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# Inter-relationships between Vine Vigour and the Incidence of Bunch Stem Necrosis in Cabernet Sauvignon Grapevines.

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## Abstract

**Bunchstem Necrosis (BSN), is a physiological disorder in grapes, which results in unripe shrivelled berries with poor quality attributes. Past research into this area is conflicting with many different hypotheses being proposed to explain the disorder. Vines on SO4 rootstock, a high vigour rootstock, have demonstrated high incidence of BSN and the published literature has also indicated that shading of vines at a particular time may influence BSN incidence. In this study, it was proposed that there was a positive relationship between vine vigour and BSN incidence due to a shift in the source-sink relationship between the developing fruit and vine growth. Treatments to manipulate shoot vigour and the source-sink relationship were applied to Cabernet Sauvignon grape vines growing on SO4 rootstock. Treatments included root pruning to reduce vigour, heading back of canes, the application of a reflective mulch (Extenday) to increase vigour, 50% shading for three weeks prior to flowering, and 50% shading for three weeks after flowering. A strong positive relationship between vigour and BSN incidence was determined in the first growing season. In the following season where all treatments were reapplied except root pruning, the relationship was not as strong but was still positive. Root pruning still reduced BSN and vigour in the second season, just as heading back of the canes and the reflective mulch increased vigour and BSN incidence. Environmental conditions between the two seasons were very different and this may have influenced the observed responses. Neither shade treatment significantly changed the vigour of the vines in either season. Shade prior to flowering reduced BSN incidence in both seasons. However, shade after flowering only influenced the BSN incidence in the second season where the BSN incidence was increased. It is proposed that the shade treatments had a direct affect on the source-sink mechanism rather than manipulating the vigour of the vine. These results provide evidence that some management practices are available to manage this disorder but their effectiveness will be influenced by the prevailing environmental conditions especially around the time of flowering.**

## INTRODUCTION

Bunch stem necrosis (BSN) is a complex physiological problem in grapes. It results in shrivelled unripe berries, which are detrimental to wine quality, and it reduces yield (Ureta et al., 1981). Symptoms occur at any time after the onset of veraison and include the appearance of dark necrotic spots on the pedicel, rachis or peduncle which can then spread and girdle the affected area. Berry appearance becomes dull and opaque, and berries are soft in texture (Morrison and Iodi, 1990; Ureta et al., 1981). Certain varieties are more susceptible than others and the severity of incidence differs from year to year (Jahnl, 1983).

Results from research into this problem tend to be contradictory and therefore no one conclusive explanation for the disorder has been found. Capps and Wolf (2000) found that the application of nitrogen fertiliser reduced the incidence of BSN but other researchers have found the exact opposite response (Christensen and Boggero, 1985). A magnesium (Mg) deficiency has been related to BSN incidence (Haub, 1986) yet Nahdi *et al.* (1993) determined that BSN was caused by an imbalance in the K/Mg ratio, and not solely by a Mg deficiency alone. This ratio has been found to be effective only in certain locations (Boselli et al., 1987). In contrast, Kadam *et al.* (1995) found that BSN incidence was correlated with Ca deficiency and some studies have found that Ca application does reduce BSN (Hartmair, 1977) while others have not (Rizzotto, 1977). Environmental conditions such as temperature around flowering and precipitation during veraison have also been correlated with BSN incidence (Boselli et al., 1986; Holzapfel and Coombe, 1995; Nicolli et al., 1977) but many of the correlations with environmental conditions differ from study to study.

Vine vigour has also been suggested to influence BSN incidence. Treatments which increase the vigour of individual shoots or which increase vine canopy area have been found to increase BSN incidence (Redl, 1984; Theiler, 1979).

Root pruning is well known to reduce the vigour of the crop when it is applied (Ferree, 1990; Schupp et al., 1992), including grapes (McArtney and Ferree, 1999; Saayman and Huyssteen, 1983). It also has other advantageous effects such as earlier maturity (Schupp, 1991), increased sugar concentration (Ferree, 1992) and smaller fruit (Ferree, 1992) which is beneficial in some crops. The objectives of this study were to investigate the possible positive relationship between vine vigour and BSN incidence and to determine if root pruning was a possible management tool for controlling this disorder.

## MATERIALS AND METHODS

### Plant Material

**1. Field trial.** Seven-year-old field grown Cabernet Sauvignon grape vines on SO4 root stock where used for this study. Vines were situated on a Montana vineyard near Taradale, New Zealand. The vineyard was situated on a sandy loam soil called Poporangi.

Spacing between vines was at 2.0 m within-rows, and 2.4 m between-rows. Vines were cane pruned in winter months. There was no permanent irrigation system but in dry years a travelling irrigator could be used. Common commercial practices were carried out to maintain the vines.

**2. Controlled environment (CE) rooms.** Four-year-old Cabernet Sauvignon grape vines on SO4 root stock grown in 40 litre pots were used for the CE trials. Vines were trained onto a frame 1.5 m long and 1.5 m high and spur pruned in the winter months. The spray regime was based on common commercial practices.

**Treatments**

For treatments in the field, vines were blocked due to a variation in soil fertility. The experimental design consisted of eight blocks. The overall design was a randomised block.

**1. Root pruning.** In the winter months prior to bud break of Season One, field grown vines were root pruned approximately 25 cm from the trunk on either side to a depth of 60 cm. A spinning wood saw blade mounted on the back of a tractor was used to cut through the soil and roots.

**2. Shade cloth.** In Seasons One and Two 50% shade cloth was draped over one group of field grown vines for three weeks prior to full bloom and a second group of field grown vines for three weeks after full bloom.

No treatments were imposed in Season Three.

**3. Controlled environment rooms.** Groups of potted vines were placed in the controlled environment rooms during one of three stages: three weeks prior to flowering, three weeks after flowering or three weeks prior to veraison. Rooms were set at a 16/8 hr day/night regime with daylight intensity of 650 µmols $m^{-2}$ $s^{-1}$. The day/night temperature was set at 23/11 $^{o}$C in order to encourage strong vine growth while in the CE treatments.

**Measures**

Vine vigour on field grown vines was determined using the point quadrant method as detailed by Smart and Robinson (1991). Vine canopy area was determined by counting leaf and gap numbers at 57 points within a sample area of 2 m by 2 m. Survey points were spread evenly at 10 cm intervals horizontally and vertically at 1 m, 1.5 m and 2 m intervals above the soil surface. Leaf layer number (LLN) was determined as per Smart and Robinson (1991).

Point quadrant measures began close to flowering and were repeated four times approx. one month apart in Seasons One and Two. In Season Three only two measures were taken - the first close to flowering and the second approximately six weeks later when it was estimated that maximum measurable vigour had occurred as indicated by Season One and Two measures.

In the winter of Season Two the number of canes and the number of growing points per vine were counted on field grown vines.

Bunches on both field and pot grown were scored to record BSN development. Scores were carried out non-destructively by visually estimating the progress of BSN through the number of berries that were shrivelled.

**RESULTS AND DISCUSSION**

Root pruning imposed in Season One dramatically reduced the vigour of the field grown vines in all three seasons compared to the control (Figure 1). There was a lower leaf layer number for root pruned vines for all seasons. There was also a significantly lower overall growing point number for root pruned vines in the second season. However, this significance was reduced for growing points per cane due to the reduction in overall cane number for root pruned vines (Table 1). Neither shade treatment affected LLN in any season (Figure 1) or overall growing points per vine in Season Two (Table 1). Shade post full bloom did, however, significantly increase growing points per cane (Table 1).

Season Two was a more vigorous season overall when compared to the other two seasons. Final vigour measures where higher than in the other two seasons

(Figure 1) and trimming was carried out weekly from one week after flowering. In contrast, in Season One it commenced three weeks after full bloom and was carried out two-weekly during the remainder of the season (data not shown).

In Season Three, vines began much more vigorously than in the other two seasons (Figure 1). The first trim was carried out two weeks before flowering in this season, but was not repeated until three weeks after full bloom and then continued at two-weekly intervals (data not shown). This is probably due to the amount of rain experienced early in the season. This demonstrates that while early season vigour was much higher in Season Three, the growth of the vines had reduced by the time of flowering and then continued at a less vigorous rate than had occurred in Season Two.

Root pruning significantly reduced the incidence of BSN compared to the control. This reduction continued for the two seasons after root pruning (Figure 2). Root pruning reduced BSN incidence by 80% in Season One, 35% in Season Two and 45% in Season Three. Shade post full bloom did not affect BSN incidence in Season One or Three when comparing raw data (Figure 2). BSN incidence was increased by more than two-fold in the second season by shade post full bloom (Figure 2). Shade pre full bloom did reduce BSN incidence from the control in Seasons One and Two but not in Season Three (Figure 2).

Values were adjusted so that they could be compared at a maturity ratio of 1.8 in order to compare results amongst years (Figure 3). Raw data suggests that Season Three was the most affected season of the three. However, this is only due to BSN measures being carried out for a longer period following veraison. When results were adjusted for maturity, which is the basis on which the crop is harvested, Season Two clearly had the highest incidence of all seasons for the control vines and the incidence in both Seasons One and Three was similar (Figure 3).

The raw data indicates that absolute BSN incidence began to increase each additional year after root pruning (Figure 2). The maturity adjusted data indicates that Season Three had, in fact, the same absolute incidence as Season Two. However, when adjusted for maturity, root pruning reduced BSN incidence from the control by 90% in Season One, 75% in Season Two and 65% in Season Three. Clearly there was a marked reduction of BSN where vines had been root pruned.

Conclusions drawn from the raw data for the shade treatments also apply to the adjusted data in Seasons One and Two. However, in Season Three, adjusted data indicate that there may in fact be an increase in BSN incidence for shade post full bloom treated vines even though this treatment had not been reapplied in that season (Figure 3). This indicates a possibility of a carry over affect for this treatment.

There was a strong positive correlation between vigour (LLN) and BSN incidence over all three seasons (Figure 4). Although this correlation was more significant when only using root pruned and control vine data, there was still a strong positive correlation when the data from shade treatments were also used. This correlation was more significant when using maturity adjusted data (Figure 4).

BSN incidence was significantly higher for pot grown vines placed in the controlled environment rooms during post flowering (Table 2). There was no significant difference between vines exposed pre flowering and those exposed pre veraison.

## CONCLUSIONS

Root pruning reduced the vigour of vines compared to the controls for at least three seasons after the root pruning was carried out. Coincidentally, BSN incidence

was considerably reduced in root pruned vines. This effect carried over for at least three seasons after the root pruning had been carried out.

Shading did not affect vine vigour as measured by LLN but shade post full bloom did increase the number of growing points per cane on a vine.

There was a strong positive correlation between LLN and BSN incidence across all of the three seasons for which measurements were taken.

There is a critical time in both the previous and current season immediately after flowering in which conditions may increase the incidence of BSN. Vine vigour or leaf canopy development, around this time maybe the mechanism which controls the incidence of BSN. Conditions which lead to high leaf canopy development at this critical time may therefore increase the incidence of BSN.

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## Figures

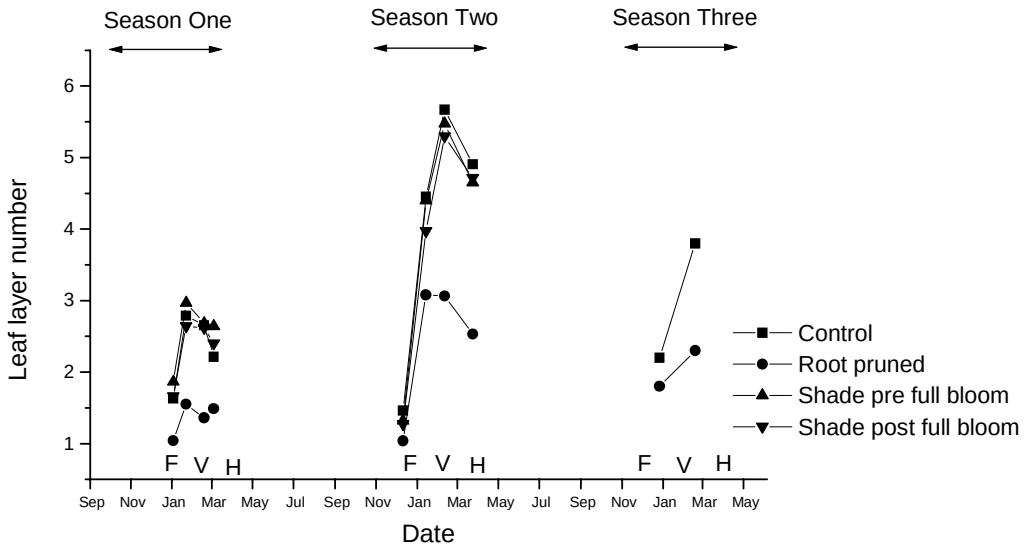


**Figure 1: Leaf layer number obtained from point quadrant analyses. F indicates flowering, V indicates 50% veraison, H indicates harvest.**

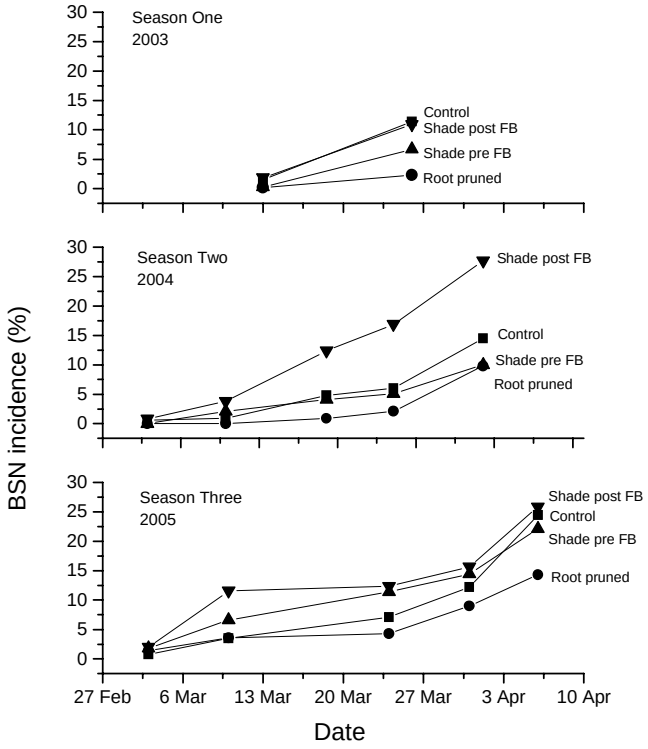


**Figure 2: Bunch stem necrosis development over the season for Seasons One, Two and Three for field grown vines.**

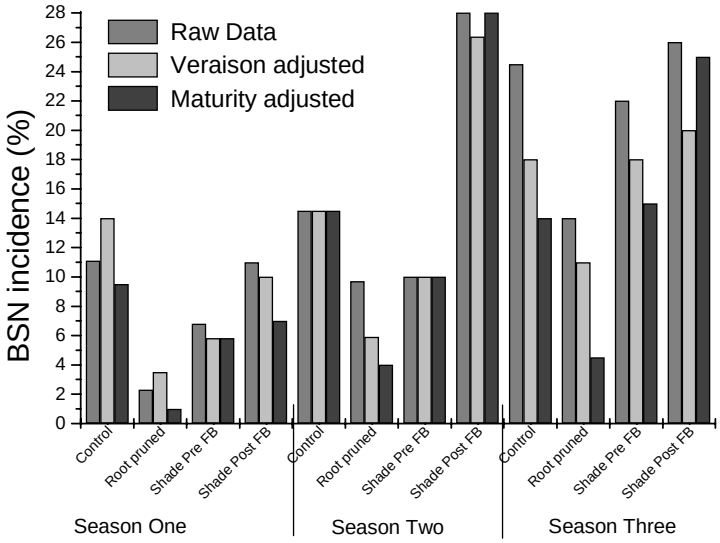


**Figure 3: Raw and adjusted BSN incidence for Seasons One, Two and Three for field grown vines.**

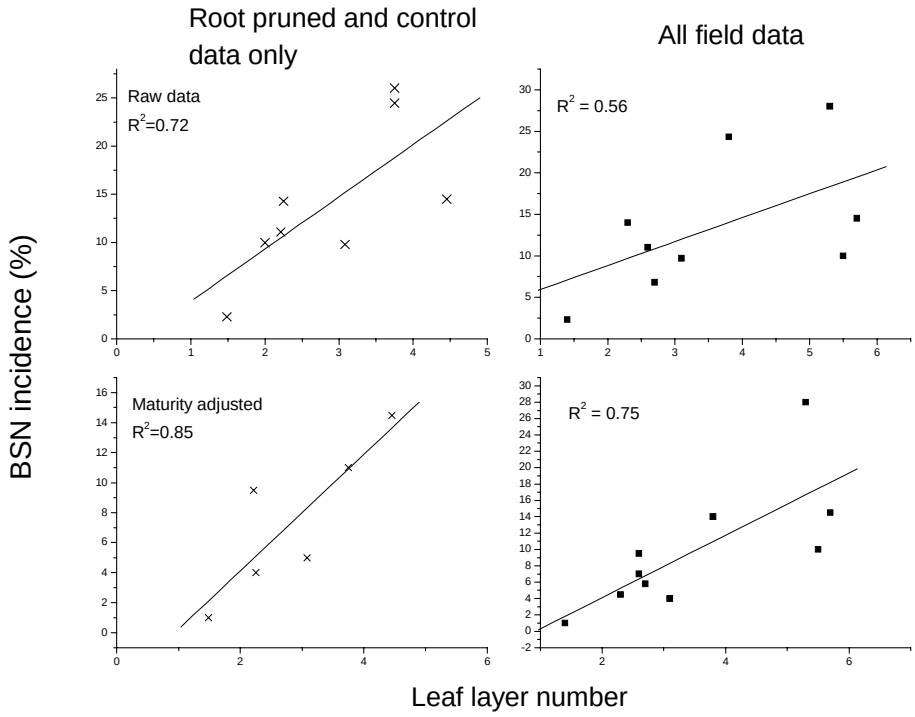


**Figure 4: Correlation between leaf layer number and BSN incidence for field grown vines.**

## Tables

**Table 1: Number of growing points per vine and number of growing points per cane per vine for field grown vines in Season Two.**

| Treatment | Growing points per vine | Growing points per cane |
|---|---|---|
| Control | 65a | 3.0bc |
| Root prune | 50b | 2.7c |
| Shade Pre FB | 66a | 3.8ab |
| Shade Post FB | 69a | 4.1a |

Values with the same letter are not significantly different from each other (Lsmeans P<0.07)

**Table 2: BSN incidence for pot grown vines placed in controlled environment rooms during three different stages of development.**

| Stage | BSN incidence |
|---|---|
| Pre flowering | 30 b |
| Post flowering | 76 a |
| Pre veraison | 23 b |

Values with the same letter are not significantly different from each other (Lsmeans P<0.07)