THE INFLUENCE OF SITE ASPECT AND PRUNING TYPES ON PINOT NOIR PHENOLOGY AND SHOOT GROWTH

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Abstract

Aim: Managing the influence that terroir in vineyards has on vine development depends on improving our understanding the effect of the interaction of within-site variability, within-vine variability, and management practices (such as pruning types) on phenology and vine development. This study evaluates the consequence of site aspect and pruning management on budburst, leaf appearance rate, and shoot growth in Pinot noir vines.

Methods and Results: Two rows of 19-year-old Pinot noir vines were selected within a commercial vineyard with south, hilltop, and north-facing aspects (note: the north-facing slope is sun-facing in the Southern Hemisphere). Vines were either cane- or spur-pruned, retaining 20 nodes per vine. Budburst, shoot development, and leaf appearance were assessed, and vine trunk circumference was measured to quantify the accumulated differences in vine vigour.
Hilltop plots had smaller trunk circumferences when compared to the south- and north-facing plots. Irrespective of topographical positions, budburst was earlier in cane-pruned vines compared to spur-pruned vines, but no differences were observed by the time of 12-leaf stage. The rate of shoot growth reflected the variations in topographical positions and trunk circumference. Cane-pruning exhibited more significant within-vine variation in budburst, budburst duration, and shoot growth when compared with spur-pruning. Shoots from hilltop vines were shorter relative to the vines at other plots for both pruning systems.

Conclusions: The rate of shoot growth and development was associated more with site and vine vigour as determined by trunk circumference than pruning type. Spur-pruned vines had a later but more uniform budburst when compared to cane-pruned vines.

Significance and Impact of the Study: Pruning type and within-site variability may lead to differences in canopy density and vine vigour, which can ultimately impact subsequent growth and development of the grapevine. Determining the influence of terroir within the vineyard on budburst, leaf appearance, and shoot growth variability will enable the development of improved phenology and growth models to describe within vineyard variability.

Keywords: Terroir, pruning system, within-vine variability, vine vigour, shoot growth and development, Pinot noir

Introduction

Spatial variability of vine phenology, growth, yield, and quality in the vineyard is influenced by environmental factors like topography and soil characteristics (Bramley *et al.,* 2011a; Tardáguila *et al.,* 2011; Verdugo-Vásquez *et al.,* 2017) and management practices such as pruning (Jones *et al.,* 2018; Reynolds and Heuvel, 2009). Managing terroir in vineyards depends on improving our understanding of the effect of the interaction of topography or site factors and management practices on grapevine growth and development. Variation in phenology and growth within a vineyard can be described at different scales: between vine variation, within vine variation, between shoot or bunch variation, and between berry variation. A study conducted in a spur-pruned vineyard of South Australia showed the range of within-vineyard variation in yield was up to 8 to 10-fold (i.e., 2 to 20 t/ha), and this is most likely due to different spatially dependent soil properties (Bramley and Hamilton, 2004). However, within-vineyard variation in vine vigour and its association with yield is affected by the pruning type (spur-pruned and cane-pruned), where cane selection and the history of the development of that cane may have a more significant influence on yield and yield components than vine vigour (Bramley *et al.,* 2019). In contrast, other studies showed that spur-pruned vines had a denser canopy with similar yields when compared to cane-pruned vines (Jones *et al.,* 2018). Most of the studies performed on spur- versus cane-pruning systems were focused primarily on grape yield and berry composition (Skinkis and Gregory, 2017; Jones *et al.,* 2018) and did not consider phenological and shoot growth variations due to pruning type. This study evaluates the consequences of site aspect and the influence of spur- or cane-pruning on the timing of budburst, leaf appearance rate, and shoot growth in Pinot noir vines.

Material and Methods

This study was undertaken in a commercial vineyard located in Waipara, North Canterbury, New Zealand (43°6′ south, 172°44′ East). Pinot noir (clone UCD 6, rootstock Riparia Gloire) vines were planted in 1997 and trained using a three cane Vertical Shoot Positioned (VSP) system. Vines were converted to retain either (i) two canes with eight nodes retained per cane and two renewal spurs, or (ii) spur-pruned to eight 2-budded spurs with two renewal spurs per vine (total of 20 nodes per vine) in 2018-19. The experimental area was in hilly terrain with two slopes of opposing aspect (Figure 1A, 1B). A split-plot design experiment was applied across two rows as blocks. Main plots of eight uniform vines were established at six topographical locations (labelled plots 1-6) on each row, and two pruning systems (cane- and spur-pruning) as four-vine sub-plots (96 vines total), with pruning treatments allocated in a stratified manner (Figure 1A). Budburst (EL-4, Coombe 1995) was noted for all the 16 buds on the cane and spurs on each vine in each sub-plot. Leaf appearance and shoot length (cm, starting at EL-7) on eight buds from one cane or cordon (south-facing) on each vine were recorded twice a week. General vineyard management was undertaken by the vineyard manager following the New Zealand Sustainable Winegrowing practice (http://wineinf.nzwine.com/swnzabout.asp). Leaf plucking and fruit removal did not occur. The effect of topography and pruning was analysed by split-plot ANOVA with means separation by Fisher's least significant difference (LSD) at the 5% level of significance using Genstat 19 (Genstat, UK), and graphs presented in figures were plotted using Minitab 18 (Minitab Inc., USA).

Results and Discussion

Vines at hilltop positions (3 and 4) had smaller trunk circumferences when compared to those at the North (1 and 2) and South (5 and 6) positions ($p<0.01$, Figure 1B). As previous research has reported a strong relationship between trunk cross-sectional area (TCA) and total weight and annual grapevine pruning weight (Bramley *et al.,* 2019), the differences in trunk circumferences indicate that vines in the hilltop positions had accumulated less vegetative growth over time and experienced lower vigour than those at other locations.

The average date of 50% budburst of spur-pruned vines was 1.4 days later, and the duration 4.4 days shorter when compared with cane-pruned vines ($p<0.01$, Figure 2A and $p<0.05$, Figure 2B, respectively). Vineyard topography had no significant effect on the date of 50% budburst, but budburst duration was two days shorter for vines growing in the south-facing plots (5 and 6) compared to those in the north (5 and 6) and hilltop plots for both pruning types (3 and 4) ($p<0.05$, Figure 2B). Longer budburst duration for cane-pruned vines may be due to correlative inhibition, as suppression of basal buds occurs with more buds retained on canes at pruning time (Howell and Wolpert, 1978). In spur-pruned vines, the individual spurs acted like two-node canes and were, therefore, more uniform in budburst duration. These differences between cane- and spur-pruning types had disappeared by the 12-leaf separation stage (Figure 3A), and it appears that topographical position did not influence the days required to reach this stage (Figure 3A).

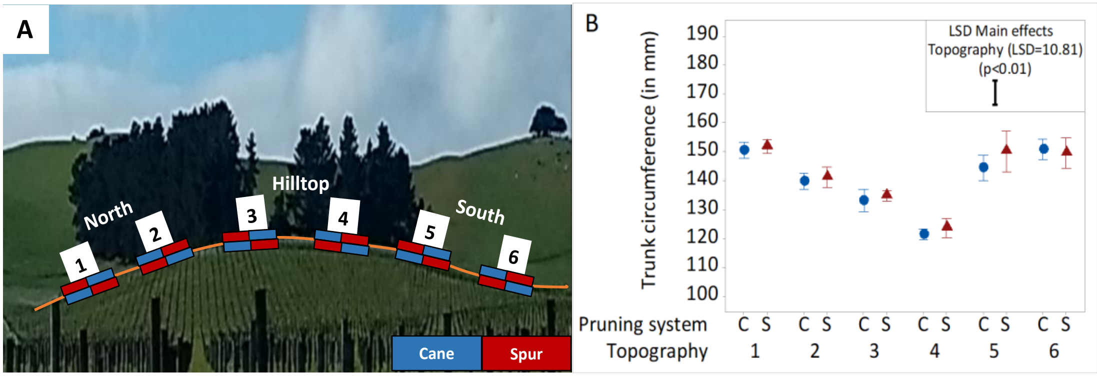

Figure 1: (A) Trial site looking east. (B) Differences in vine trunk circumference separated using Fisher's Unprotected LSD test ($p<0.05$). Error bars = standard error of the mean. Pruning system: C=Cane (blue coloured), S=Spur (red coloured). Topography: North= sites 1 & 2, Hilltop= sites 3 & 4, and South= sites 5 & 6.

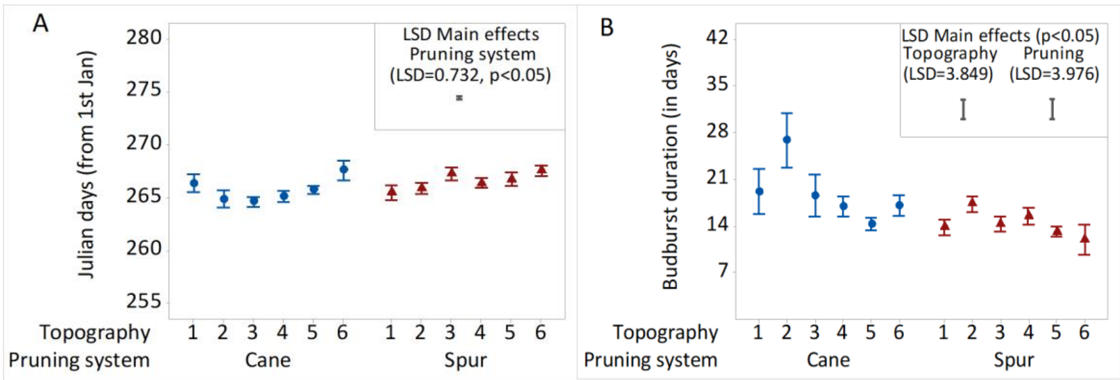

Figure 2: (A) Days to reach 50% budburst. (B) Duration of budburst (from first to last bud) at six sites in cane-pruned and spur-pruned vines during 2019-20. Values separated using Fisher's Unprotected LSD test ($p<0.05$). Error bars = standard error of the mean. Sites numbers as in Figure 1.

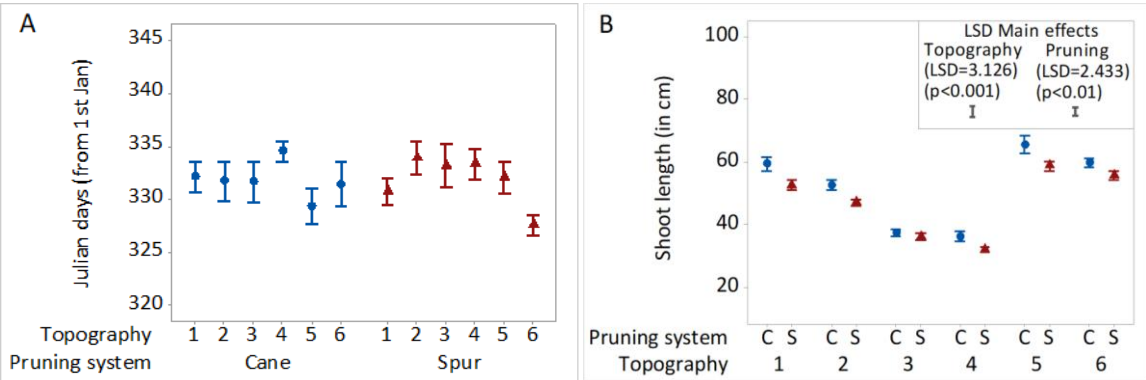

Figure 3: (A) Days to reach 12-leaf separation stage (EL-17). (B) Shoot length at 12-leaf separation stage (EL-17) at six sites in cane-pruned (C, blue coloured) and spur-pruned (S, Red coloured) vines during 2019-20. Values separated using Fisher's Unprotected LSD test ($p<0.05$). Error bars = standard error of the mean. Sites numbers as in Figure 1.

Average shoot length of vines at north and south locations (sites 1, 2, 5 & 6) was double that of average shoot length at the hilltop plots vines (sites 3 & 4) at 12-leaf stage ($p<0.001$, Figure 3B) for both pruning types. Differences in shoot growth reflected variations in trunk circumference and are related to differences in overall vine vigour and size (Figure 1B) resulting from factors such as soil moisture, soil texture and wind (Tardáguila *et al.,* 2011; Bramley *et al.,* 2011b; Dry *et al.,* 1989). Average shoot length at the 12-leaf separation stage was longer for cane-pruned vines compared with spur-pruned vines, although pruning type was less important than topography ($p<0.01$, Figure 3B). Longer average shoot lengths for cane-pruned vines may be partly due to their earlier budburst and, therefore, greater time to achieve longer shoot lengths compared with spur-pruned vines. However, shoots of spur-pruned vines were more uniform in length compared to cane-pruned vines at 12-leaf stages (Figure 3B).

Conclusion

Budburst was earlier for cane-pruned vines compared with spur-pruned vines. Topography affected shoot growth, with shorter average shoot lengths being recorded at hilltop locations, where vines also had smaller trunk circumferences. Cane-pruned vines exhibited longer shoot lengths than spur-pruned vines at each topographical position. Parameters like air temperature, soil moisture and wind speed need to be explored in the future to understand the mechanisms behind these differences.

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