Arched Canes vs Horizontal Canes on Single Guyot Trained Chardonnay Vines in East Sussex

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Introduction

The question of how to combat the problem of uneven shoot growth over single Guyot trained vines was addressed at a vineyard in east Sussex three years ago with a potential solution adopted in the form of converting twenty rows of single Guyot Chardonnay vines onto a pendelbogen system that promotes arched canes and monitoring the results. This investigation attempts to address the outcome of this venture through comparative analysis of both pruning systems and the affect they have on canopy density, fruit quality and yield. A comparative analysis was also conducted on shoot lengths, diameters and bunch numbers with regard to whether arched canes have been successful at reducing the effects of what Jackson has identified as 'end point principle' (EPP).

End point principle (EPP) identifies those shoots at the distal end of long canes which can exhibit a vigorous advantage over the other shoots on a cane. While there is evidence to suggest that shoot growth has a phenological relationship (growth affected by climatic factors) (Galet, 2000), the specific problem of EPP is more likely of a physiological nature (Mullins, 1992). Jackson has suggested these conditions are probably in some way related to apical dominance. As virtually no other independent research exists, one can only accept Jackson's principle as it is, and postulate on what other potential factors may be. What is certain

is that this uneven shoot growth can lead to an underdeveloped canopy in the middle of the cane, and may result in poor fruit quality, decreased number of bunches, and overcrowding of shoots and foliage on crowns of adjacent vines.

There is a natural tendency to try and combat this problem and encourage an even distribution of growth across the cane, thus filling the fruit zone evenly and with less risk of disease and competition for sunlight. Achieving this end has been open to some debate, but the most common method, as suggested by Jackson, is to arch the cane, (see Fig. 1), thus restricting sap flow to the extreme ends of the canes, and reducing end point vigour (Jackson, 2001).

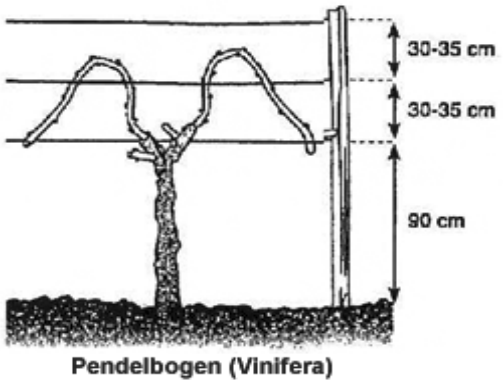

Fig. 1 Arched canes on double Guyot pruned vines (Slingerland, 2003 [online]).

This arching of the cane is similar to a culture system used extensively in Germany and Eastern North America called pendelbogen (Slingerland, 2003). It was primarily adopted to increase available cane surface area by arching the cane, thus creating a higher bud/metre ratio between closely planted vines (Muller, 2000).

Results

***Shoot growth*:** Distribution of growth across the cane for both culture systems was analysed with a comparison of the means. Mean shoot diameters for single Guyot were recorded in their positions along the cane and compared against the means of all the pendelbogen shoots in the same positions. In looking at the mean shoot diameters for single Guyot horizontal trained canes there is a definite inconsistency of growth distributed across the cane. Shoots in the middle are some 0.32cm smaller than those in both the extreme ends, suggesting an uneven distribution of growth. (see Fig.2).

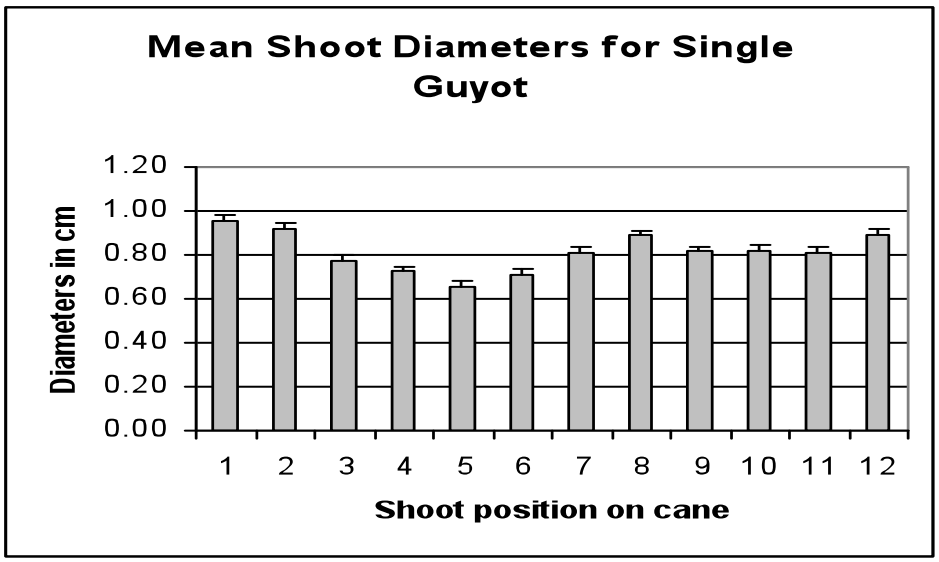

Fig. 2. Canes on single Guyot are smaller in the centre and more vigorous at the ends.

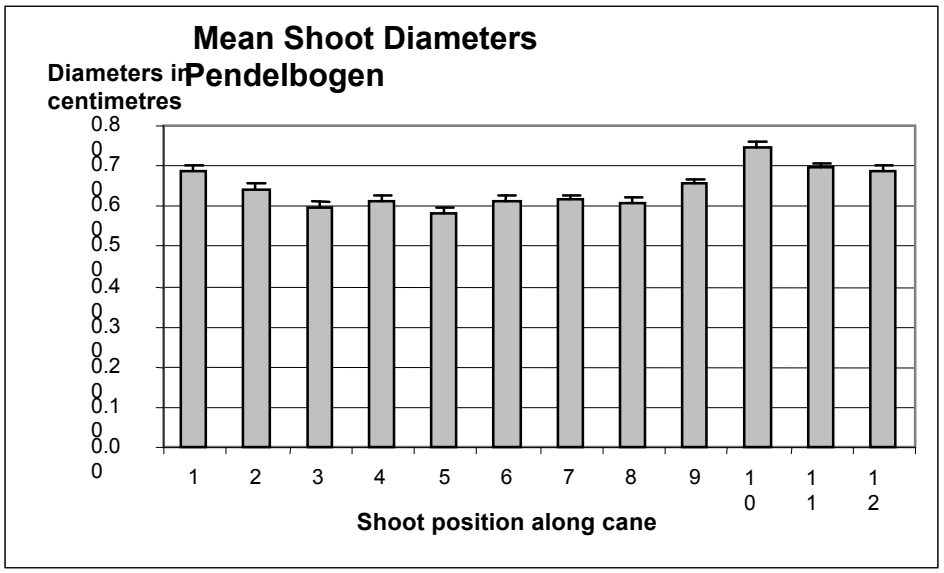

Fig. 3. Canes on pendelbogen are similar in vigour distribution, but less of a variance between canes in the middle and those on the end suggesting a slightly better growth distribution.

Mean shoot growth and distribution across the pendelbogen trained vines is very similar to the distribution of those across single Guyot horizontal trained canes, however the degree of variance between the middle and end shoots is only 0.17cm difference, suggesting a slight improvement on the shoot growth and distribution across the cane (see Fig. 3).

Canopy density: Percentages for gaps, leaf layer numbers, interior and exterior leaves, and clusters were calculated and analysed against Smart's optimum values to determine which of the culture systems had a low to high canopy density. Optimum values for a point quadrat analyses are set

at 20-40% for gaps, 1.5-1.0 or less for leaf layer numbers, less than 10% for interior leaves and less than 40% for interior clusters (Smart, 1991). With these values in mind, both systems are supporting a relatively high density canopy; however the pendelbogen is leaning toward slightly better foliage cover with noticeably improved cluster exposure (see Fig. 4).

Table of results for canopy density comparison

Single Guyot			**Pendelbogen**		
Percent Gaps	**Apr-50**	**8%**	Percent Gaps	**Mar-50**	**6%**
Leaf layer number	**124/50**	**2.48%**	Leaf layer number	**109/50**	**2.18%**
Percent interior leaves	**42/124**	**33%**	Percent interior leaves	**28/109**	**25%**
Percent interior clusters	**Dec-17**	**70%**	Percent interior clusters	**Apr-15**	**26%**

Fig. 4.Showing the results of the point quadrat analyses

Bunch numbers and distribution: The mean bunch distribution across the cane for both systems was also varied. The means were calculated in the same manner as the shoot diameters with the sample size changing per shoot position. Single Guyot saw an average of between 1-1.75 bunches per shoot across the cane, with a slight increase towards the extreme ends. Pendelbogen saw a variance of 1.2-1.5 bunches across the cane with a marked increase on the 10^{th} and 11^{th} shoot position. At these positions the mean bunch numbers increased to 2.8 and 2.5 respectively (see Fig. 5).

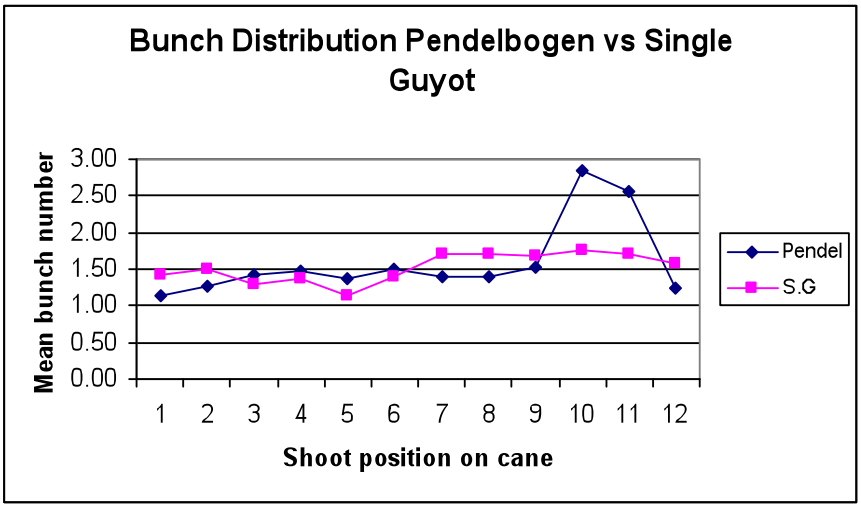

Fig.5. Showing the results of the mean bunch distribution across the cane for both culture systems.

The total number of bunches recorded for single Guyot and pendelbogen were 482 and 487 respectively. This is a very similar number considering two different culture systems are concerned. This gives a mean bunch distribution per shoot for single Guyot at 1.516 and 1.522 for pendelbogen.

Fruit weight and quality: Weather conditions were optimal for the period during which the sample population was harvested. Fruit weights are, therefore, the result of what can be deemed for all intensive purposes as an average ripening period, and are not swollen from excessive rain. Total fruit weight of the sample population for single Guyot was 64.64 kg and had a mean weight of 2.15 kg per vine. Total fruit weight for pendelbogen was 65.75kg, and had a mean weight per vine of 2.19kg (see Fig. 6).

Must analysis shows a slight advantage to vines on single Guyot with specific gravity at 1.080 and total acidity at 13.08, while pendelbogen only showed a 1.076 specific gravity and a total acidity of 14.15, with pH at 3.00 for both systems.

The botrytis test was performed on must samples taken prior to sulphuring as this will have a direct affect on the outcome of the assay. Incidents of botrytis were recorded in the field on the infected bunches and had a number of 47 (9.9%) for single Guyot, and a number of 101 (20.7%) infected bunches for pendelbogen.

	Fruit weight		**Must Quality**			**Botrytis infection**		
	Total kg	**Mean kg**	**SPG**	**TA**	**pH**	**incidence**	**%**	**ELISA value**

Single Guyot	64.64	2.15	1.080	13.08	3.00	47	9.9	2
Pendelbogen	65.75	2.19	1.076	14.15	3.00	101	20.7	4

Fig.6. Showing the results of the fruit quality test including: weights, must analyses and disease infection.

The colour chart accompanied with the ELISA kit gives arbitrary botrytis units in order to make a quantitative estimate of the fungal antigen present in the must. The values assigned are from 2-128 and represent increasing relative concentrations only. The kit, therefore, does not give the exact amount per volume, but a value for increase over a standard known concentration. The must from pendelbogen trained vines showed a value of fungal antigens twice that as those from the single Guyot vines.

Discussions

Culture systems do affect the outcome of canopy density and distribution with the additional affect their microclimates have on fruit composition and ripening (Baigorri, 2001). While different culture systems are adapted for different needs, the sample vines on single Guyot have additional problems associated with its use.

With regard to solving the problem of uneven growth, there does seem to be some improvement on the distribution of growth across the cane on the pendelbogen system. Shoot diameters for single Guyot have a 0.65cm mean at their smallest and 0.98cm mean at their largest, giving a 0.33cm mean discrepancy in shoot diameters across the cane.

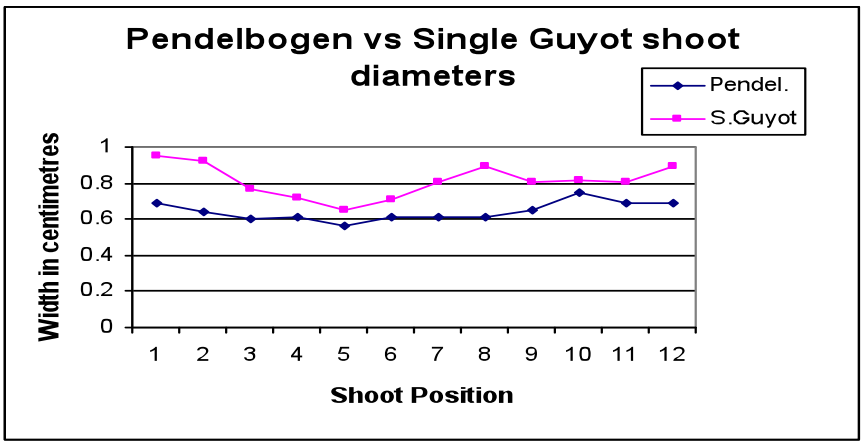

Fig 7. Showing the advantage of pendelbogen over single Guyot with regard to distribution of growth across the cane

Pendelbogen has only a 0.14cm mean discrepancy in shoot diameters across the cane and is therefore showing a 51% better spread towards even shoot distribution (see Fig. 7).

Canopy density is problematic as it is far too dense on both systems; however, pendelbogen is showing a better cluster exposure with less interior clusters recorded. Pendelbogen is exposing the fruit better, but not necessarily improving bunch distribution. As mentioned in Muller (2000) one disadvantage to the pendelbogen system is the poor leaf/fruit ratio. This may be one of the side affects to the system in place at the sample vineyard.

Bunch distribution is more even across the single Guyot trained vines then it is across the pendelbogen. The means are identical for bunch numbers per shoot over the two systems at 1.52 per shoot, however the distribution is leaning towards the shoots at the end of the pendelbogen cane at 2.6 bunches per shoot (see Fig. 5). This is a curious figure when we consider that even shoot growth distribution is actually improved on the pendelbogen system. This begs the question of whether shoot growth has a role in bunch numbers and their distribution.

From all the quality tests performed, there are three notes of interest. The yield was slightly greater in favour of vines on pendelbogen, where the projected mean improvement overall is 0.4 tons of increased yields. This is subject to the figures for the 2005 vintage only and suggests that yields may be increased by 1% over the total annual yield if the entire Chardonnay vineyard was converted to the pendelbogen system in the future.

	Mean per Vine kg	**Total Vines**	**Mean Total Yield kg**
Pendelbogen	2.19	10000	21900
Single Guyot	2.15	10000	21500

21500 / 21900 = 0.98% or 1% increased yield over single Guyot

Must weights were not particularly better when samples from the two systems were compared. Single Guyot had a distinct advantage over the pendelbogen at 1.080 versus 1.076 specific gravity. It is no longer possible to explain this away as a direct result of the leaf to fruit ratio common with pendelbogen systems as suggested by Muller (2000). Where it is thought that increased leaf area is impacting on fruit exposure

is contradicted by the canopy density trials that have pendelbogen with a low value for interior clusters at 26%, well within Smart's (1992) optimum level of 40%. In fact this data suggests that pendelbogen has very good fruit exposure, better then single Guyot, but yet a lower must weight has been achieved.

Another aspect of quality to be considered is the higher incidents of disease on the pendelbogen vines. Botrytis has twice as high an incidence over the single Guyot vines suggesting that the problem is probably related to the culture systems in use. This may be explained by the distal shoots growing into the adjacent crown and causing increased density and crowding making it more susceptible to disease.

Conclusions

Overall canopy distribution is marginally better on the pendelbogen culture system, but no real quality advantage has been gained. In fact, single Guyot has produced slightly better must weights and significantly less disease infected fruit. Jackson's EPP principle has been moderately improved with the use of the pendelbogen culture system on chardonnay vines while the arched canes have effectively helped to control the uneven shoot distribution. That EPP has a direct negative impact on fruit quality is inconsequential, and does not support the cost of converting the remaining chardonnay blocks onto the pendelbogen system.

This is an edited version of the complete study. Contact james@vine-works.com for a copy of the complete study

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