Growth Characteristics of *Vitis vinifera* L. cv. Cape Riesling

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The effect of topping on the growth behaviour of *Vitis vinifera* L. cv. Cape Riesling vineyard was investigated. Shoot and leaf growth of both topped and untopped vines, can be described as sigmoïdal. Shoot (cm) and leaf growth (cm^2) of the topped vines were significantly more than that of the untopped vines and are attributed to lateral shoot growth. Topping had no effect on bunch development. The development of skin, pulp and seed of both topped and untopped vines expressed as a percentage dry mass per berry can be described by a hyperbolic function for the skin, linear for the pulp and parabolic for the seed.

Growth has been defined as "the advancement towards or attainment of full size or maturity; development: a gradual increase in size and the process whereby plants and animals increase in size by taking in food" (Bidwell, 1974; Salisbury and Ross, 1978). Growth may be evaluated by measurements of mass, length, height, surface area or volume (Noggle and Fritz, 1976). Growth curves of plants are generally sigmoïdal (Bidwell, 1974; Noggle and Fritz, 1976; Salisbury and Ross, 1978) although double and triple sigmoïds have been reported (Pratt and Reid, 1974; Coombe, 1976). Sigmoïds and double sigmoïds have been described for shoot growth and berry development for *Vitis* spp. and cultivars (Coombe 1960; 1973; 1976; 1980; Nitsch *et al.*, 1960; Hale, 1968; Harris, Kriedemann and Possingham, 1968; Coombe and Hale, 1973; Kliewer and Schultz, 1973).

Removal of the apical 25 cm or more of the growing shoot tip is called topping (Winkler, *et al.*, 1974) and is normally recommended to inhibit growth of vigorously growing shoots and to induce uniform and upright growth (Theron, 1944). By removing 25 cm of the shoot tip, apical dominance is removed, resulting in the development of lateral shoots.

Results obtained in the northern hemisphere indicate that the juvenile leaves of the lateral shoots are the major sinks for nutrients (Hale & Weaver, 1962; Koblet, 1977) but after two to three leaves have matured, basipetal translocation of nutrients takes place (Koblet & Perret, 1971; 1972).

It is important that only vigorously growing vines should be topped because poor growth will be further aggravated by the effect of topping (Malan, 1935; Theron, 1944). The timing and severity of topping are very important because the removal of photosynthetically active leaves at the wrong time will result in insufficient grape nourishment. Le Roux & Malan (1945) and Coombe (1959) reported that repeated topping (three to four times or more during one season) decreased berry mass. Similarly El-Zeftawi & Weste (1970) found that a drastic decrease in leaf area usually causes a loss in berry mass and sugar concentration.

Since 1945 no research work on the effect of topping on the vine was reported in South Africa. It is therefore important that the effect of topping on the vine under South African climatic conditions should be investigated. The aim of this investigation was to determine the effect of topping on the growth characteristics of *Vitis vinifera* L. cv. Cape Riesling.

MATERIAL AND METHODS

Material: *V. vinifera* cv. Cape Riesling vines were selected as described by de la Harpe & Visser (1983).

Methods: The selected vines were divided into two groups of 104 vines each. One section was topped by removing the apical 30cm of each shoot of the vine at pea berry size (56 days after bud break). For the purpose of this investigation bud break was defined as that stage at which 10 % of the shoots had two leaves. Topping was done at pea berry size to ensure that the treatment was applied before the rapid growth phase of the shoot. The other group was left untopped. Ten topped and 10 untopped vines were randomly selected and on each the two shoots on the second spur of each cordon were used for determination of shoot length and leaf area. Shoots lengths and leaf areas were determined frequently at irregular time intervals. Leaf areas were determined with a model LI-3000 Li-Cor Portable Area Meter. Four bunches on shoots of the second spur of both cordons of three topped as well as three untopped vines were sampled 69, 76, 82, 92, 97, 110, 117, 131, 138, 145 and 152 days after bud break. These bunches were taken from vines not used for growth measurements.

After all the berries were removed from 12 bunches of the topped and untopped vines sampled at 69, 76, 82, 92, 97, 110, 117, 131, 138, 145 and 152 days after bud break the berries were mixed and 60 berries were used to determine the berry volume by water displacement in a measuring cylinder. The fresh and dry mass of the berry, skin, pulp and seed were determined on these 60 berries. Dry mass was determined by drying at 80°C to a constant mass.

One way analyses of variance were done and regression analyses by a linear Least Squares Curbe fitting programme (Wood & Gorman, 1971).

RESULTS AND DISCUSSION

The vegetative growth phase:

Shoot growth: The mean, total shoot length for the

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untopped vines was 267,8 cm (Fig. 1). Shoot growth started off with a slow elongation rate but the rate increased from 60 days after bud break i.e. shortly after topping (Fig. 2). This sharp increase lasted about three days after which the growth rate dropped to approximately three cm per day and declined steadily until no elongation could be measured at 135 days after bud break.

The mean, total shoot length of the topped vines was 410 cm (Fig. 1) which is significantly more than that of the untopped vines mainly as a result of lateral shoot development. The tendency of the growth curve (Fig. 1) of the topped vines was almost identical with that of untopped vines. Five days after topping the elongation rate increased significantly and reached 37 cm day^{-1} for two days after which it declined sharply to about three cm day^{-1} (Fig. 2). Shoot growth of the topped vines stopped 155 days after bud break in contrast to the 135 days of the untopped vines (Fig. 2).

The growth curve of the untopped vines reported here is very similar to those obtained by Van der Westhuizen (1974), Winkler *et al.*, (1974) and Zelleke & Kliewer (1979).

Leave growth: A total number of 129 leaves per shoot had differentiated on the untopped vines (Fig. 3). A mean of 194 leaves per shoot for topped vines was obtained 134 days after bud break which amounted to a significant increase of 65 leaves over that of untopped vines.

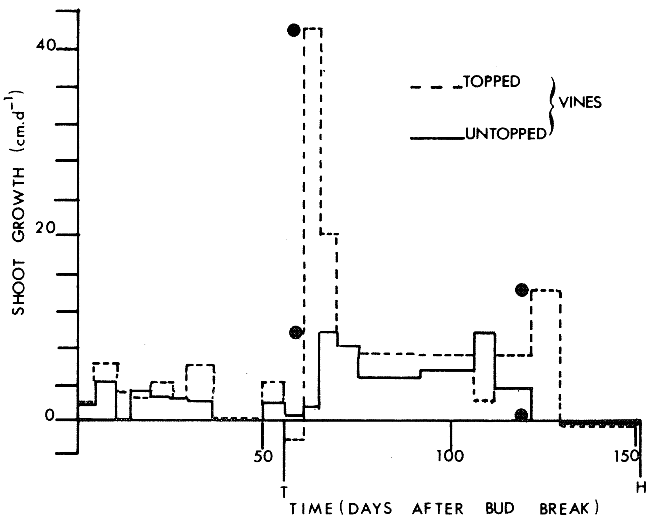

FIG. 2

Daily shoot elongation for topped and untopped *Vitis vinifera* L. cv. Cape Riesling vines. (● significant differences ($P \leqq 0,05$)) in the data set. (T = Time of topping, H = Harvest).

The total leaf area of 4728 cm^2 per shoot for the untopped vines was significantly less than the 7741 cm^2 for the topped vines (Fig. 5). The pronounced burst in shoot growth (Fig. 2) after topping seams to coincide with the decrease in leaf area expansion.

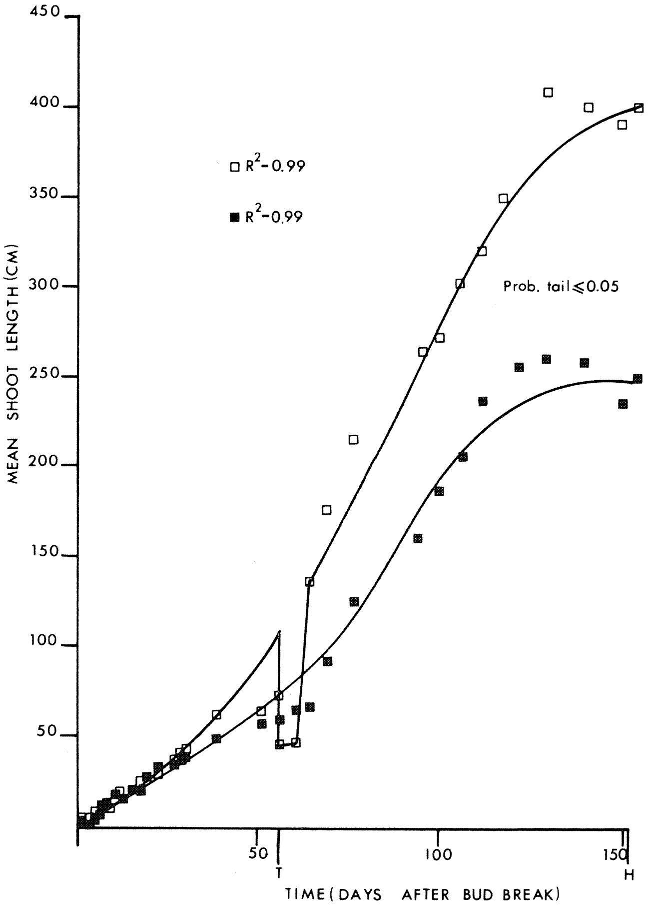

FIG. 1

Fitted curves and observed shoot growth data for topped (□) and untopped (■) *Vitis vinifera* L. cv. Cape Riesling vines. (T = Time of topping, H = Harvest).

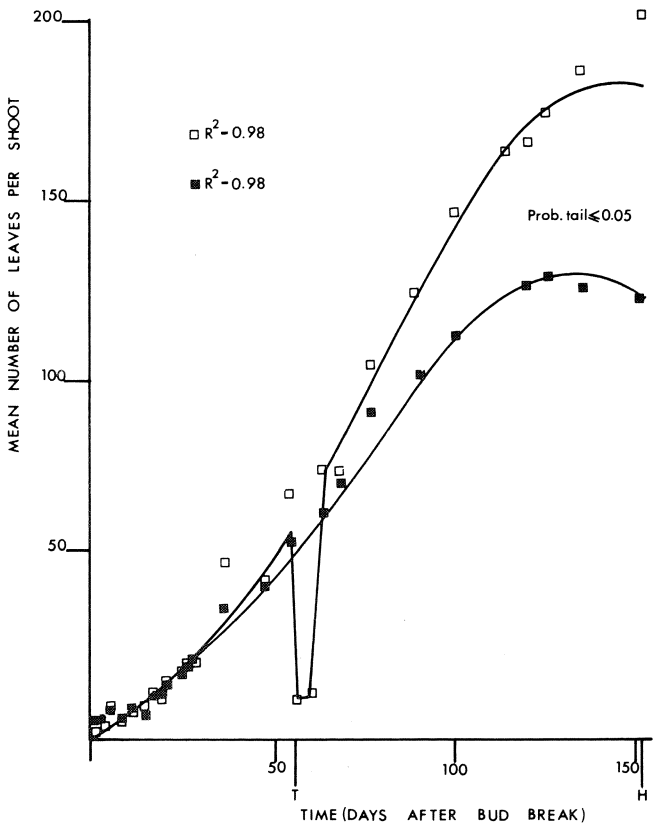

FIG. 3

Fitted curves and observed number of leaves data for topped (□) and untopped (■) *Vitis vinifera* L. cv. Cape Riesling vines. (T = Time of topping, H = Harvest).

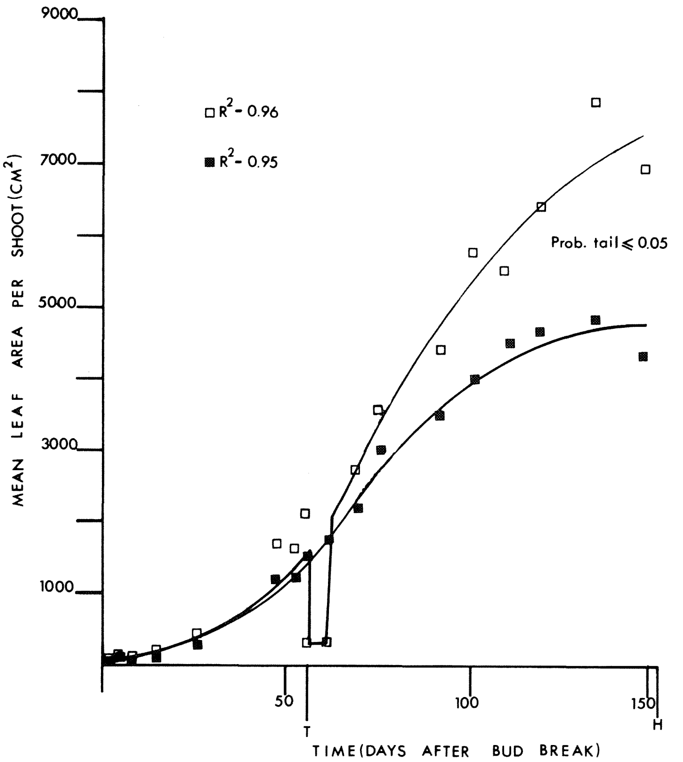

FIG. 4.

Fitted curves and observed leaf area data for the average increase in leaf area from bud break to harvest for topped (□) and untopped (■) *Vitis* 12 *vinifera* L. cv. Cape Riesling vines. (T = Time of topping, H = Harvest).

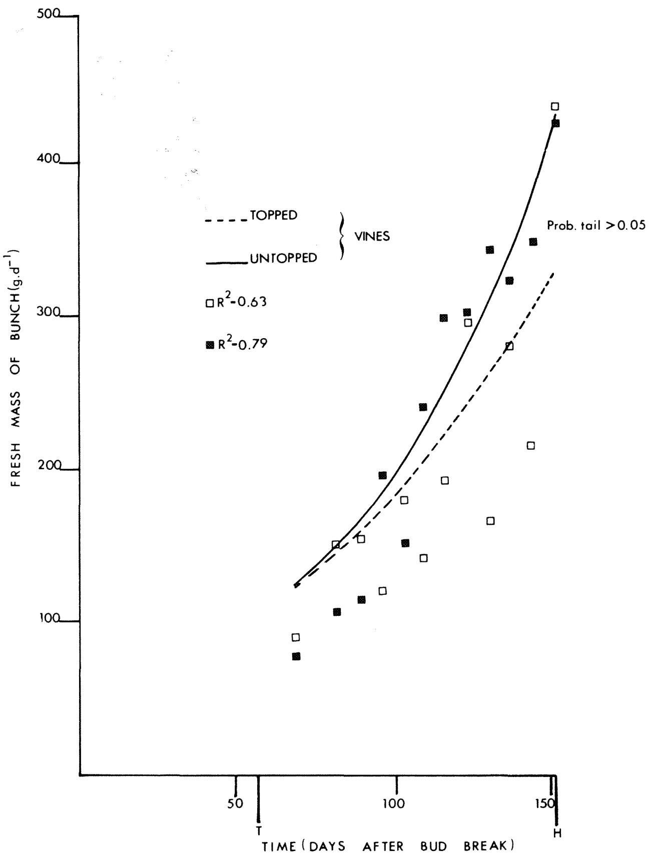

FIG. 6.

Fitted curves and observed data for the increase in mean fresh mass of the bunch from pea berry size to harvest for topped (□) and untopped (■) *Vitis vinifera* L. cv. Cape Riesling vines. (T = Time of topping, H = Harvest).

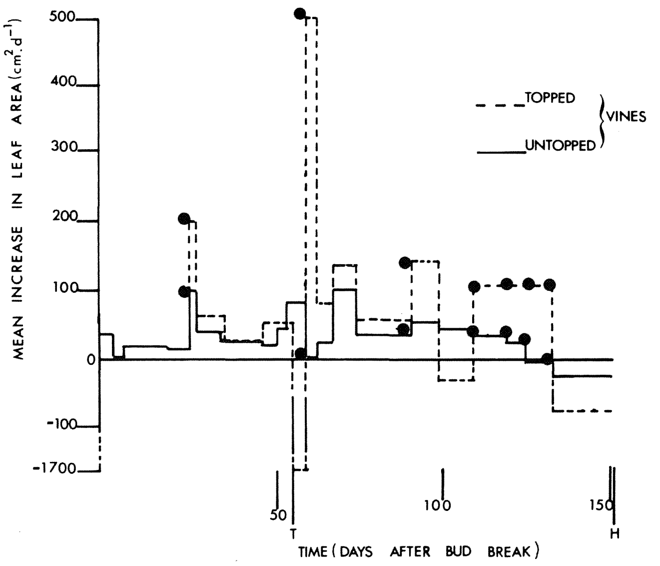

FIG. 5.

Increase in leaf area per shoot per day during the growing season for topped (□) and untopped (■) *Vitis vinifera* L. cv. Cape Riesling vines (● significant differences (P ≦ 0,05)) in the datas set. (T = Time of topping, H = Harvest).

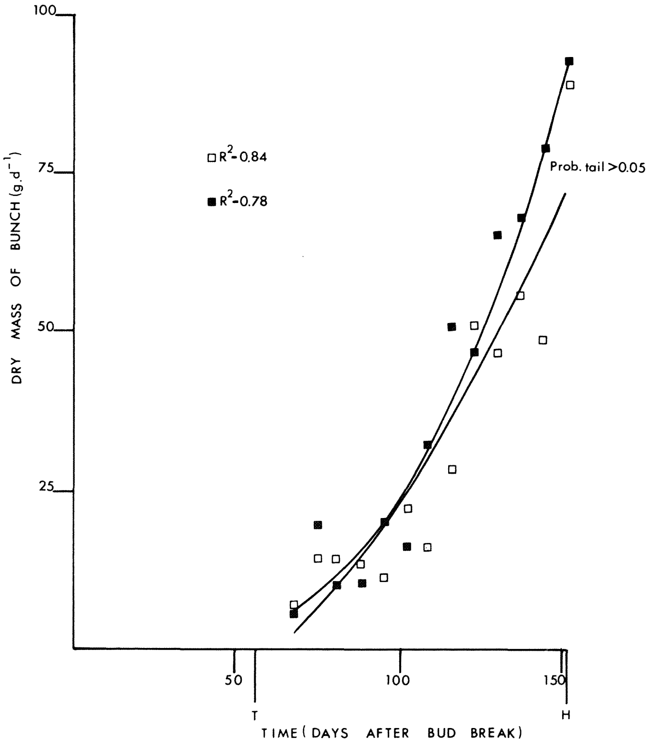

FIG. 7.

Fitted curves and observed data for the increase in mean dry mass of the bunch from pea berry size to harvest for topped (□) and untopped (■) *Vitis vinifera* L. cv. Cape Riesling vines. (T = Time of topping, H = Harvest).

Reproductive growth phase

Bunches: The development of the bunches on topped and untopped vines is shown in Figs. 8 and 9. No statistically significant differences were found between the fresh and dry mass per bunch of topped and untopped vines (Figs. 8 & 9) indicating that topping did not affect bunch development or that variation was so large that the effect of topping was not statistically different.

Berries: Although the fitted curves for the increase in berry volume were linear the actual data points followed a double significant curve (Fig. 11) and could be divided into three stages as described by Coombe (1960; 1973; 1976; 1980), Harris, *et al.*, (1968), Coombe & Hale (1973). The berry volume for both topped and untopped vines was 0,5 cm^3 69 days after bud break, attained a final value of 1,67 and 1,56 cm^3 respectively 152 days after bud break and did not differ significantly.

The dry mass accumulation for the berries of topped and untopped vines was obtained by plotting the accumulated dry mass against time (Fig. 12) and was similar to those reported by Nitsch *et al.*, (1960) for "Concord" and "Concord Seedless", Hale (1968) for "Shiraz", Coombe (1973) for "Doradillo" and Kliewer & Schultz (1973) for "White Riesling", "Cardinal" and "Carigan" grapes. As in the case of "Concord Seedless" grape (Nitsch *et al.*, 1960) the curve of the accumulated dry mass for Cape Riesling was more linear that those reported in the literature with the result that it became difficult to determine the different growth stages. A regression analysis showed a linear fit with R^2 values of 98 % for both the topped and untopped vines. The actual data points, however, showed that up till veraison i.e. 46 days after bud break, little increase in the dry mass of the berry took place. At veraison the berry started rapidly to increase in dry mass which is attributed to the rapid sugar accumulation occurring from veraison to harvest. Topping had no statistically significant effect on the dry mass of the berries of either topped or untopped vines.

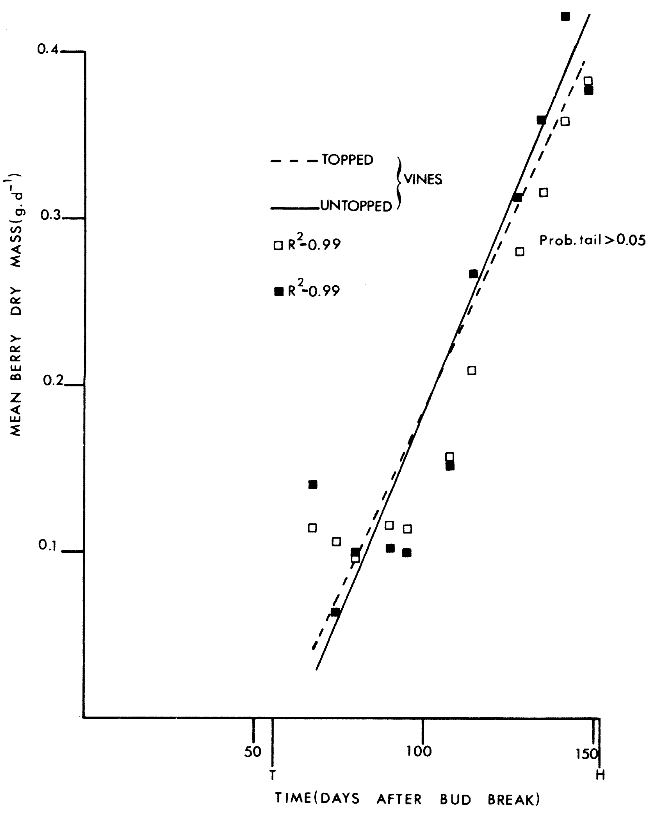

FIG. 9.

Fitted curves and observed data for the average dry mass per berry from pea berry size to harvest for topped (□) and untopped (■) vines. T = Time of topping, H = Harvest).

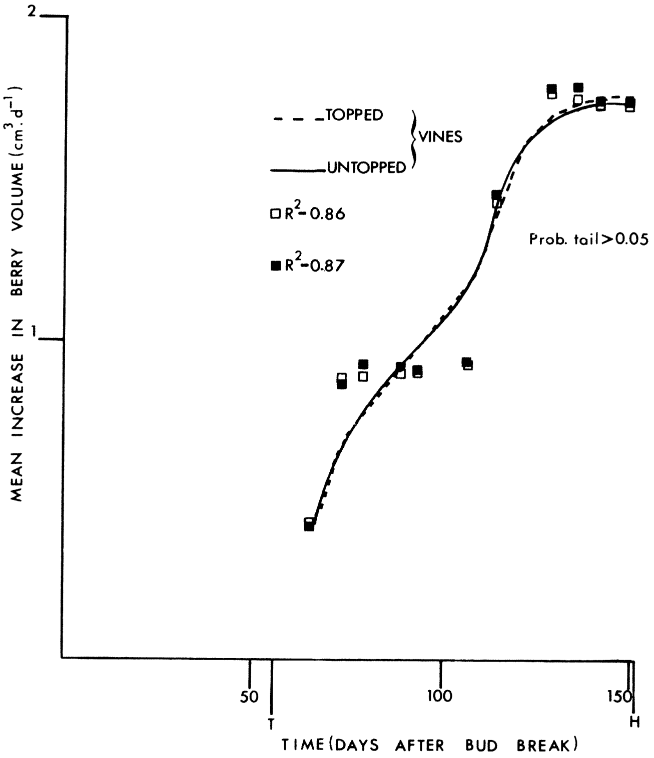

FIG. 8.

A double sigmoid curve of volume versus time expressed on a cumulate basis for topped (□) and untopped (■) *Vitis vinifera* L. cv. Cape Riesling. (T = Time of topping, H = Harvest).

Although the R^2 values for the regression analyses done on the dry mass accumulation of the skin, pulp and seed, were high (Figs. 13, 14, 15) the data points showed the trend expected on biological grounds namely, little increase until veraison followed by a sharp rise till harvest. No statistically significant differences were found between topped and untopped vines for three components. During the early stages of the growth cycle the skin contributed more than the pulp and seed to total berry mass for both topped and untopped vines (Figs. 13, 14 & 15.).

When expressed as a percentage of the dry mass of the berry, the dry mass of the skin declined for more or less 100 days after bud break before a constant dry mass was obtained. In contrast the dry mass of the pulp increased throughout the season. The seed, however, increased in dry mass for more or less 100 days after bud break but then decline till harvest (Figs. 13, 14 and 15). This conspicuous change in skin and seed dry mass accumulation might coincide with chemical changes in the berries at that time of the season. These chemical changes i.e. a sugar concentration increase and an acidity decrease are defined as veraison.

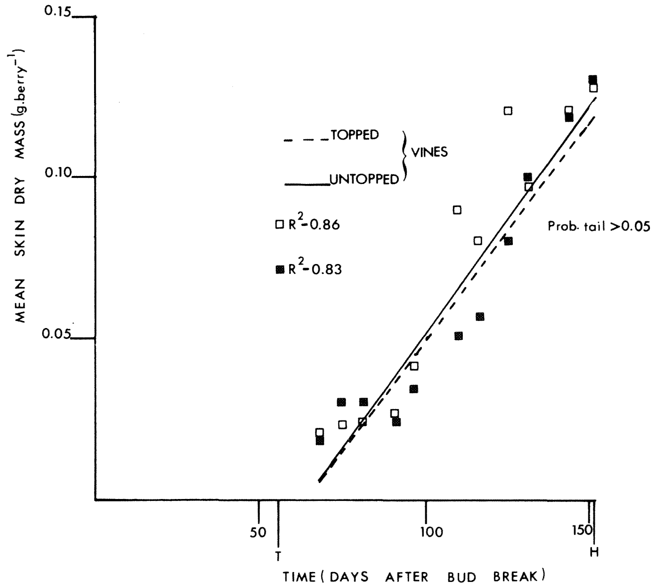

FIG. 10.

Fitted curves and observed data for the average dry mass per berry skin from pea berry size to harvest for topped (□) and untopped (■) vines. (T = Time of topping, H = Harvest).

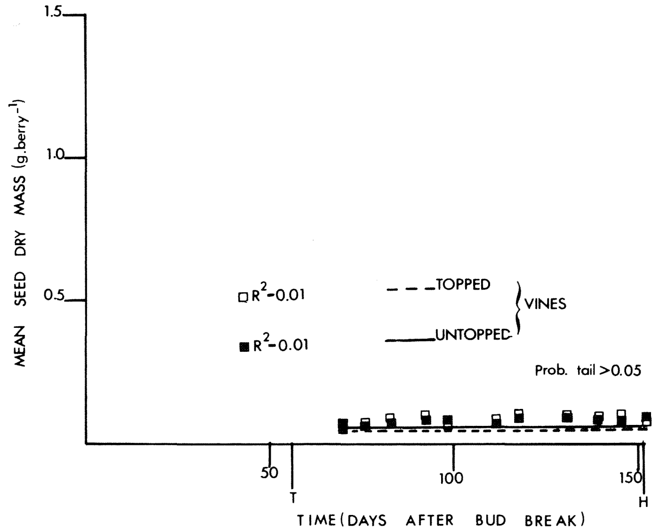

FIG. 12.

Fitted curves and observed data for the average dry mass per berry seed from pea berry size to harvest for topped (□) and untopped (■) vines. (T = Time of topping, H = Harvest).

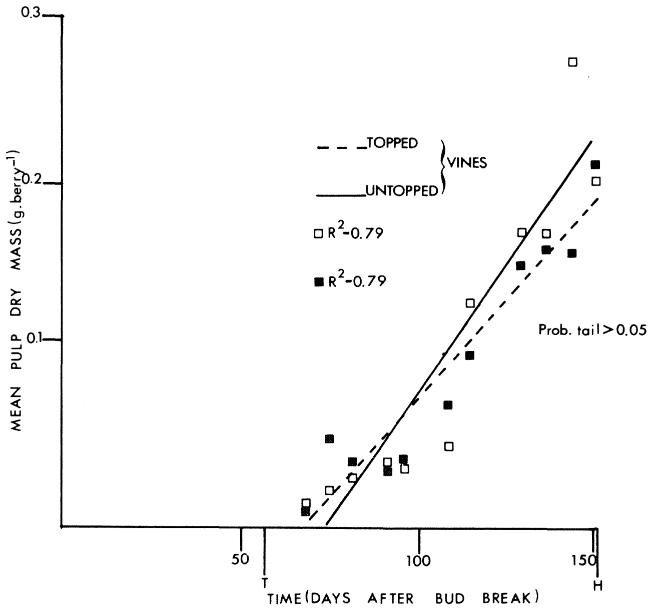

FIG. 11.

Fitted curves and observed data for the average dry mass per berry pulp from pea berry size to harvest for topped (□) and untopped (■) vines. (T = Time of topping, H = Harvest).

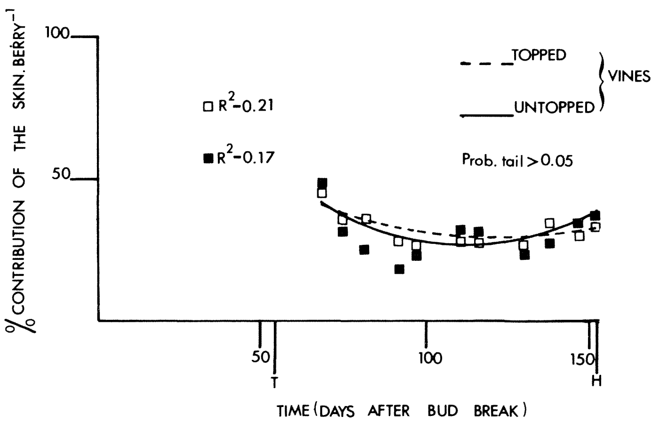

FIG. 13.

Fitted curves and observed data for the percentage contribution of the skin to the dry mass of the berry for topped (□) and untopped (■) vines (T = Time of topping, H = Harvest).

SUMMARY AND CONCLUSION

The shoot and leaf growth of *V. vinifera* cv. Cape Riesling can be described as sigmoïdal. Significant differences were found between topped and untopped vines as far as rate of shoot and leaf growth is concerned. In the case of topped vines larger shoot and leaf development can be attributed to lateral shoot growth, enlarging the leaf area and resulting in a different leaf canopy.

Topping had no measurable effect on bunch development. The berry development is sigmoïdal as far as volume and linear as far as dry mass is concerned. The skin, pulp and seed development is linear in function although the actual data points showed biphasic growth and no statistical differences were found between topped and untopped vines concerning these parameters.

Vegetative growth is stimulated by a single topping of the vineyard early in the season, while no effect is found

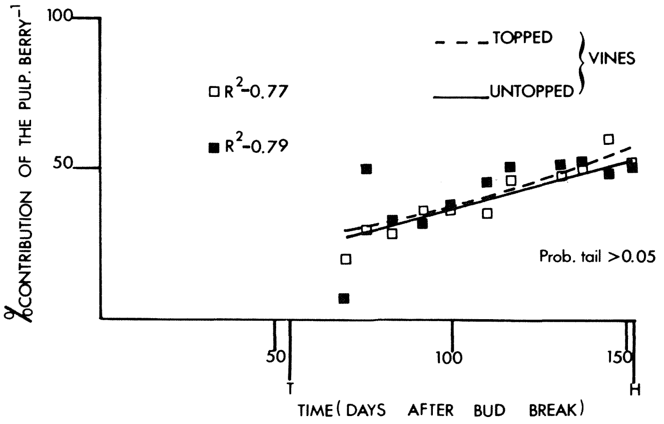

FIG. 14

Fitted curves and observed data for the precentage contribution of pulp to the dry mass of the berry for topped (□) and untopped (■) vines (T = Time of topping, H = Harvest).

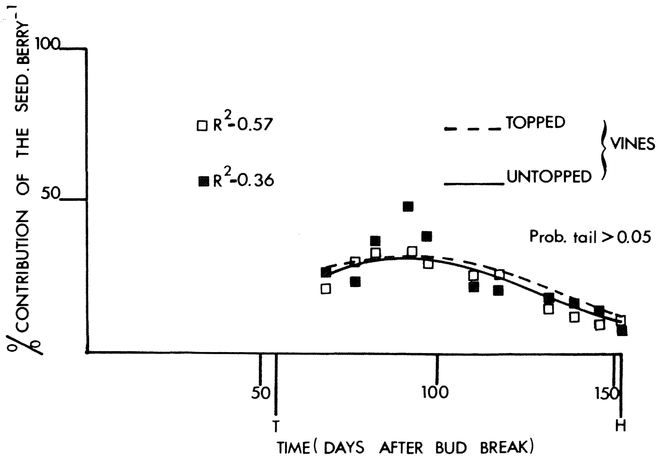

FIG. 15.

Fitted curves and observed data for the percentage contribution of the seed to the dry mass of the berry for topped (□) and untopped (■) vines (T = Time of topping, H = Harvest).

on the reproductive growth of the vines. This implies that a single topping of vineyard has no effect on crop size but does not exclude changes that may effect wine quality. These results are only valid for one season. Further studies in the following season showed that although real values obtained i.e. shoot growth, leaf area, berry volume and dry mass, differ (data not shown), the developmental tendency are still the same. These results obtained in this study are in harmony with results found in literature.

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