Vitis, 11, 131—134 (1972)

Department of Botany and Plant Pathology, Punjab Agricultural University, Ludhiana, India

Studies on the characterisation of physiological sink in Anab-e-Shahi grapes (Vitis vinifera L.)

by

O. S. Singh and V. K. Sharma

Untersuchungen zur Charakterisierung des physiologischen „sink" bei Vitis vinifera „Anab-e-Shahi"

Zusammenfassung. — Bei der Rebsorte Anab-e-Shahi wurden für Trauben unterschiedlicher Größe die Anzahl der Gefäßbündel und die Phloemfläche in den Querschnitten der Traubenstiele bestimmt. Die Anhäufung von Trockensubstanz in den Trauben hing von der Beerenzahl und dem Gesamtquerschnitt des Phloems ab. Zur Zeit der vollen Blüte angewandte Gibberellinsäure steigerte das Traubengewicht durch Vergrößerung der Beeren. Bei den Gibberellinsäure-behandelten Trauben wurde eine Korrelation zwischen Traubengewicht und Gesamtquerschnitt des Phloems festgestellt. Die Zunahme des Traubengewichtes hing ab vom gesamten Phloemquerschnitt und der Höhe des Trockensubstanztransportes nach den sich entwickelnden Beeren.

Introduction

The quantitative yield of crops chiefly consists of storage organs, i. e., fruits, seeds, tubers etc., which provide a physiological sink to accumulate the photosynthate and depends on the pathways through which the assimilates are promulgated to the storing region (Watson 1968). Grape-vines produce abundant foliage to synthesize the organic substances which are to be translocated through the stem to meet the needs of developing berries. Moreover, the size of the clusters and berries may be significantly improved by certain cultural practices like ringing and girdling (Weaver and Pool 1965). It has also been well documented that a GA_3 application at bloom and fruit set stages stimulates the berry enlargement in seedless grapes (Weaver and Pool 1971, Kasimatis *et al.* 1971). Seeded berries of Anab-e-Shahi grapes also respond to GA_3 application (Nijjar and Bhatia 1969). There exists a possibility that the capacity of the vascular system to transport the assimilates from the foliage might be a limiting factor for berry development in the grapes. The present investigation envisages the prelimanary reports to qualify, (1) the relationship between the transport of photosynthates and sink capacity of the berries to accomodate them, and (2) the co-ordination between the phloem area and the extent of rate at which organic substances are to be translocated by the clusters.

Materials and Methods

Experiment 1

(a) Maintenance of varying levels of physiological sink

Sink capacity in terms of variable number of berries per cluster was manipulated on vines by preferential selection. Five year old vines of Anab-e-Shahi grapes of uniform vigour were selected from the Punjab Agricultural University Orchard, Ludhiana in 1971. The vines were trained to the Vower system and were pruned in first week of February, when still dormant. Prebloom stage commenced on 5th April, 1971, and full bloom stage coincided with 80—90 percent flower opening on 8th April, 1971. After setting of the berries, when abscission of fruitlets ceased, 30 clusters accommodating the required number of berries in each cluster i. e., 30, 60, 90, 120, 150, 180, 210, 240, 270 and 300 ± 5, were rigorously selected and tagged. Five clusters from each group were randomly harvested at intervals of 7 days starting after berry setting. The period for maximum rate of dry matter transport to the berries was worked out by measuring the dry matter accumulation rate of the berries.

(b) Anatomical studies

From the basal portion of the peduncle — 5 cm below the junction region of the cluster on the stem — a 2 cm long piece from each replicate at each observation was preserved in formalin-acetic acid-alcohol (FAA). Cross sections from these pieces were cut and double stained in safranin — fast green combination, using xylene as a clearing agent. The outline of the phloem in all the vascular bundles in the cross section was drawn using a lucida camera at 100×. The phloem area was determined by using a sensitive planimeter. The photomicrographs were taken with a 35 mm camera attached to the microscope with an adapter.

Experiment 2

Effect of GA_3 on berry development

Flower clusters of uniform size were selected for GA_3 treatment. Ten randomly selected clusters at full bloom stage were dipped for a moment in each concentration of GA_3, i. e., 10, 20, 40, 60, 80 and 100 ppm. There were 5 replicates in each treatment. Clusters from all the treatments were harvested 40 days after the fruit set when they had attained full growth. The basal region of the peduncles was used for anatomical studies and the fresh and dry weights of clusters were recorded under each treatment.

Results and Discussion

A linear relationship existed between number of berries, dry matter accumulation per bunch, number of vascular bundles per cross section area of the peduncle and total phloem area per cross section (Fig. 1). An increase in the dry weight of the cluster, mainly by virtue of the organic substances imported through the peduncle, seemed to be interrelated with the size of the total area of the phloem and the number of berries per cluster. Dry matter accumulation (rate of mass transfer per unit area per unit time) in Anab-e-Shahi grapes varied from 0.110 to

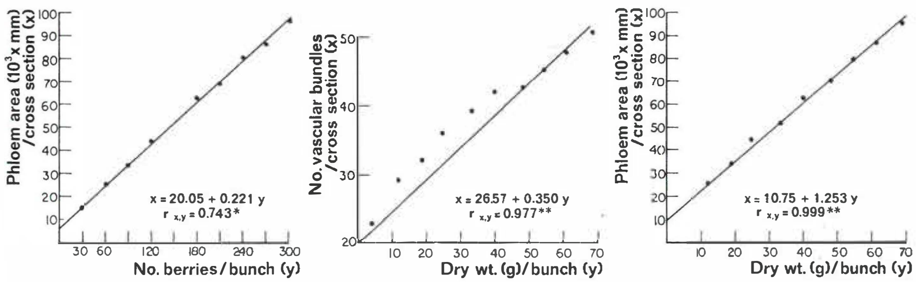
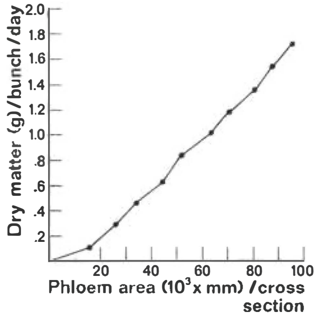


Fig. 1: Relationships between number of berries, dry matter accumulation and phloem area in Anab-e-shahi grapes at full maturity stage. * significant at $P < 0.05$, ** significant at $P < 0.01$.

Fig. 2: Rate of dry matter accumulation in different size of bunch and phloem area.



0.171 g per day per bunch (Fig. 2). The relation between the phloem area and the estimates of the maximum transporation rate of assimilates by the cluster was more or less similar to a specific mass transfer of organic substances in various monocotyledons and dicotyledons as reported by EVANS *et al.* (1970) and CANNY (1960). This suggests that the phloem area is more likely to be a limiting factor in deciding the size of the bunch where the dimension of the transport path in relation to cluster need is high. Data also suggest that the extent of phloem development during berry growth appears closely related to the rate of assimilate transport required by the cluster to support its subsequent development.

Significant positive correlations between dry matter/bunch and number of vascular bundles, dry weight/bunch and total phloem area/cross section, number of berries/bunch and phloem area/cross section of peduncle (Fig. 1), suggest that these attributes are interdependent. It has been observed that the endogenous level of plant growth substances like auxins, gibberellins and kinins, control the developmental phases of berries in grapes in a synergistic manner (COOMBE 1960, IWOHARY *et al.* 1968). Moreover, the division and differentiation of vascular cells are also dependent on growth hormones (BRANAS and VERGNES 1970). High auxin level favours xylem differentiation whereas high gibberellin level is conducive for phloem differentiation (DIGBY and WAREING 1968, SHININGER 1971). It is possible that a cumulative amount of endogenous growth hormones from each berry exerts an influence on the differentiation of the vascular system in the peduncle of the grapes. An indirect proof of this statement can be sought from the effect of exogenous application of GA_3 on Anab-e-Shahi grape at full bloom stage (Table 1). In this case too, treated bunches had greater dimensions of phloem compared to untreated ones, with iso-number of berries per bunch. Moreover, growth hormones induce the capacity in the berries to attract more food materials from the foliage (EL-ZEFTAWI and WESTE 1970). On the basis of the present investigation it may be concluded that growth hormones might

Table 1

Effect of gibberellic acid, applied at full bloom, on bunch of Anab-e-Shahi grape 40 days after berry set

Treatment (GA_3 ppm)	Control	10	20	40	60	80	100	C.D. at 5%
Fresh wt/bunch (g)	321.5	350.0	384.5	460.5	407.0	375.5	363.5	3.92
Dry wt./bunch (g)	28.7	37.5	37.2	43.8	40.5	39.0	37.0	2.37
Phloem area/cross section ($10^3 \times mm^2$)	50.2	54.0	57.1	59.1	60.5	58.1	59.0	2.37

increase the weight of the bunch by increasing the size of the transporting path and diverting the flow of food substances towards the developing berries.

Summary

The number of vascular bundles and area of phloem per cross section in the peduncle were determined from the clusters of variable sizes in grape variety Anab-e-Shahi. Dry matter accumulation of the bunch was dependent on the number of berries and total phloem area in cross section of the peduncle. Gibberellic acid applied at full bloom stage increased the weight of the bunch by enlarging the berry size. A correlation between bunch weight and total phloem area was established in the gibberellic acid treated bunch. Increase in bunch weight was dependent on the total phloem area and the rate of transport of dry matter towards the developing berries.

Acknowledgements

The authors are highly indebted to Dr. J. S. Chohan, Professor and Head, Department of Botany and Plant Pathology, for providing the laboratory facilities and to Mr. J. L. Kaul, Assistant Professor of Econometrics for doing the statistical analysis.

Literature

Branas, J .and Vergnes, A., 1970: Effects de gibberellines sur la vigne. Progr. Agric. Vitic. **77,** 182—191 and 220—228.

Canny, M. J., 1960: The rate of translocation. Biol. Rev. 35, 507—532.

Coombe, B. G., 1960: Relation of growth and development to changes in sugars, auxins and gibberellins in fruit of seeded and seedless varieties of *Vitis vinifera*. Pl. Physiol. **35,** 241—250.

Digby, J. and Wareing, P. F., 1966: The effect of applied growth hormones on cambial divisions and differentiation of cambial derivatives. Ann. Bot. N. S. **30,** 539.

El-Zeftawi and Weste, H. L., 1970: Effect of some growth regulators on the fresh and dry yield of Zante currant *(Vitis vinifera)*. Vitis 9, 47—51.

Evans, L. T., Dunstone, R. L., Rawson, H. M. and Williams, R. F., 1970: The phloem of the wheat stem in relation to requirements for assimilate by the ear. Austral. J. Biol. Sci. **23,** 743—752.

Iwahori, S., Weaver, R. J. and Pool, R. H., 1968: Gibberellin like activity in berries of seeded and seedless Tokay grapes. Pl. Physiol. **43,** 333—337.

Kasimatis, A. N., Weaver, R. J., Pool, R. M. and Halsey, D. D., 1971: Response of Perlette grape berries to gibberellic acid applied during bloom or at fruit set. Amer. J. Enol. Viticult. 22, 19—23.

Nijjar, G. S. and Bhatia, G. G., 1969: Effect of gibberellic acid and parachlorophenoxy acetic acid on the cropping and quality of Anab-e-Shahi grapes. J. Hort. Sci. **44,** 91—95.

Shininger, T. L., 1971: The regulation of cambial division and secondary xylem differentiation in *Xanthium* by auxin and gibberellin. Pl. Physiol. **47,** 417—420.

Watson, D. J., 1968: A prospect of crop physiology. Ann. Appl. Biol. 62, 1—10.

Weaver, R. J. and Pool, R. M., 1965: Relation of ringing to gibberellin like activity in berries of *Vitis vinifera*. Pl. Physiol. **40,** 770—776.

— — and — —, 1971: Berry response of Thompson Seedless and Perlette grapes to application of gibberellic acid. J. Amer. Soc. Hort. Sci. **96,** 162—166.

Eingegangen am 20. 10. 1971

Dr. O. S. Singh
Dept. of Botany
Punjab Agricult. Univ.
Ludhiana (Punjab)
India