Use of soil amendments when planting new vines

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Introduction

Grapevines have different nutritional requirements depending on the developmental stage of the vine, and the type of rootstock or own-rooted vinifera variety, the soil types, climate and irrigation. It is important for the health of the vines in later productive years, for the young vines to have the best possible start once planted in the vineyard. Not only does the vine require feeding and moisture, but the soil biology can also be enhanced in order to maintain good soil structure and assist with nutrient absorption through the roots. Direct application of compost, green manure or mulch around the roots of young vines during planting is not recommended. These products easily become water-logged, causing root or collar rots and may also cause mineral depletion if still actively decomposing. There are a range of soil amendments that can be added to the soil to enhance the growth of young vines during vineyard establishment as well as the natural populations of soil organisms.

A field trial was conducted at Corbans Viticulture to test the effectiveness of six soil amendments on young grapevines. A number of tools were used to assess nutrient uptake in the vines, vine growth, root structure and biological activity in the soil during the first year of vineyard establishment.

Materials used

The soil amendment formulations used in this trial included:

- Bioplex™ liquid fertiliser (Abron Living Solutions Ltd, Waharoa, NZ) containing a mixture of fish hydrolysate, urea, sea minerals and sugar
- Rok Solid™ solid fertiliser (Agrissentials, NZ), BIO-GRO certified with an NPK ratio of 1:5:9 plus trace elements and 43% silica to aid paramagnetism in the soil
- Vitazyme™ (Mantissa), a bio-stimulant containing elicitors for plant growth
- Mycorrcin™ (Biostart), a bio-stimulant, particularly to enhance mycorrhizal colonisation of the roots
- Myco-gro™ (New-Edge Microbials Pty Ltd, Australia) containing the mycorrhizae species Glomus intraradices
- Superzyme™ (JH Biotech) containing several fungi and bacteria, including Trichoderma, Bacillus and Pseudomonas species.

The vines used were Sauvignon Blanc Clone 1 grafted onto either 3309, 101-14, Riparia, Schwarzman or SO4. Prior to planting, half of the vines were given hot water treatment, with remaining vines of each rootstock untreated. Each rootstock variety had duplicate control groups with no soil amendment added.

Methods

In order to test the effectiveness of each soil amendment at supplying nutrients to vines during the first months of vineyard establishment, no other fertilisers were added to the soil prior to planting. Soil tests taken during the previous autumn showed that the nutrient pool was adequate with 10.5% organic matter.

The soil amendments were added according to label rates to the base of the hole just prior to planting of the Sauvignon Blanc vines in October 2007. A second application of each soil amendment was added to the soil surface in December 2007. A foliar feed of Wuxal Super, Aminoquelant Calcium and Boron and Biomin Zinc was applied to all vines in January with two further applications of Aminoquelant Calcium and Boron in February and March. No fertigation or irrigation was used during the trial.

Two months after planting, visual assessments were made of the vines for nutrient deficiencies and 40 leaf and petiole samples were taken from mature leaves of vines given each treatment in December and again at the end of January. These were assessed for nutrient content by Hills Laboratories, Hamilton, New Zealand using the combined grape profile and mycorrhizal colonistion and soil biology assessed by the Soil Foodweb laboratory.

At the end of the first growing season, vine survival was assessed, the vines trimmed back to two buds then uplifted from the field. Root growth was measured by trimming the roots that had grown during the season from the vine and weighing the trimmed root mass. Twenty cm lengths of the thickest root from 10 vines from each of the 3309, 101-14 and Riparia Gloire rootstock were selected, weighed and photographs taken to compare root structures.

Results and discussion

Seven of the 750 vines used in the trial failed to establish during the first two months. Three of these vines were on SO4 rootstock, two on Schwarzman, and one each on 101-14 and Riparia.

An overall visual assessment of each group of vines treated with different soil amendment showed marked differences in shoot growth in the Spring compared to the dry Summer months and after Autumn rains. There were some foliar symptoms of nutrient deficiencies seen in vines even after two months and without additional nutrient sources added to the soil or an irrigation/fertigation programme in place, these deficiencies continued over the dry summer until the autumn rains (Table 1) .

Leaf and petiole tests taken in mid-December confirmed several nutrient deficiencies occurring when soil amendments were singularly used without additional fertilisers. The second set of leaf blade tests

Table 1. Visual assessment of vines in mid-December 2007 (two months after planting).

Treatment	Visual assessment of vines two months after planting	Visual assessment of vines over summer and autumn
No Treatment	Yellowing leaves, stunted growth in all varieties	Yellowing leaves, stunted growth in all varieties. Little autumn shoot growth
Bioplex	Green leaves, best shoot growth of all of the treatments	Shoot growth slowed after Christmas with little growth after autumn rains
Rok Solid	Leaves slightly yellow, shoot growth greater than control groups	Very little summer growth, but best shoot growth after autumn rains
Superzyme	Yellowing leaves, Schwarzman & SO4 vines had stunted shoot growth	Best summer growth with good shoot growth after autumn rains
Myco-gro	Yellowing leaves, smaller shoot growth than control groups	Very little summer growth but and good shoot growth after autumn rains
Mycorrcin	Slightly yellow, bigger than controls, second best shoot growth.	Shoot growth better than controls but limited growth after autumn rains
Vitazyme	Yellowest leaves, smaller shoot growth than the controls	Yellowest leaves, shoot growth similar to that of the controls

Table 2. Nutrient deficiencies of vines in early-December 2007 and January 2008 (two weeks after a foliar feed as added).

Treatment	Nutrient deficiencies showing in leaf blade tests in early-December	Nutrient deficiencies showing in leaf blade tests at the end of January
No Treatment	**N**, P, **S**, Ca, **Zn**, **B**	**N**, P, **S**, Ca, Mg, **Zn**, **Cu**
Bioplex	P, S, Zn, **B**	**N**, P, S, Ca, Mg, **Zn**, **Cu**
Rok Solid	P, **S**, Zn, **B**	**N**, P, S, Ca, Mg, **Zn**
Superzyme	N, P, S, Ca, Cu, **B**	**N**, P, **S**, Ca, Mg, **Zn**, **Cu**
Myco-gro	P, **S**, Ca, **Zn**, Cu, **B**	**N**, P, **S**, Ca, Mg, **Zn**, Cu
Mycorrcin	P, S, Zn, **B**	**N**, P, **S**, Ca, Mg, **Zn**, **Cu**
Vitazyme	**N**, **P**, **S**, Ca, **Zn**, Cu, **B**	**N**, P, **S**, Ca, Mg, **Zn**, **Cu**

* Bold indicates nutrient levels are critically below the range recommended for grapevines.

were taken at the end of January, after the second application of each soil amendment and the first foliar feed (Table 2).

Table 2 showed that several nutrients were below the recommended levels for grapevines within two months of planting for all soil treatments, and even in vines that were not yet showing deficiency symptoms in the leaves. Of the soil amendments tested, Mycorrcin, Bioplex and Rok Solid provided the most balanced nutrient supply during the spring, with the least number of nutrients deficient in leaves in early December. However, by mid-summer, nutrient deficiencies were similar in untreated and treated vines. A Boron deficiency was successfully ameliorated by addition of the foliar feed in mid-January, but a second application of each soil amendment in early summer and subsequent foliar feeds did not alleviate deficiencies over the drier summer months.

The soil foodweb analysis of soil samples (Table 3) taken in December from the 0 to 30cm rootzone showed low activity in the

Table 3. Results of Soil Foodweb analysis in mid-January 2008.

Sample	Dry Weight of 1 gram Fresh Material	Active Bacterial Biomass (µg/g)	Total Bacterial Biomass (µg/g)	Active Fungal Biomass (µg/g)	Total Fungal Biomass (µg/g)	Percent Mycorrhizal Colonization of Root
No Treatment (HWT)	0.80	1.61	582	0.000	251	33%
No Treatment (No HWT)	0.79	2.49	517	0.680	97.6	60%
Bioplex (HWT)	0.79	1.84	289	0.000	81.3	44%
Bioplex (No HWT)	0.79	1.19	428	8.002	143	37%
Mycorrcin (HWT)	0.79	3.37	460	0.683	90.3	48%
Mycorrcin (No HWT)	0.79	2.05	695	1.358	86.3	31%

* Bold indicates levels are very low

bacterial and fungal populations and that the soils were at this stage dominated by bacterial populations. Although the majority of soil bacteria are non-pathogenic to grapevines, trees, shrubs and vines grow best in fungal-dominated soils with a fungal:bacteria biomass ratio of 2:1 to 5:1 (Ingham, 2006). Mycorrcin™ enhanced the activity of bacteria and fungi in the soil to a greater degree than Bioplex™ or the untreated controls. However, Bioplex™ treated soils had the greater total fungal and total bacterial biomass than soils treated with Mycorrcin™. This suggests that Bioplex™ fertiliser may provide nutrition for both the vines and the soil biology, but Mycorrcin™ does indeed act as a bio-stimulant for fungal and bacterial activity in the soil.

Vine growth after a full season

Once vines were uplifted from the soil, the shoots and roots were removed and then the trimmed vine and trimmed roots were weighed.

After a full season of growth, the shoot growth of at least 90% of the vines was satisfactory despite drier than normal conditions and nutrient deficiencies. The Riparia, Schwarzman and SO4 rootstock varieties had a greater incidence of shoot stunting (Figure 2) when hot water treated than the 3309 and 101-14 rootstock varieties used in this trial. The latter two varieties may be more heat tolerant and therefore respond better to hot water treatment.

Overall, when the vines given each soil amendment were pooled together, the average trimmed vine mass did not differ greatly between any of the soil amendments tested and the untreated controls (Figure 3a). This suggests that none of the soil amendments was clearly better than the others for all of the Sauvignon Blanc:rootstock combinations. However, differences in vine masses were observed between the five rootstocks given each of the soil treatments (Figure 3b). Figure 3b shows that vine

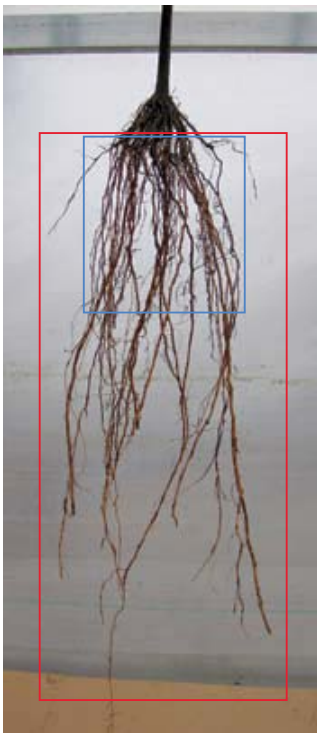

Fig. 1. The roots of a harvested vine showing □ the whole root structure trimmed from each harvested vine and □ where the 20cm lengths of roots were taken which equates to the 10 to 30cm rootzone.

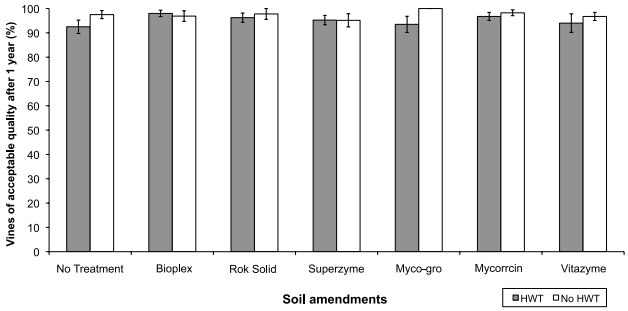

Fig. 2. Vines with acceptable shoot and root growth after the 1st year in the vineyard (error bars denote the standard error).

growth of rootstock responded differently to each soil amendment, with growth Sauvignon Blanc on 3309 best when given Mycorrcin™ and Schwarzman best when given Bioplex™. Generally these soil amendments were the most consistent across the rootstock varieties. These soil amendments caused the most immediate effect on shoot growth during the season, compared to other treatments whose effect on growth was delayed until the Autumn rains. Superzyme™ consistently produced good growth in most vines, most likely due to the continued growth of vines given this soil amendment over the Summer months.

Figure 4a (see page 34) summarises the whole trimmed root mass of vines given different soil amendments. There was not a large difference in the whole root mass between the untreated controls and the soil treatments when the vines given each soil amendment were pooled, except for poorer growth in hot water treated vines given Mycorrcin™.

However, there were noticeable differences in root growth of each rootstock variety given individual treatments in the top 10-30cm rootzone, nearest to where the amendments were applied. Figure

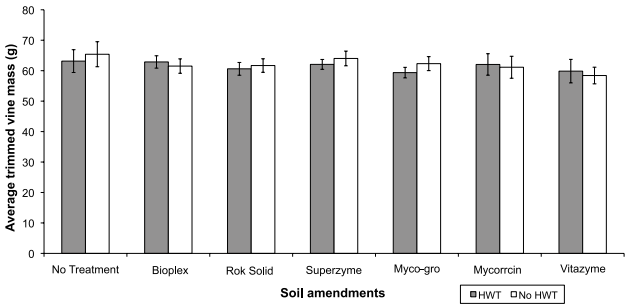

Fig. 3(a.) Average trimmed vine mass, including all rootstocks, after the first year in the vineyard (error bars denote the standard error).

Rootstock variety	Treatment	No Treatment	Bioplex	Rok Solid	Superzyme	Myco-gro	Mycorrcin	Vitazyme
3309	No HWT	65	62.0	59.4	70.6	67.5	81.4	76.7
	HWT	60	57.5	65.6	74.4	55.0	79.4	58.3
101-14	No HWT	69.4	67.0	68.1	60.0	65.6	75.6	83.0
	HWT	53.1	80.5	67.1	75.6	65.6	74.0	73.3
Riparia	No HWT	52.5	66.9	57.2	57.5	53.9	51.3	57.5
	HWT	51.3	61.0	62.0	61.5	55.6	61.9	55.8
Schwarzman	No HWT	50.6	73.0	51.9	57.5	56.3	65.0	48.3
	HWT	53.5	66.5	47.0	66.4	60.0	47.5	52.2
SO4 Sica8	No HWT	52.2	49.0	54.4	58.3	49.4	68.0	47.0
	HWT	70.6	47.5	65.6	63.1	57.1	60.0	60.0

Fig. 3(b). Average trimmed vine mass of individual rootstock after the first year in the vineyard (n= 18 vines per treatment). Denotes the vines with the largest average mass and the 2nd largest vines.

4b (see page 34) shows poor root growth in the top 10-30cm of the rootzone of 3309 and Riparia vines given hot water treatment and Mycorrcin™. The soil amendments generally improved root growth in this region compared with untreated controls. Superzyme™ was overall the most effective treatment for enhancing root growth in young vines. This effect is shown clearly in the photographs of 101-14, 3309 and Riparia root samples in Figure 5.

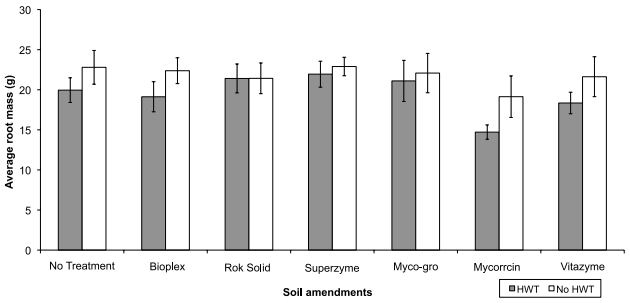

Fig. 4(a). Average whole trimmed root mass of vines given different soil amendments after the season of growth in the vineyard (error bars denote the standard error).

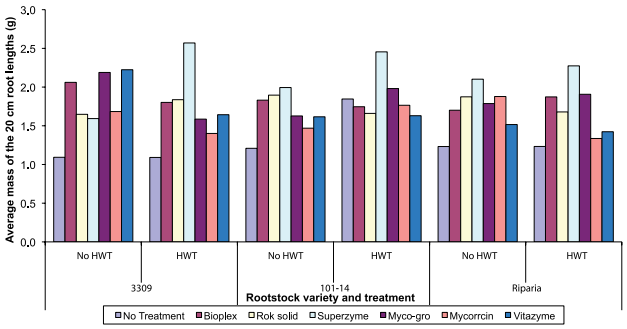

Fig. 4(b). Average mass of 20cm lengths of roots from the different rootstock from each treatment after the first year in the vineyard (n=10 samples per value).

Discussion

The soil amendments used in this trial were applied in isolation, without the benefit of additional soil fertilisers and an irrigation programme over the dry months. This method was employed to find out how and when each soil amendment was most effective. No single soil amendment provided sufficient nutrients as a stand-alone product to the vines to prevent nutrient deficiencies. This study shows that soil amendments are not suitable substitutes for a soil conditioning programme to ensure that the nutrient pool in the soil is adequate and available to the vines. Rather, soil amendments may enhance shoot and root growth during periods of rain and stimulate biological activity in the soil at key times in the first year of vine establishment growth.

Of the two fertilisers tested, Bioplex™ was the most effective at enhancing early Spring growth during vine establishment, but its effect on shoot growth was short-term with minimal growth during Summer and Autumn. Rok Solid™, on the other hand did not enhance spring growth but enhanced Autumn shoot growth. This effect may have been delayed until autumn by an absence of sufficient moisture in the soil over summer and early Autumn and may be rectified by irrigation over the dry months or addition of Rok Solid™ to the soil in the Winter prior to planting to allow time for nutrients to become available when the vine is planted.

Mycorrcin™ appeared to be the most effective for vine establishment of the two bio-stimulants when used as a soil amendment. Mycorrcin™ also contains some nutrients in soluble form apart from the bio-stimulants, which produced an immediate affect on vine growth during the Spring. However, like Bioplex™, this effect was short-term. Vitazyme™ is recommended more as a foliar feed, and may be more effective if applied in this way rather than via the soil. Mycorrcin™ did improve the activity of fungi and bacteria in the soil within two months of application. However, Mycorrcin™ appears to enhance shoot and trunk growth rather than root growth during vine establishment.

Superzyme™ was the most effective of the biological formulations, particularly noticeable in enhancing root growth near the soil surface in young vines. This may explain why the vines treated with Superzyme™ showed the best growth during the dry Summer months.

Good vine growth during the first year of vineyard establishment is important to ensure vines have well established root and canopy systems prior to cropping. These results highlight the importance of planning a soil fertiliser programme for the first year of vine establishment that includes a balance of readily available nutrients during the Spring, promoters of root growth and soil biological activity to help the vines get through the drier months, and some slow release fertiliser with low nitrogen content to provide limited growth without delaying lignification to coincide with autumn rainfall.

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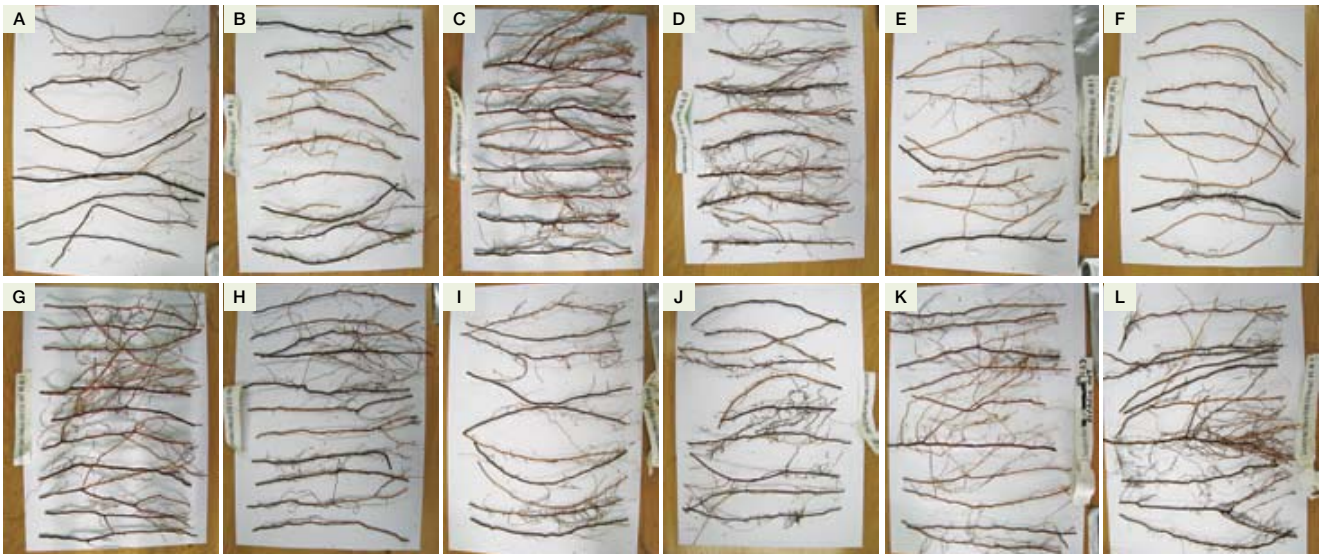

Fig. 5. Root structures of 20cm root lengths taken from rootstock of vines with controls and the two best soil amendments: 101-14 rootstock given (A) No HWT, No soil amendment, (B) HWT, no soil amendment, (C) HWT, Superzyme, and (D) HWT, Rok Solid. 3309 rootstock given (E) No HWT, no soil amendment, (F) HWT, no soil amendment, (G) HWT, Superzyme, and (H) HWT, Bioplex. Riparia Gloire rootstock given (I) No HWT, no soil amendment, (J) HWT, no soil amendment, (K) No HWT, Superzyme, and (L) No HWT, Mycorrcin.

misrepresented or inaccurate, or reliance placed on that information by readers.

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