Gran-Am (Incitec Pivot). Morphological measurements of each vine (EL stage 39) (n=50) were recorded for shoot length (cm), average internode length (cm), node number, and cane weight (g) at the end of the growing season (Cooperative Research Centre for Viticulture, 2004). Petiole nutrient levels were analysed for each treatment (n=100) at 80% flowering (EL stage 25) (Australian Wine Research Institute, 2010). Treatment effects on vine attributes were tested independently using analysis of variance (ANOVA) with the significance level set at $p<0.05$ (R Core Team, 2024, v 4.3.3).

Results

Total cane weight (Figure 1), internode length, and total cane length were significantly higher in compost treated grapevines compared to the control group and other treatments. Compost treatments also recorded the greatest increase in several soil chemical properties (Table 1), with increases in organic carbon, nitrate, phosphorus, potassium, and cation exchange capacity (CEC) compared to the control and fertiliser treatments. Soil pH increased from 5.7 to 6.2 with compost application and compost plus fertiliser, and decreased with fertiliser application to pH 5.5 (Table 1). Compost and fertiliser applications resulted in higher ammonium nitrogen levels in petioles (Table 2). However, only the compost treatments resulted in higher phosphorus and potassium in petiole tissue.

Table 1. Soil chemical characteristics pre- and post-treatments

Analyte	Before Trial	End of Trial			
		Control	Compost	Fertiliser	Compost and Fertiliser
Organic Carbon (W&B) (%)	4.3	3.74	4.7	4.28	5.02
pH (1:5 Water)	6.6	6.4	7	6.2	6.9
pH (1:5 CaCl2)	5.7	5.7	6.2	5.5	6.2
Aluminium (KCL) (cmol(+)/kg)	<0.1	0.22	0.18	<0.10	<0.10
Aluminium (KCL) (mg/kg)	<9.0	14	16	<9.0	<9.0
Aluminium % of Cations (%)	<1.0	0.93	0.91	<1	<1
Electrical Conductivity (1:5 water)(dS/m)	0.1	0.18	0.19	0.21	0.2
Electrical Conductivity (Sat. Ext.)	0.8	1.1	1.2	1.3	1.2
Chloride (mg/kg)	18	80	30	100	38
Sodium (Amm-acet.) (cmol(+)/kg)	0.17	0.22	0.43	0.24	0.41
Sodium% of Cations (%)	1.2	1.4	2.2	1.6	2.2
Calcium/ Magnesium ratio	2.6	2.5	2.7	2.4	2.7
Nitrate Nitrogen (mg/kg)	14	7.2	9.4	7.1	9.9
Ammonium Nitrogen (%)	7.4	11	9.4	11	9.9
Phosphorus (Colwell)	110	100	130	110	160
Phosphorus (BSES) (mg/kg)	160	160	230	180	240
Sulphur (KCl40) (mg/kg)	5	17	12	11	11
Calcium (Amm-acet.) (cmol(+)/kg)	8.7	10	12	9.2	12
Magnesium (Amm-acet.) (cmol(+)/kg)	3.4	4	4.5	3.9	4.5
Potassium (Amm-acet.) (cmol(+)/kg)	1.5	1.8	2.5	1.8	2.5
Available Potassium (mg/kg)	570	690	970	720	990
Phosphorus Buffer Index	83	110	120	120	120
Cation Exch. Cap. (CEC) (cmol(+)/kg)	13.8	16.3	19.8	15.2	19.1

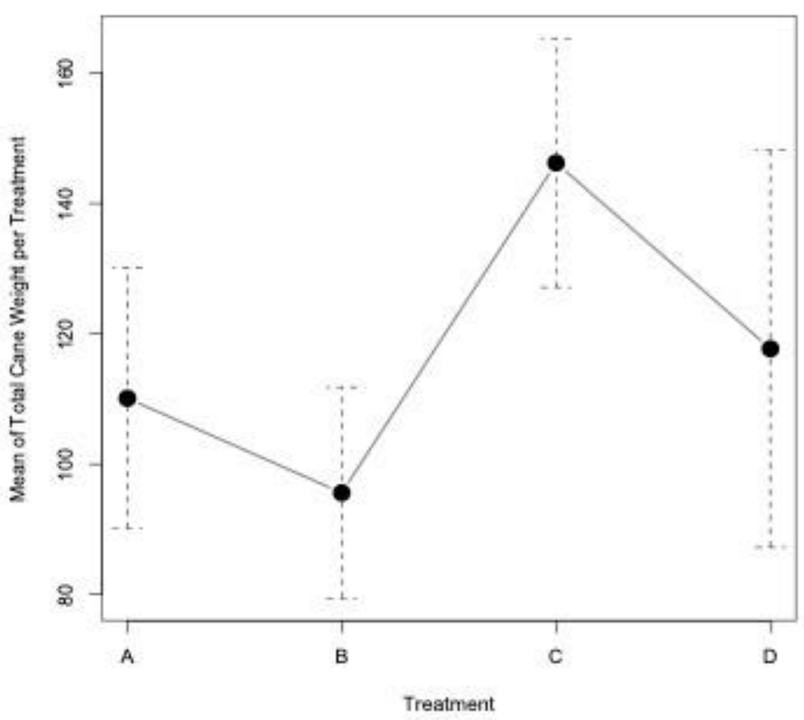

Figure 1. Mean of total cane weight (95% CI). Treatment A = Control, Treatment B = Fertiliser, Treatment C = Compost, Treatment D = Compost & Fertiliser

Table 2. Chemical analysis of nutrient uptake in petioles

Analyte	Control	Compost	Fertiliser	Compost and Fertiliser
Total Nitrogen (%)	0.96	0.99	1	1
Nitrate Nitrogen (mg/kg)	<50	<50	<50	<50
Ammonium Nitrogen (mg/kg)	140	190	210	280
Phosphorus (%)	0.21	0.25	0.21	0.25
Potassium (%)	4.7	5.1	4.4	5
Sulphur (%)	0.17	0.15	0.2	0.15
Calcium (%)	0.93	0.89	0.89	0.98
Magnesium (%)	0.56	0.57	0.53	0.55
Sodium (%)	0.058	0.045	0.055	0.048
Chloride (%)	0.1	0.088	0.12	0.093
Copper (mg/kg)	8.3	7.6	7.9	7
Zinc (mg/kg)	81	66	81	65
Manganese (mg/kg)	83	64	85	66
Iron (mg/kg)	60	29	31	27
Boron (mg/kg)	45	40	40	39

Discussion and Conclusion

Compost and compost plus fertilizer treatments showed the most significant results by improving several soil chemical properties. The increase in soil organic carbon, as found in other studies, may result in decreased bulk density, improved infiltration and water holding capacity and increased microbial diversity and activity, as well as possible soil carbon sequestration (Martinez-Casasnovas & Ramos, 2006; Pinamonti, 1998). Compost applications resulted in increased soil nitrate which may account for the observed increases in total cane weight and length, as soil nitrogen is considered the main driver for vegetative growth in grapevines (Keller, 2010). Soil pH was observed to increase from 5.7 to 6.2 with the application of compost or compost plus fertiliser, whereas the application of fertiliser lowered the pH to 5.5. Compost applications increased phosphorus uptake in petioles which is known to closely mirror nitrogen uptake, supporting photosynthetic activity and contributing to further vegetative growth. In conclusion, a single application of Repurpose It Viticulture Compost improved soil organic carbon, grapevine biomass, soil chemical characteristics, and weed suppression. Importantly, these additions did not adversely impact electrical conductivity or pH.

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