STRUCTURE AND PHYSIOLOGY OF THE GRAPEVINE

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ROOT SYSTEM

The primary functions of the roots are:

- anchoring the plant in the soil
- absorption of water and mineral nutrients
- storage of food reserves

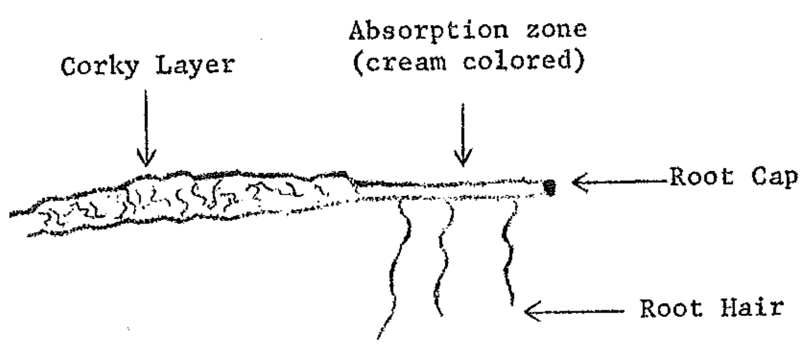
- Anchorage

The root system of a grape vine has irregular spreading and descending roots (not a tap root as found in some plants). The bulk of the roots is in the upper 2 to 5 feet of soil. However, grapevine roots have been found as deep as 40 feet.

Root penetration can be limited by: shallow hardpan soils, high water table, or a chemical composition of the soil that is toxic to root growth.

- Absorption

During active growth each rootlet has at its end a cream-colored region which varies in length from practically nothing to one inch. This region is the absorption zone through which most of the water and minerals enter the vine. The corky layer behind this cream-colored zone retards or prevents the entry of water.



Root hairs penetrate between soil particles and greatly increase the absorptive area. Once water and nutrients are inside the root hairs, they move inward into the root by diffusion, then on to the xylem. The xylem transports the water solution upward from the root system. The phloem transports the manufactured carbohydrates (food) downward for storage.

- Storage

Under favorable conditions the tissue of the vine roots accumulate high concentrations of starch in the late summer and autumn. These starches serve as food and food material for next year. A good accumulation of starches results in good root growth.

New feeder roots are being formed at all times during the growing season. A healthy vine has thousands of rootlets or feeder roots.

SHOOT SYSTEM

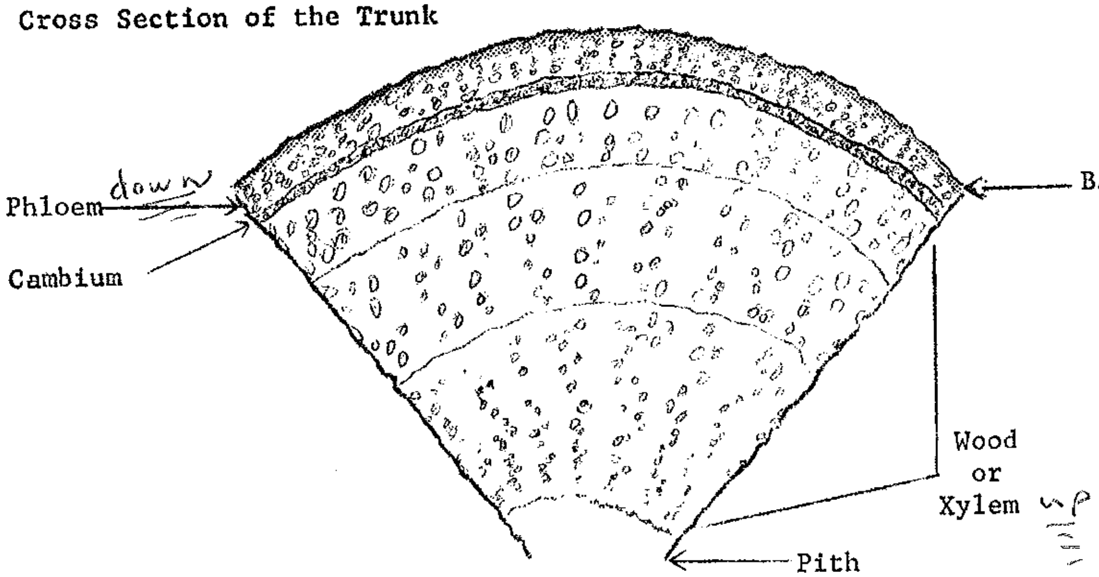
The shoot system consists of the above-ground parts of the vine: trunk, arms, shoots, canes (mature shoots), and leaves.

- Trunk

Supports the vine (body of the vine). It is the permanent stem of the vine which forms the connecting link between roots and arms.

Function of trunk: (a) Supports the bearing wood of the vine at the desired height from the ground; (b) supplies the vessels (pipelines) through which water and mineral nutrients move upward (xylem) from the roots and starches move downward (phloem) for root storage.

Cross Section of the Trunk



- Arms

The arms are the division of the trunk. Arms bear the spurs and canes retained at pruning for next year's new shoots and crop.

- Shoot

This is the green succulent growth arising from a bud. (When it matures, it is called a cane.)

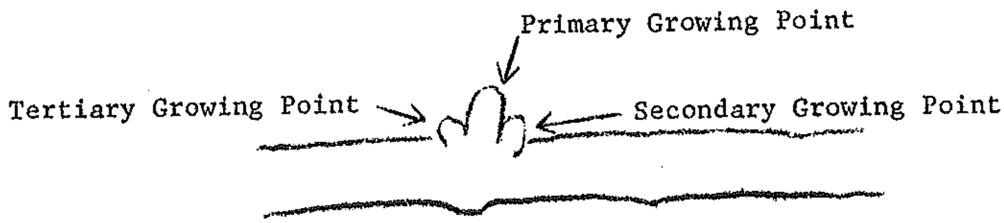
A shoot is divided into several parts: the growing tip, nodes, internodes, buds, tendrils and laterals.

- Growing tips consist of the 4 to 8 inches at the end of the shoot. This area accounts for the growth of the shoot by division of older cells and the increase in size of these newly formed cells.

- Nodes are the enlarged areas along the shoot from which leaves are located. Also, buds are developed at the nodes.

- Internode is the distance between two nodes.

- Buds develop at each node above the leaf axil. A grape bud is a compound bud consisting of 3 growing points.



Under normal growing conditions only the primary (center bud) growing point will push. However, severe pruning or even good sun exposure during the previous growing season can result in growth of secondary or tertiary shoots. If the primary is completely destroyed (by frost, mechanically, etc.) the others may push.

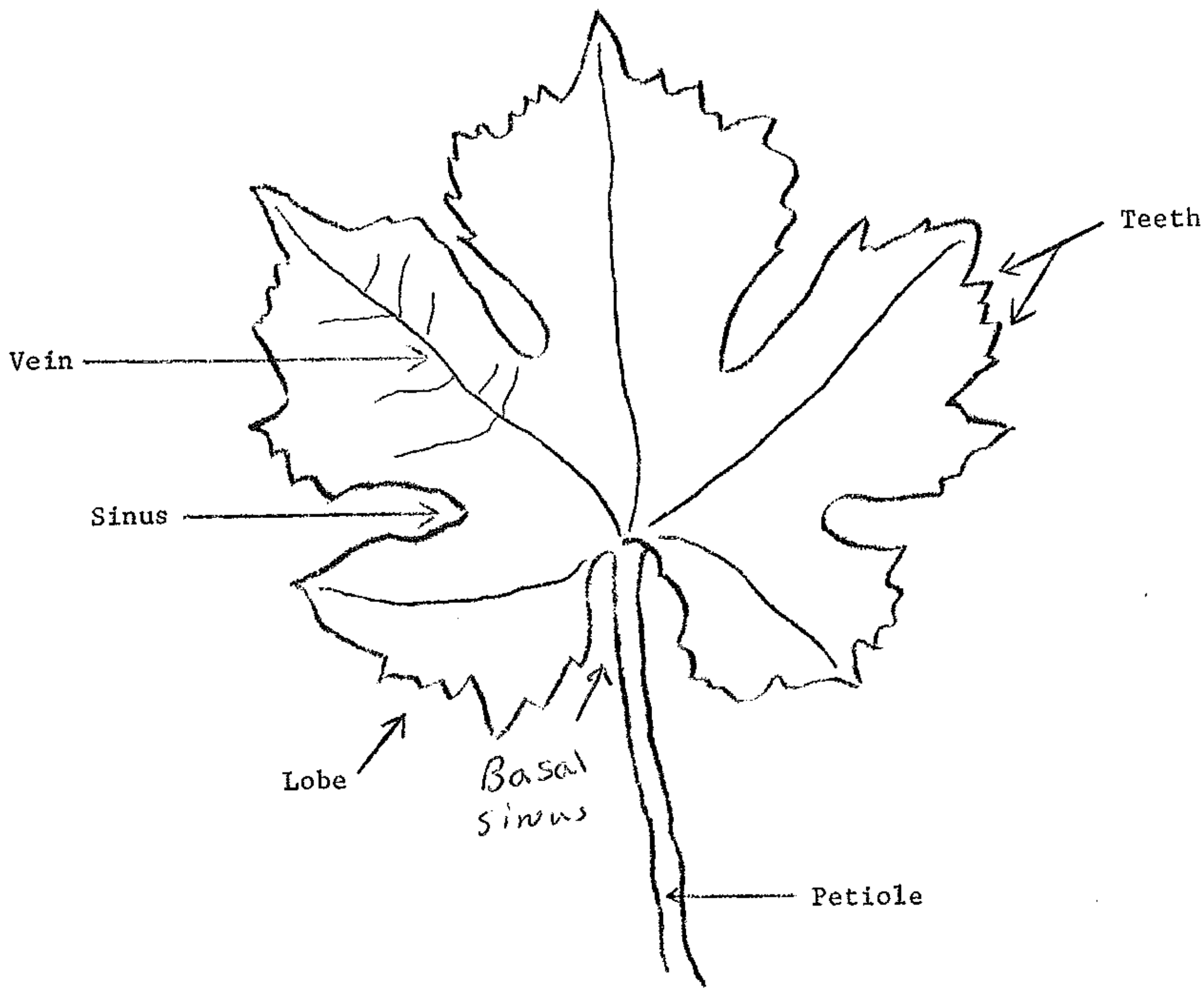
Grape buds may be leaf buds or fruit buds. A fruit bud contains a shoot with both rudimentary leaves and flower clusters.

A group of buds, on spur-pruned varieties, can be found at the base of the spurs. These buds may push out if the spurs are cut back severely (one or two nodes). Some of these basal buds are fruitful but usually produce smaller clusters than the nodes further out. Many basal buds usually push following severe frosts.

Latent buds are buds that fail to develop and grow for a year or more. Suckers and water sprouts arise from latent buds.

LEAVES

The parts of the leaf are illustrated below:



- Veins are the conducting tissue in the leaf.

The function of the veins is to conduct water, mineral nutrients and food to and from the leaf.

- The blade is the broad flat part of the leaf, commonly called the leaf.

- The petiole attaches the blade to the shoot. Petioles are often analyzed to determine the fertilizer needs of the vine.

The primary function of the leaves is to manufacture carbohydrates (sugar and starches) for ripening the fruit and for maintenance of the vine.

The process of food manufacturing by the leaves is called photosynthesis, which is the most important physiological process of a plant.

Photosynthesis can be expressed by the following:

$$6\ CO_2 + 6\ H_2O + \text{light energy} = C_6H_{12}O_6 + 6\ O_2 \uparrow$$

Carbon dioxide + water + sunshine = sugar + oxygen
(from air) (from soil) (goes off into atmosphere)

A healthy leaf area is a must if a vine is going to produce good yields year after year.

External factors which affect the rate of photosynthesis are:

1. Temperature

   - Optimum for grapes is 77°F. to 86°F.
   - Maximum for grapes is 100°F. to 104°F.

2. Intensity of illumination

   -Light can be measured in the number of foot candles by a light meter. Midday readings in the full sun can be as high as 12,000 Ft. C. Under a vigorous vine the light intensity can be as low as 100 Ft. C. (foot candles).

Recent research on the effect of temperature and light on the rate of growth of grapevines was conducted by Drs. Lider and Kliewer of the University of California at Davis. The following chart is most interesting:

THE EFFECT OF TEMPERATURE AND LIGHT INTENSITY ON THE RATE OF GROWTH OF THOMPSON SEEDLESS VINES

Daytime Temp.* °F.	Light Condition	Average Midday Light Intensity (Ft. C.)	Increase in Dry Wt. in 30 Days (gms)	Net Assimilation Rate Grams/M^2/Day
104	High Light	6,000	25.34	3.15
104	Low Light	200	3.56	.45
95	High Light	5,700	36.57	3.30
95	Low Light	200	1.93	.18
86	High Light	6,000	41.66	3.61
86	Low Light	150	7.36	.60
86	High Light	6,300	45.57	3.67
86	Low Light	175	3.46	.31
Field	Full Sun	11,500	51.22	4.20
Field	Under Vine	100	15.32	1.08

* All the phytotron vines were grown at a constant night temperature of 59° F.

From this table it can be seen that the growth rate of the Thompson Seedless vines was markedly reduced under the low light, shaded conditions.

3. Carbon dioxide content of the atmosphere.

4. Water supply.

- Transpiration is the escape of water from the vine as water vapor.

External factors that affect the transpiration rate are:

1. Humidity of the atmosphere

   The less moisture there is in the air (low humidity) the greater the transpiration rate.

2. Light intensity

   The stomates (pores) are regulated by light. They are open in the light and closed in darkness. It is through these microscopic pores on the lower surface of the leaves that most of the water vapor escapes into the atmosphere. Sunlight affects the temperature of the leaves. The leaf temperature is usually higher than the surrounding air during sunlight hours, thus transpiration occurs.

3. Air temperature

   Transpiration (water loss) increases with the rise in the surrounding air temperature. (Of course leaf temperature increases with a rise in air temperature.)

4. Wind

   An increase in wind velocity usually increases the rate of water loss.

5. Soil moisture

   The pores give up water vapor much less freely when there is a water shortage than when there is a good supply of water.

LOSS OF WATER FROM SOIL BY EVAPORATION AND TRANSPIRATION
IN ACRE-INCHES PER ACRE

	CARIGNANE		TOKAY	
	For period	Cumulative	For Period	Cumulative
April	0.3*	---	0.5*	---
May 1-15	1.4	1.7	1.3	1.8
May 16-31	1.7	3.4	1.4	3.2
June 1-15	1.7	5.1	1.4	4.6
June 16-30	2.5	7.6	2.5	7.1
July 1-15	2.5	10.1	3.4	10.5
July 16-31	2.2	12.3	2.8	13.3
Aug. 1-15	2.1	14.4	2.3	15.6
Aug. 16-31	2.1	16.5	2.3	17.9
Sept. 1-15	1.8	18.3	1.5	19.4
Sept. 16-30	1.1	19.4	0.9	20.3
Oct. 1-31	0.8	20.2	0.6	20.9

* Loss by evaporation and transpiration from upper 6 feet of soil.

- Respiration is a breaking down of substances in the cell which provides energy for the work of the plant. Oxygen is taken in and carbon dioxide given off. In this process sugar is transformed into simpler substances. It can be expressed by the equation

$$C_6H_{12}O_6 + 6\ O_2 \longrightarrow 6\ CO_2 + H_2O + \text{energy}$$

Sugar + Oxygen ⟶ Carbon dioxide + Water + energy

Growth and the production of flowers and seeds are external examples of the utilization of energy by the vine.

Grape growers' greatest concern about respiration is after harvesting table grapes. The grapes continue to live after picking and their respiration (breakdown) continues. Respiration detracts from the grape quality. So to reduce respiration, growers have their grapes pre-cooled as soon as possible after picking, place the grapes in cold-storage, and apply sulfur dioxide.

References:

Winkler - General Viticulture

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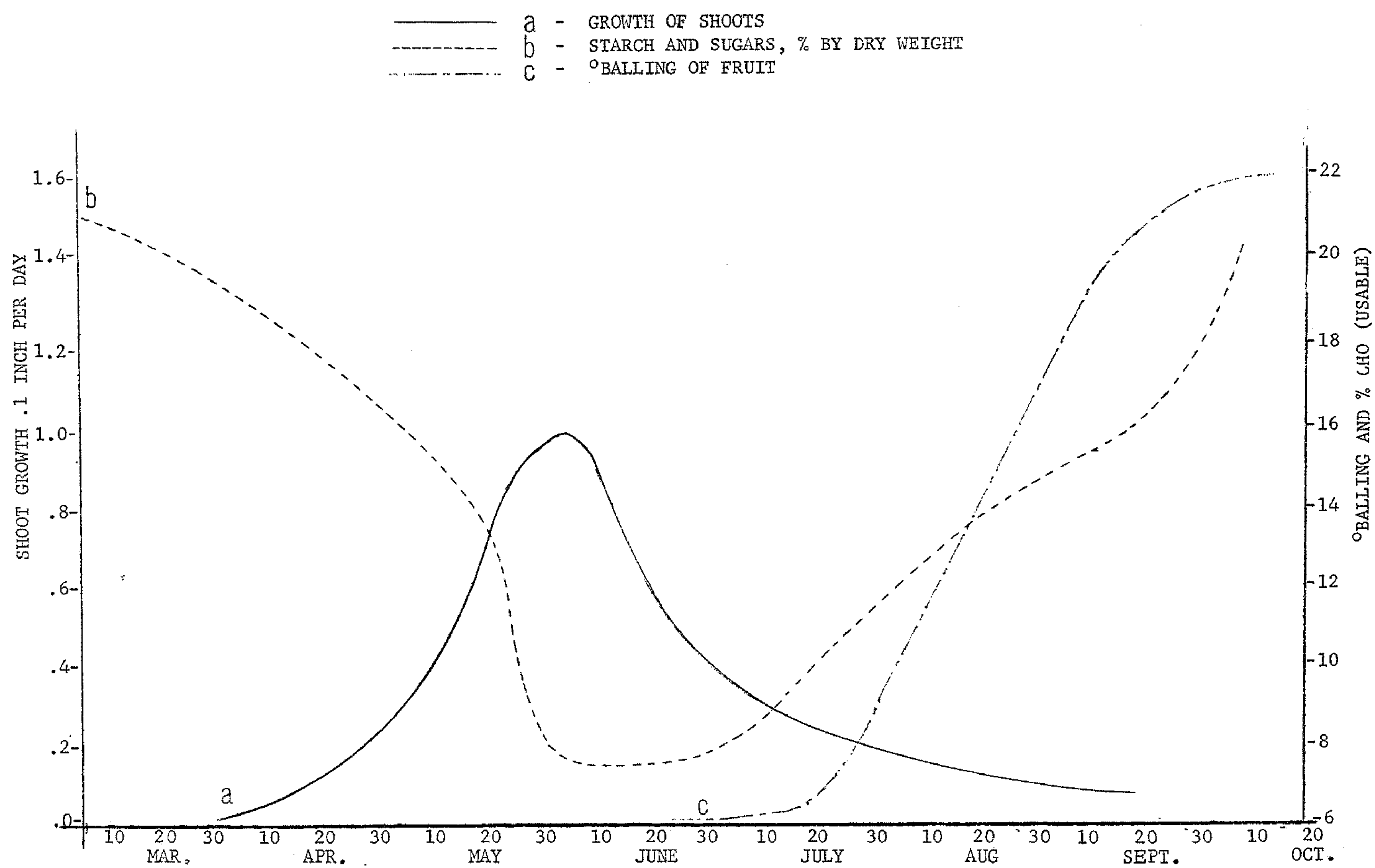
Holman & Robbins - Textbook of General Botany

November 1970
100 c.

ANNUAL GROWTH CYCLE OF VINES, DEVELOPMENT OF FRUIT, AND SEASONAL LEVEL OF USABLE CARBOHYDRATES



ILLUSTRATED DIAGRAM

OF

HOW A PLANT FUNCTIONS