

## Vegetative growth of grapevine varieties under controlled temperature and light intensity

by

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### Introduction

Some growth responses of the variety Muscat Gordo Blanco, when maintained for up to 3 months in growth cabinets using combinations of three temperatures and three light intensities, have been described (3). It was not known whether the response of Gordo was typical of the cultivated varieties of *Vitis vinifera*. In order to obtain some information on this question, four additional varieties have now been maintained under a range of temperature and light intensity, and some growth parameters of all five varieties are compared in this paper.

### Materials and Methods

The varieties of grape-vine (*V. vinifera* L.) investigated were:

1. Muscat Gordo Blanco (syn. Muscat of Alexandria)
2. Rhine Riesling
3. Shiraz (syn. Syrah)
4. Ohanez (syn. Almeria)
5. Sultana (syn. Sultanina, Thompson Seedless).

These varieties include three normally grown only in warmer areas (Gordo, Sultana, and Ohanez), and one which is widely grown in cooler areas (Rhine Riesling). Shiraz may be regarded as intermediate in distribution.

Plants were established from dormant hardwood cuttings and maintained in growth cabinets as described previously (3). In brief, after adventitious roots were established, the cuttings were placed in growth cabinets, set at 25° C, until budburst. Environmental conditions for an experiment were set at budburst and plants grown for 13 weeks thereafter. At 9 weeks measurements were made of main-shoot length and node number, and of length of primary laterals. At 13 weeks plants were harvested and dry weights of leaves, stem and roots measured. For Gordo and Sultana there were 20 replicates (plants) for each environmental condition, and for the remaining three varieties there were 8 replicates for each.

### Results

a) Dry weights. Effects of temperature: Results are shown in Fig. 1. At 15° C there was little difference between the three varieties examined, and by extrapolating it can be concluded that growth would have been close to zero at about 13° C. Gordo, Shiraz and Sultana attained maximum dry weight at approximately 20° C, whereas Rhine Riesling and Ohanez had attained only one half to two thirds their maximum at that temperature, and reached a maximum close to 25° C. Gordo, Shiraz and Sultana maintained a dry weight close to their maxima over the range 20° C—35° C, and Rhine Riesling over the range 25° C—35° C.

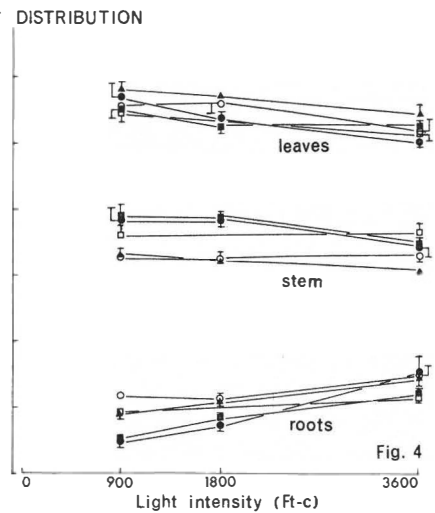
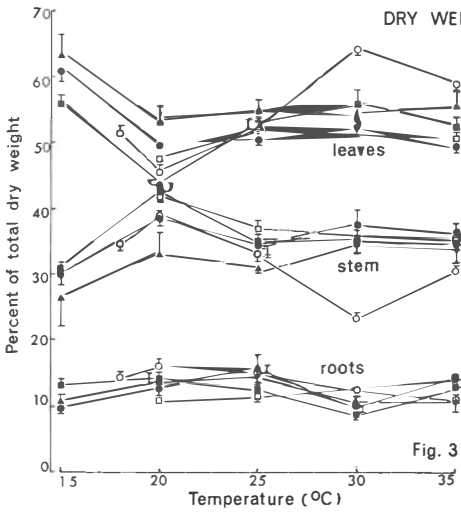
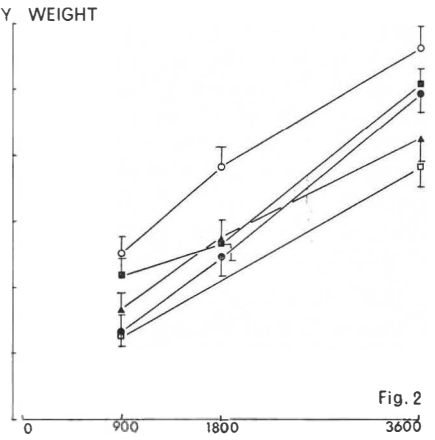
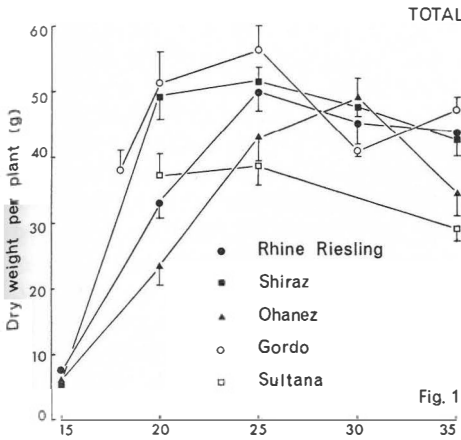


Fig. 1—4: Effect of temperature (Fig. 1) and light intensity (Fig. 2) on mean dry weight per plant (g); and effect of temperature (Fig. 3) and light intensity (Fig. 4) on the proportional distribution of dry weight between leaves, stem and roots. Data obtained at 13 weeks after budburst. Symbols listed in Fig. 1 have been used throughout. Vertical bars equal  $1 \times$  standard error of the mean.

The distribution of dry weight between leaves, stem and roots, as affected by temperature, is shown in Fig. 3. The proportion of total dry weight due to roots was similar for each variety, ranging from 10% to 14%, and it was not affected by temperature. The proportion due to leaves (for those varieties grown below 20° C) fell with increasing temperature up to 20° C, and there was a corresponding rise in the proportion due to stem. There were some fluctuations in dry weight distribution between 20° and 35° C, notably at 30° C with Gordo. Comparing the five varieties with each other, it was found that Ohanez had the strongest tendency to accumulate dry weight in leaves rather than stem or roots; that Gordo and Shiraz were least "leafy" at low temperatures and most "leafy" at high temperatures; and Rhine

Riesling was relatively "leafy" at low temperatures and was least "leafy" at high temperatures.

b) Dry weights. Effects of light intensity: Dry weight in all varieties increased proportionally with increase in light intensity (Fig. 2). Distribution of dry weight between the three organs is shown in Fig. 4. There was a general tendency for the root value to rise with increase in light intensity. This increase was compensated for, in the cases of Gordo, Ohanez and Sultana, by a fall in the proportion of dry weight due to leaves, and, in the cases of Rhine Riesling and Shiraz, by a fall in the value for stem. Ohanez was most "leafy" at all intensities; Rhine Riesling changed from being secondmost "leafy" at 900 f. c. to least "leafy" at 3600 f. c.

c) Main shoot length: Responses to temperature are shown in Fig. 5. Shiraz shoots increased in length more rapidly at 20° C than the other varieties, and there was maximum shoot lengths at 25° C, but Rhine Riesling and Ohanez reached maxima at about 30° C. The response, in respect of total plant dry weight (Fig. 1), of the dif-

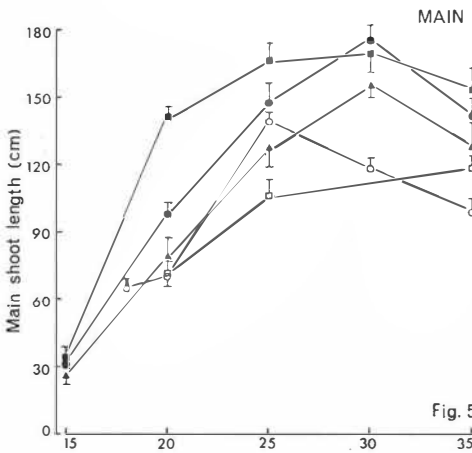


Fig. 5

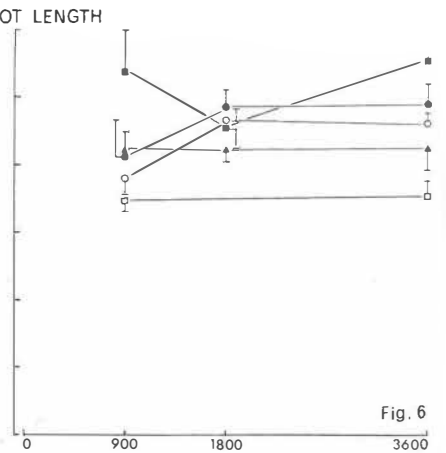


Fig. 6

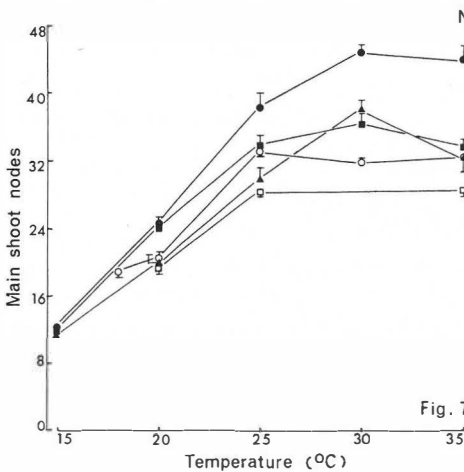


Fig. 7

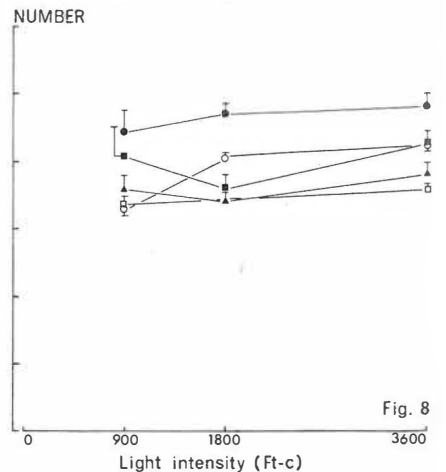


Fig. 8

Fig. 5—8: Effect of temperature (Fig. 5) and light intensity (Fig. 6) on main shoot length (cm); effect of temperature (Fig. 7) and light intensity (Fig. 8) on node number per main shoot. Symbols and vertical bars as for Fig. 1.

ferent varieties to temperature was, on the whole, similar to the response in respect of main shoot length (Fig. 5), except for Gordo. The increase in weight per unit length of shoot, resulting in short, thick shoots, at 20° C, as compared with higher less effect of temperature over the range 20°—35° C. Gordo and Shiraz attained temperatures, has already been described for Gordo (3). The present results indicate that this may not be typical of grape-vine varieties.

Light intensity had little effect on main shoot length (Fig. 6). The low value at 1800 f. c. for Shiraz does not differ significantly from those at the other intensities.

d) Number of nodes on the main shoot: Values at 9 weeks after budburst, as affected by temperature, are shown in Fig. 7. There were approximately 12 nodes at 15° C, and as buds of grape-vine normally have 8—12 leaf primordia (2), shoot growth at 15° C was little more than expansion of these pre-existing nodes. For each variety the node number increased steadily up to 25° C, at which temperature Gordo and Shiraz had attained maximum values, which were maintained up to 35° C. The node number for Ohanez and Rhine Riesling reached a maximum closer to 30° C, and in the case of Ohanez the number fell beyond 30° C. Details for Sultana at 30° C are not available. Rhine Riesling had the greatest node number at all temperatures, especially at 30° C and 35° C, and by calculating mean internode lengths (Fig. 5 cf. Fig. 7) it was found that this variety had the shortest internodes. By contrast, Shiraz had long shoots and a medium node number, due to the characteristic long internodes of this variety. Sultana had the fewest nodes at each temperature examined.

Light intensity had little effect on node number, except that there was a general tendency for an increase with increasing light (Fig. 8). Rhine Riesling had the largest number of nodes at each intensity.

e) Mean length of primary laterals: Temperature effects are illustrated in Fig. 9. At 15° C the few laterals present were short for each variety examined. At temperatures above 15° C the varieties fell into three groups. Gordo and Rhine Riesling had short laterals up to 30° C, the length remaining more or less steady with rise in temperature; at 35° C both varieties had much longer laterals. Ohanez and Shiraz showed a steady increase in lateral length with increasing temperature over the whole range 15°—35° C. Sultana similarly showed a steady increase between 20° C and 35° C, but throughout, its laterals were considerably longer than those of the other varieties.

Light intensity had no significant effect (Fig. 10) but the same grouping was evident as for temperature. Thus Gordo and Rhine Riesling had short laterals at each intensity, Ohanez and Shiraz had longer laterals, and Sultana had the longest laterals at the intensities examined.

f) Day length: Some daylength effects were studied with four of the varieties, and results are presented in Table 1. The 16-hour-day data have already been presented (Fig. 1). Reducing daylength from 16 hours to 8 hours approximately halved Gordo and Ohanez dry weights, reduced Shiraz weight to approximately one-third, and Rhine Riesling to one-sixth. Thus Gordo and Ohanez increased in dry weight in proportion to the amount of light energy received as day length increased, whereas Rhine Riesling increased disproportionately and Shiraz fell in between. If 16 hours light was given with a 4-hour dark interruption at 12 hours, Gordo and Ohanez behaved as for 16-hours uninterrupted, whereas Shiraz and Rhine Riesling were adversely affected. The effect of increasing daylength above 16 hours was investigated only at 900 foot candles. In no case did the increase in daylength from 16 to 24 hours result in a significant increase in dry weight.

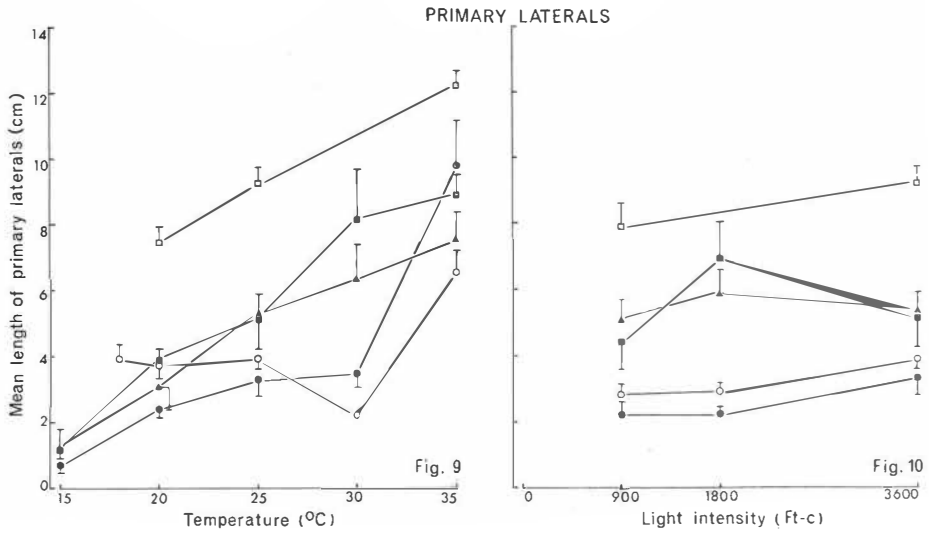


Fig. 9—10: Effect of temperature (Fig. 9) and light intensity (Fig. 10) on mean length of primary laterals (cm). Data obtained at 9 weeks after budburst. Symbols and vertical bars as for Fig. 1.

### Discussion

In response to changes in light intensity, all five varieties behaved similarly regardless of the parameter measured. In response to changes in temperature, there were some varietal differences. For instance, in terms of dry weight accumulation, both Ohanez and Rhine Riesling performed relatively poorly at 20° C compared with higher temperatures; whereas the other varieties performed relatively well. Gordo was the only variety that responded to 20° C by developing short thick stems, compared with longer thinner stems at all higher temperatures. Shoot extension of Shiraz was much superior to that of the remaining four varieties at 20° C, and both Shiraz and Gordo had a lower temperature optimum for shoot growth than the other varieties. In general, however, the five varieties responded similarly in showing little growth below 15° C, in achieving optimum growth at approximately 25° C, and in their tolerance of temperatures up to 35° C.

Table 1

Mean dry weight (g) of plants (leaves + stem + roots), and associated standard errors, at 13 weeks after bud burst under temperature conditions of 25° C for 16 hours and 20° C for 8 hours

Light regime	Gordo	Ohanez	Rhine Riesling	Shiraz
3600 f. c., 8-h days	26.0 ± 2.5	20.9 ± 1.4	8.1 ± 0.7	18.7 ± 2.0
3600 f. c., 16-h days	56.2 ± 3.7	42.7 ± 4.1	49.5 ± 2.8	51.1 ± 2.3
3600 f. c., 12 h/dark 4 h/ 3600 f. c., 4 h/dark 4 h	59.0 ± 2.1	35.8 ± 2.9	29.1 ± 3.1	35.5 ± 2.1
900 f. c., 16-h days	25.3 ± 2.6	16.8 ± 2.4	13.3 ± 2.7	22.1 ± 2.9
900 f. c., 24-h days	31.8 ± 4.7	16.1 ± 2.0	17.6 ± 2.4	27.3 ± 3.5

ALLEWELDT (1) has already described the response of vegetative growth of Riesling to daylength. This variety showed some response, but it was relatively tolerant to short-day treatment compared with *Vitis riparia* material. It is now clear that, over a daylength range of 8—16 hours, there is a range of short-day tolerance amongst grape-vine varieties, from tolerant (Gordo) to intolerant (Rhine Riesling). In respect of vegetative growth, an intolerant variety, like Rhine Riesling, could be at a disadvantage in low latitudes, with relatively short days, compared with high latitudes. However effects of light intensity and temperature on the daylength response have not been investigated here; under field conditions they could be operative.

Two conclusions, drawn from the earlier results with Gordo alone, are confirmed by the present results with four additional varieties. First, the ratio of root weight to shoot weight in these young plants remained constant with widely differing environmental conditions, which had large effects on whole plant growth. Secondly, despite changes in light intensity, there was a remarkable constancy in shoot extension, in node number and in lateral growth. Only dry weights responded to changes in light intensity. Thus, with a reduction in light intensity, stems tend to become thinner but are otherwise unchanged.

### Summary

Five commercial grape-vine varieties (Muscat Gordo Blanco, Rhine Riesling, Shiraz, Ohanez and Sultana) have been grown from rooted cuttings in controlled environment growth cabinets for 3 months. Measurements were made, after growth at different light intensities or temperatures, of plant dry weight, shoot length, node number and lateral growth. All varieties responded similarly to light intensity; only dry weights were affected by changes in light intensity. In respect of temperature, no variety grew well below 20° C, most reached optimum growth at about 25° C, and all tolerated temperatures up to 35° C very well. There were some minor differences between varieties. In respect of daylength, there was a range in short-day tolerance from Rhine Riesling (relatively intolerant) to Muscat Gordo Blanco (tolerant).

### Acknowledgment

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