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Growth, Development, flowering, fruit set and crop regulation in Grape

C. Ravindran, . Jagadeeswari and M.Kavitha
Associate Professor and Head, Horticultural Research Station, Kodaikanal, Dindigul, Tamil Nadu, India
Associate Professor, Grape Research Station, Theni District, Tamil Nadu, India
Assistant Professor, Biochemistry, RVS Padmavathy College Horticulture, Sempatty, Dindigul
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The grape is cultivated plan of antiquity as is evident b references in the Bible and other old authentic literatures. Its association with man is older than that of Wheat and Rice. Its great age is confirmed fossil leaves and seeds discovered in deposits. The cultivation of grape is a very ancient art. Documentation concerning viticulture and wine making in Egypt date back to some 5000 to 6000 years. Grape occupies 155kHa and 3358K Tonne and the premier position in exports with 246.13K Tonne valued at Rs. 233525 lakh. Maharashtra (Nashik, Sangli, Solapur, Pune, Osmanabad) Karnataka (Bijapur, Chikballapur, Belgaum, Bagalkot, Bangalore Rural) Tamil Nadu (Theni, Dindigul, Coimbatore,) are the main region of grape growing in India. The growth, development, flowering, fruit quality and regulation of crops is very important to get higher yield and quality.

GROWTH

The grapevine has a definite cycle of growth, including flowering, berry set, and berry development. The grape siding to in subtropical climate of North India, the vine sheds its leaves and enters dormant period. In southern India, the grapes do not shed their leaves naturally. The vines are normally pruned only once during January in North India, while twice in March and October in South India. As the temperature rises and reaches about 10°C, the buds begin to swell and green shoots emerge from them. The buds of the vine may be vegetative or reproductive. The vegetative buds give rise to a shoot that bears only leaves, while the reproductive buds are mixed buds that give rise to a shoot which normally bears one or more clusters of flowers. The two buds can be distinguished by observing under dissecting microscope with clearly visible flower cluster primordium.

The temperature during the summer months governs the time of bud-burst or bud-break bloom and ripening as well as quality of berries. The temperatures between 28-32°C are most congenial for the development of all parts of vine. After bud-break, with the rise in temperature, the shoots grow rapidly in length and thickness. The leaf arises at the node and bears buds in the axil. Full bloom usually occurs 6-8 weeks after bud-break under North Indian conditions depending upon the cultivar and the prevailing temperature. The rapid shoot growth usually slows down during

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blooming time. This does not cease the growth completely by forming terminal buds as in many other tree fruits.

Flowering, Pollination and Fruit Set

The process of flower initiation for the next year's crop starts before bloom and development of different parts continues until about harvest time. The different parts of flower, corolla, stamens and pistils are differentiated in the order named.

In the spring and early summer, the vine grows and forms a bud in the axil of the leaf. The bud grows for some period, depending upon agroclimatic conditions, after which it may grow up to 10-leaf primordia and during this period the fruiting primordia may be formed. Fruiting primordia are multi-lobbed undifferentiated masses of tissue which are located on the bud axil opposite to leaf primordia. After developing, the activity ceases as bud enters into a state of deep organic dormancy.

This state lasts for the remainder of the growing season followed by low-temperature-induced dormancy. Some differentiation of the fruiting primordia has been said to occur in late autumn. The flowers are fully differentiated some 3-4 weeks after bud-burst, and flowering then occurs. However, for a given cultivar, the number of fruiting primordia per be then occurs. However, to season, the grape flowers are borne in clusters which appear to be lateral to the shoots. The flower-cluster consists of many small greenish individual flowers. Most Vinifera cultivars have perfect or hermaphroditic flowers that have both a functional pistil and stamens. Female or pistilate flowers have short stamens, more or less reflexed, which produce pollens that are generally sterile. Male or staminate flower has an undeveloped pistil that has neither a stigma nor a style, but contains only a small ovary which cannot be fertilized. Some species of grapes are dioecious. These have male flowers on one plant and female flowers on another. These are fertilized with hermaphrodite flowers. Blooming progresses for several days on a vine and even the flowers within a panicle do not bloom at one time. A cultivar generally is considered in full bloom when, on an average, 50 per cent calyptras have fallen. When the calyptras fall, the pollens are released, fall on the stigma and germinate under favorable conditions. The pollen tube reaches embryo sac through the style and the sperm fertilizes the ovule. There are usually four ovules, two in each half of the ovary which form seeds. The fertilization occurs 2 or 3 days after anthesis and pollination.

Berry set results from pollination, fertilization and seed development. However, some cultivars set by parthenocarpy, i.e., the berry set without fertilization. Only the stimulus from pollen is required for berry set as in Black Corinth. In other seedless cultivars fertilization occurs but the embryo subsequently aborts, which is termed as 'stenospermocarpy'. In certain other cultivars where abortion is delayed, the seeds remain hard and empty.

According to Winkler et al., self-pollination is a rule with Vinifera grapes. However, cross pollination is not only possible but also, under certain conditions, desirable and necessary. Several

days after bloom, there is a natural heavy drop of berries. It is also beneficial because it keeps cluster from becoming too compact. The berries, which do not fall from the cluster, are said to have set. An appreciable and detectable increase in berry size is also referred to 'berry set stage'. The berry set and development are controlled by growth substances and their interactions. The predominant ones are gibberellins, auxins, cytokinins, ethylene and inhibitors. In some cultivars, the clusters set poorly and are small. Under- developed, seedless berries which fail to enlarge are 'shot' berries. Such a condition is known as 'millerandage' and may be aggravated by bad weather at the time of pollination and heavy crop load. Poor pollen viability and lead to flower drop, resulting in poor set.

Fruit Growth and Development

Growth of the grape berry was first investigated by Lewis who found the transition from the first to phase was accompanied by a colour change called 'veraison'. They divided berry growth into three phases, where two phases of rapid growth were separated by a phase of little growth. According to Coombe, the three phases can be characterized as follows:

- Rapid increase in the berry volume, highest rate of cell division in the peri. carp and endosperm growth completed; seeds almost fully grown.
- Decrease in growth rate, auxin level reaches the maximum, ABA level at first low, increasing towards the end of the phase.
- At the beginning of the third phase, change in color and consistency of the berries, further increase in volume due to storage of sugars and water. ABA content reaches maximum at the beginning of the phase and decreases later.

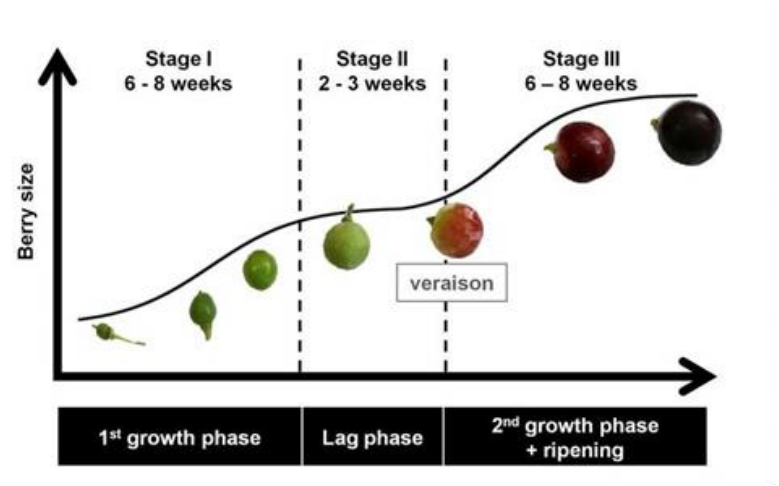
Fresh weight was maxi- mum in first phase and decreased in second and then increased in third phase. Fresh weight, dry weight, diameter and sugar followed a sigmoid curve while for acidity, it was negative sigmoid. Staudt et al. investigated the berry growth in various cultivars under field conditions and in vitro. Fresh and dry weight curves showed a double-sigmoid course and three transition points could clearly be defined. The central transition point, occurring around 42 days after anthesis, may be defined as the change-over from the first to the second growth phase. The relative growth rates did not show a phase of 'slow growth' at the beginning of the first growth phase. Indeed, the relative increase in fresh weight is maximum at the beginning of the first growth phase. In other studies, the delimitation of a separate phase of little or no growth in the region of the transition from the first to the second growth phase was not supported. The definition of such phase boundaries is arbitrary. During the first growth phase there is high cell activity. The growth of the emrbyo showed no relation to the double-sigmoidal growth of the pericarp. Final embryo size was reached at 70-75 days after anthesis. Seed weight on the other hand, showed a biphasic increase.

These three stages are more pronounced in seeded grapes while seedless berries usually show less distinctive growth period. However, Rao and Pandey observed double-sigmoid pattern of growth

in Pusa Seedless cultivar. They further showed that suspended growth during the second phase coincided with higher endogenous growth inhibitors which were also noted by Coombe. The treatment of berry at the end of second stage with ethrel has been reported.

The berry development stages are green stage, ripening stage, ripe stage and overripe stage. The green stage extends from the berry set up to the starting of ripening. It is characterized by rapid increase in berry, the amount of sugar remains low and consistent and the acidity is high. The berry remains hard. The ripening stage extends from the beginning of ripening until the grapes are fully ripe. The berries start to show colour and soften. The colour of red and black cultivars becomes more intense, while in the others, the green colour turns white or yellow. The sugar content increases with decrease in acidity.

The berries at the apical portion ripen the last. The overripe stage starts when grape has passed the peak quality for its intended use. The sugar increases due to evaporation and acid content continues to decrease. Overripe berries are prone to fungal and insect attack, berries shrivel, in some cultivars these may shatter and finally the grapes dry.



Berry Maturation Stage: bud to cluster

Techniques of Improving Fruit Quality

It is obvious that good quality grapes will fetch premium price in the market, In table grapes, good quality represents medium-sized clusters berries with the characteristic colour, flavour and texture of the cultivar. Seed. lessness is another important requirement of quality table grapes. Apart from many general factors like cultivar, agroclimatic conditions, cultural and manage. ment practices and plant protection maesures which affect the quality, there are others which directly influence it. These include crop regulation, girdling and the use of plant growth regulators. The techniques most pertinent, which either being adopted by the growers or advocated by the scientists, are given in the subsequent paragraphs.

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Crop Regulation

Pruning is the cheapest and easiest way of crop regulation. Heavy crop load impairs the quality and delays ripening, therefore balanced pruning is considered essential. The number of fruiting units and their length should be proper so that the vine can nourish and ripen the crop.

Excessive bearing of vines can be reduced by cluster or berry thinning. Thing. ing of flower cluster consists of removing underdeveloped, mis-shaped clusters between leafing out and blooming. It is advisable not to practise severe flower cluster-thinning in the cultivars where there is a problem of poor set and panicle drying, such as Thompson Seedless and Gold under Haryana conditions. Under such conditions, cluster-thinning, which is done after berry set, should be practised. It is advisable to keep about 60-70 clusters per vine spaced at 3m×3m trained on bower system. Slight reduction in the crop load can be done by berry thinning which consists of removing part of clusters. Singh et al. had suggested that the apex of clusters should be removed immediately after cluster thinning. Likewise, thinning is known to reduce uneven ripening and improve colour development in Beauty Seedless. Apart from improving quality, thinning also advances ripening.

Girdling And Growth Regulators

The technique consists of removing complete ring of bark from any part of vine, such as shoot, cane, arm or trunk. The detailed studies by Dabas et al. have shown that the best response to girdling was that of 0.5 cm wide ring of bark from trunk which usually heals within a month. It can be done for improving berry set and yield at one week before bloom, to increase berry size at or just after berry set, at the beginning of colour change to advance ripening, uniform colouration and for better eating quality. Over-cropping of girdled vines should be avoided to get the proper response of pruning. In order to have still better effects, girdling may be combined with other treatments, such as thinning and application of growth regulators or other treatments, such as boron. Continuous girdling of vines for 6 years has shown that there is no deteriorating effect on the vine growth as the girdles heal up in a short time and the carbohydrate need of roots is very low.

Among the different growth regulators tried on grapes, 4-chlorophenoxyacetic acid, gibberellic acid and ethrel command a special place and are being used. 4-CPA is very beneficial in increasing berry set and reducing berry drop. Gibberellic acid application is made for different purposes, such as to loosen the bunch. purposes, the application is made either by spraying or by bunch dipping in diffe- at different stages of also depend upon the cultivar and the climate. Normally, lower concentrations are used in comparatively warm areas. Singh et al. have rece concentrations 40 ppm gibberellic acid should be applied either by spraying or bunch dipping at flowering and again at berry set in Thompson Seedless, Delight and Kishmish Charni. Giberellic acid application can be combined with thinning or girdling. Naito et al. reported that treating flower cluster of cv. Kyoho, 11 or 4 days before full bloom with SADH at 2500 ppm increased the number of berries/cluster to approximately

100 compared with 55 for the controls. This was mainly due to an increase in parthenocarpic fruit set. Application of SADH as pre-bloom sprays to the seeded cultivar Concord and to the seedless Himord increased fruit set. Tafazoli also reported that treatment with SADH at 7500 ppm increased number of berries/cluster in cv. Yaghooti. Girdling of shoot and application of SADH considerably increased the fruit set. Barritt, however, did not find any improvement in fruit set in seeded cultivars of V. vinifera by using SADH at pre-bloom stage. The beneficial effect of some of the auxin-like substances on set of Black Corinth has been reported by Coombe and Weaver and Williams. Growth regu- lators, if applied properly, produce effects similar to girdling, and when combined with girdling, even greater response may be obtained.

Recently, ethrel is being used mainly to advance ripening and improve quality. Its application also improves colouration and helps in uniform ripening. Generally, it is applied at veraison stage or when colour change starts or berries start softening. Application of ethrel, 5 weeks after anthesis under Delhi conditions resulted in increased berry weight, sugar content, reduced acidity and hastened ripening by a week. Spray of aqueous solution of ethephon, four weeks after berry set, produced attractive coloured berries and increased TSS/ acid ratio.

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