Technical Bulletin No. 8

Fruitfulness in Grapes

National Research Centre for Grapes
(Indian Council of Agricultural Research)
P.B. No. 3, Manjri Farm Post, Solapur Road, Pune - 412 307, India.
Tel.: (020) 26914245 Fax: (020) 26914246

Correct Citation:
Somkuwar, R. G. (2005). Fruitfulness in grapes

Technical contribution and compilation by:
Dr. R.G. Somkuwar
Senior Scientist (Horticulture)

Edited by:
Dr. P.G. Adsule
Dr. Anuradha Upadhyay
Dr. J. Satisha
Dr. S. D. Ramteke
Dr. J. Sharma

Technical Bulletin No. 8
August, 2005

Price: Rs. 50/-

Photographs by:
Dr. R. G. Somkuwar, Senior Scientist (Horticulture)
Mr. P. B. Taware, T-3, Farm Management

Published by:
Dr. P. G. Adsule, Director,
National Research Centre for Grapes,
P.B. No.3, P.O. Manjri farm,
Solapur Road, PUNE - 412 307.
Ph: 020-26914245, Fax: 2691 4246.

Printed at:
Print Impressions, 101, Raunaq Industrial Estate,
Hadapsar Industrial Estate, Pune 411 013.
Tel.: (020) 26872133 Fax: 26876833

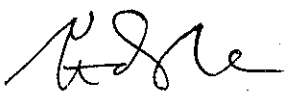
Preface

Grape is one of the important commercial fruit crop grown on a large variety of soil. Maharashtra occupies 60% of the total area under grape cultivation in the country. The vines are pruned in April for shoot formation and cane development which also leads to fruit bud formation and storage of reserve in the cane. The pruning is again done in October for yield. Number of bunches are the indicator of yield in a particular vine which depends on the fruitfulness of the canes.

Even though yield per unit area is more in tropical and subtropical regions of India, the cluster / cane ratio is far less as compared to temperate regions of the world. The measures to increase the productivity of vines are discussed in detail in this bulletin.

The bulletin covers in detail the factors responsible for the formation of fruit bud and the cultural practices to be followed right from the back pruning and care of grafted vines. All the information has been substantiated with the research data in tabular forms and photographs, etc.

The information given in the bulletin will serve as guidelines for the grape growers to follow the practices for effective fruitfulness in grapes during back pruning. Further, the bulletin is also handy for the growers as well as for the researchers and the students engaged in the research and development activities of grape. I also take this opportunity to acknowledge the help received from all the concerned of this Centre in bringing out this bulletin.



Place: Manjri, Pune
Date: August, 2005

P. G. Adsule
(Director)

CONTENTS

LIST OF TABLES

LIST OF PHOTOPLATES

1. Introduction

Grape is one of the major fruit crop grown in India. In peninsular India, grapes are pruned twice in a year. The vines are pruned during April for shoot formation and cane development which also leads to fruit bud formation and storage of reserve in the cane. The shoots are pruned for fruit during October for yield. Number of bunches are the indicator of yield in a particular vine which depends on the fruitfulness of the canes. Yield is a product of number of flower clusters over unit area and the mean weight of the cluster. Fruitfulness of the canes is decided during the same period after back pruning. Yield in grape is dependent on the cultural practices followed after back pruning (April to September). Hence, a fruiting cane is the unit of production.

Productivity refers to the inherent capacity of grapevine to produce maximum yield. The productivity of grape varies from variety to variety. There is a large gap between the productive potential of vine and the actual yield obtained under field conditions, hence, there is scope for reducing the gap between productive potential of vine and the actual yield by adopting various cultural practices. These include crop regulation, use of growth regulators, training, canopy management and disease and pest control, etc.

The measures to increase the productivity of vines are discussed in detail in this bulletin.

2. Pruning

Pruning is considered to be the most important operation in grape cultivation. Removal of any vegetative part in a vine is called as pruning. In grape, pruning is essential for fruit bud differentiation since the clusters are borne on the new growth emerging from the past seasons growth. The fruitful buds are located at different zones. If the canes are not pruned, the buds from main productive zone may not sprout leading to poor bud fruitfulness. Hence to exploit the productive potential of a vine, the past seasons growth has to be pruned. Level of pruning affects the fruitfulness of a vine to a considerable extent. It is an established fact that the shoot vigor has inverse relation with the

fruitfulness. Time of pruning in a season may also affect the fruitfulness since the light plays an important role in fruit bud differentiation. Depending on the climatic conditions in particular area, grapevine is pruned once or twice in a year.

Once the leaf falls, the vascular system becomes inactive. Before this, the minerals and carbohydrates are transformed from the leaves to permanent woody part of a vine. The purpose of pruning in grapes is to concentrate the activity of a vine in the parts left after pruning and to regulate for ensuring the production through fruitfulness every year.

2.1 Single pruning

This system is followed in temperate regions of the country. In north India only fruit pruning is done. Since only one growing season is available to the crop, it is pruned with the onset of spring or during late winter. Floral differentiation on the current shoot and the fruit set take place at the same time in this region. In order to regulate vine canopy and extend its productive life span, half of the matured shoots are pruned for fruiting and the other half are pruned for renewal spurs to give rise to shoots that develops into fruiting canes for the next year. Alternatively the fruiting canes are pruned back to renewal spurs and the mature shoots developed from the previous spurs are pruned to fruiting canes year after year (Chadha and Shikhamany, 1999).

2.2 Double pruning

This system is followed in Maharashtra, Karnataka and Andhra Pradesh. Mature shoots are pruned to canes of 7-8 buds in the forward pruning. The same canes are pruned back to 1-2 buds after harvesting the crop in summer. In Madurai region and other parts of Tamil Nadu, pruning is done during November-December for summer crop harvested during March-April and during May-June for the second crop harvested during August-September (Chadha and Shikhamany, 1999). After the harvest of grapes, the vines are given rest for about a month. During this period, the irrigation is usually withheld and the vines are allowed to accumulate the food reserve in the parts like arms and trunk. All the canes are pruned back by retaining only one basal

node. Hence it is called as back pruning. Depending upon the temperature in the area the time taken for sprouting varies from 7 to 22 days. After sprouting of buds, the shoot starts growing and the fruit bud differentiation starts after 45 days. The bud differentiation takes place in the new shoots emerged after the pruning. These shoots are pruned for fruit during October.

3. Bud Fruitfulness

Fruitfulness is the result of transformation of vegetative primordial into reproductive primordial.

This transformation is carried out in three different stages.

1. Anlagen formation
2. Formation of inflorescence primordial
3. Formation of flower.

Anlagen are the protuberances of meristematic tissue from the apices of latent buds. These are undifferentiated primordial, which develop into inflorescence primordial or tendril primordial and shoot primordial depending upon various growth promoting substances in the shoot or canes influencing the fruit bud differentiation. Inflorescence primordia are formed by extensive branching of anlagen (Satyanarayana and Shikhamany, 1986).

Formation of inflorescence primordial is the most sensitive stage though formation of anlagen itself is considered to be the stage of initiation of inflorescence axis. Any imbalances among the factor responsible for floral differentiation would make the anlagen to differentiate into either tendril or shoot. The partially differentiated inflorescence primordial can revert back into tendril primordial if the conditions for inflorescence primordial development are not congenial and that is referred to fillage (Bessis, 1968).

4. Growth stages

It is important to know the various growth stages to follow suitable cultural practices to increase fruitfulness since fruitfulness in grape involves the factors prevailing after both the foundation and fruit

pruning

1. Vegetative stage
2. Bud differentiation stage
3. Cane maturity stage

4.1 Vegetative stage (1 to 30 days)

The vegetative growth starts from bud sprouting till fruit bud differentiation. During this stage, correct application of nutrients especially nitrogen is essential for proper shoot development. Excess bud sprouts should be thinned out to facilitate development of optimum number of shoots with good vigor. Excess number of shoots causes poor sunlight infiltration into the canopy and the result is poor fruit bud differentiation. The more likely reason for poor cropping of vine is related to the conditions that influence the development of fruitfulness in buds. Fruitfulness of the buds depends on how they were exposed to sunlight during the previous growing season. When vines produce excessive shoot growth, often the nodes at the base of shoot develop in dense shade. If the pruning strategy during back pruning involve retaining short canes (4-5 nodes), a grower is likely to have many nodes that produce fruitless shoots or no shoot at all. If vines are highly vegetative with low fruitfulness of the basal nodes on canes, there will be no hope for reasonable crop.

4.2 Bud differentiation stage (31 to 60 days)

At the end of vegetative growth stage of the vine, the reproductive stage starts in which the bud on a shoot grows in size and shape and the bud differentiation starts. The anlagen are capable of differentiating into inflorescence or tendril primordial. Whether or not anlagen becoming inflorescence or tendril primordial depends on the environment around the bud at the time this differentiation is taking place. High light intensity or temperature will encourage the inflorescence primordial development, while shaded or a cool condition encourages the vegetative growth leading to tendril formation. If the cultural practices are not followed properly, the differentiating bud may get converted into tendril.

Fig. 1 Immature canes due to more shading

4.3 Cane maturity stage (61 to 90 days)

At the end of bud differentiation, the process of cane maturity takes place. The change of green color to brown is the indication of cane maturity. Depending on the weather conditions after back pruning, the shoot maturity starts after 60 days. If the temperature during the period is high, the cane matures early whereas delay in cane maturity is mainly due to application of more irrigation and nitrogenous fertilizers that makes the conditions favorable for the vegetative growth. Application of potassium at this stage is important as it helps in fixing the differentiated bud, hastening the cane maturity and also keeping the vine healthy.

5. Flower bud formation

In a vine the flower bud forms at different time in different grape growing region. In south India, vines comes to bearing 18-20 months after planting, while it takes three years in north India (Pandey and Pandey, 1993). Under subtropical condition, the formation of flower bud occurs on the current seasons growth. In some parts of Tamil nadu five crops are taken in two years. In Maharashtra, Karnataka and Andhra Pradesh, flower bud differentiation takes place on growing shoots emerging from basal buds left on the vine after the back pruning during April. The sequence and the various factors involved in fruit bud formation in the shoot are given in the flow chart (Satyanarayana and Shikhamany, 1986).

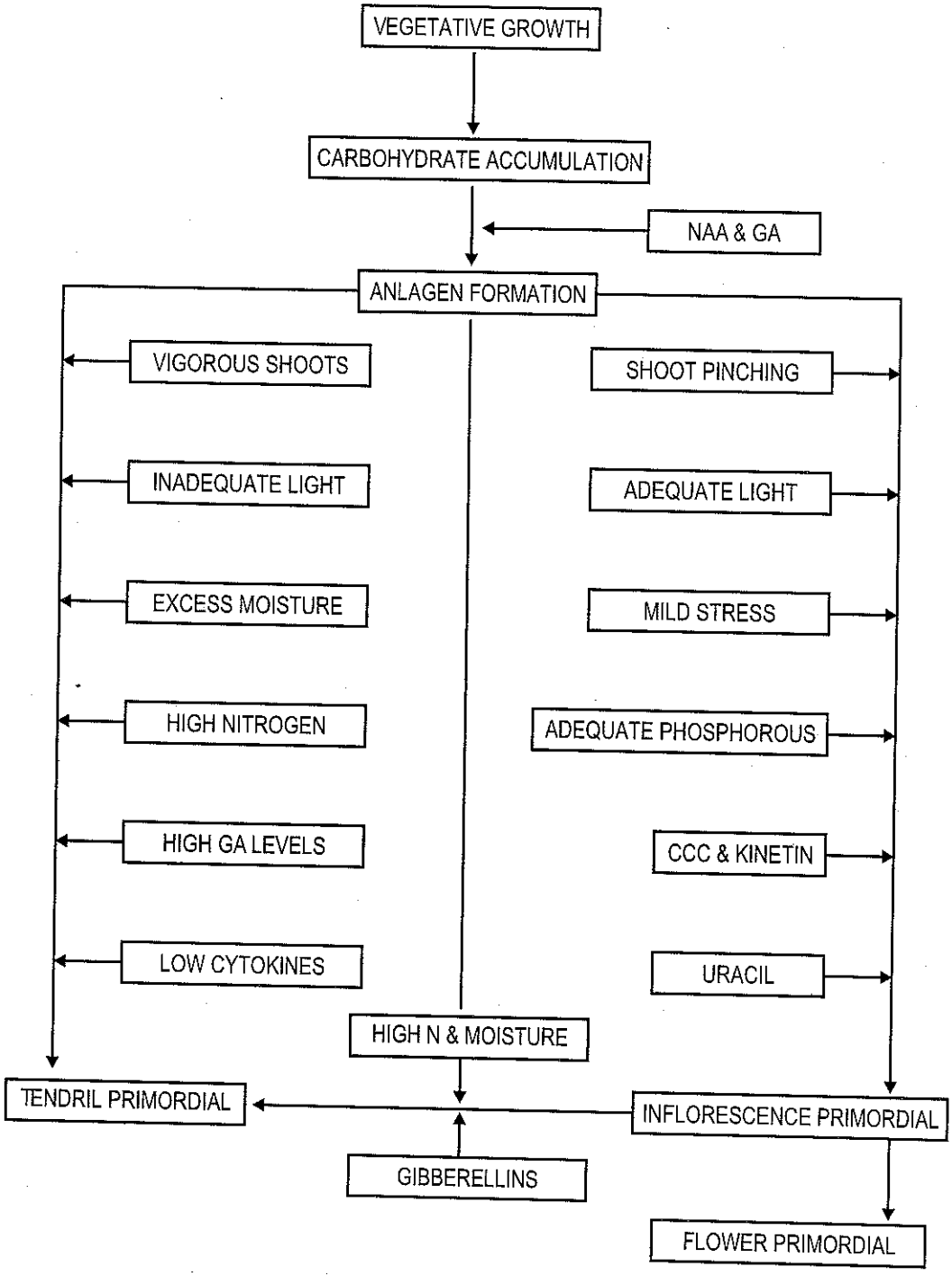


Fig. 2 Schematic diagram for bud formation

6. Factors responsible for fruit bud differentiation

6.1. Climate

6.1.1 Light

Light is essential for the photosynthesis of grapevine. Kriedman and Smart (1971) found that the light intensity required for maximum photosynthesis in Thompson Seedless ranges from 2500 to 5000 ft candles or 100 to 200 watt/sq.mtr. If the light intensity is 125 ft candle (5watt/sq.mtr.), the photosynthesis is just equal to that of respiration. Hence 125-ft candles light is called as light compensation point. At this light regime the vine neither gain nor looses it's dry matter. Net photosynthesis rate reduces if the light intensity is less than 125-ft candles. If the light intensity is more than 5000-ft candles, the leaf looses its chlorophyll by photo oxidation.

6.1.2 Rainfall

The rainfall in the grape growing area has direct impact on the fruitfulness. A rain during the stage of fruit bud differentiation (40 to 60 days after back pruning) is not favorable for grape since the excessive shoot growth will hamper the initiation of floral primordial. The only alternative will be to adjust the pruning time in such a way that the rainy season will not coincide with the important growth stage like fruit bud differentiation.

6.1.3 Relative humidity

Basically the grape requires a warm and dry climatic condition for its growth and development. High humid conditions are therefore not favorable for any growth stage and fruitfulness of the vine. The bud differentiation takes place during the month of May to June if the vines are pruned in April month when the dry atmosphere prevails with less relative humidity. Hence, problem due to high humidity is not a constraint after back pruning. However, rainfall coupled with high humidity during the period of fruit pruning (October pruning) may cause the delay in bud break and also prone for diseases. More humidity may create a problem in the region where the irrigated crops like sugarcane and rice are grown in close vicinity of grape garden.

6.1.4 Temperature

In temperate countries the fruit bud differentiation takes place in next year on current season's growth whereas it happens during the period of 30-60 days after foundation pruning (back pruning) on current season's growth in peninsular India. Bud fruitfulness varies with genotype. Shoot vigor, thickness and temperature play an important role in fruit bud differentiation. More shoot vigor with respect to its inter-nodal length reduces the productivity of a vine. Experiments have revealed light and temperatures as the contributing factors for increasing the bud fruitfulness. Temperature seems to be more favorable than light for the fruitfulness of Thompson Seedless buds or higher light intensities than 3600 ft candles above 35° C could be favorable for fruitfulness of the buds in this variety. As per Chadha and Shikhamany (1999) the critical levels of temperature and light for bud fruitfulness in Thompson Seedless is 35° C and 3600 ft. candles respectively. Butrose (1969) found that at 13° C there was little fruit bud differentiation, but the bud fruitfulness increased to maximum at 30 - 35° C in all the varieties studied.

6.2 Training system

Training system plays an important role in the fruitfulness. The position of shoot is determined by the training system. Many training systems have been developed in the past and others are being developed to adapt vine growth to the climate and cultural conditions. Studies indicate that upward growing shoots are normally more fruitful than the downward shoots. The trellis system has a critical role in the efficient accommodation of grapevine growth. According to the basic canopy management principles, the training system must allow a uniformly distributed canopy with sufficient sunlight penetration for the continued production of healthy and equally ripened grapes of high quality (Smart, 1982, 1988, Smart, et al, 1990, Hunter, 1999).

6.2.1 Bower

In India, bower (pandal) is a major and popular training system used for grapevine because of its low cost. However, this system has certain drawbacks as it poses difficulties for cultural operations. Number of secondary and the shoots retained on each secondary are more in this system. The canopy is horizontal in nature. With the development of excessive foliage, there is reduction in the light interception in the vine canopy. Poor light interception not only reduces the fruitfulness of the buds but also delays the shoot maturity due to premature leaf fall. The system also develops the microclimate congenial for the development of the fungal diseases like downy mildew.

6.2.2 Flat Roof Gable (FRG)

In this training system, the canopy is trained vertically and therefore there is a scope to harvest maximum sunlight by individual shoot uniformly. The percentage of mature and fruitful canes are always more than the bower trained vines. Cultural practices are also easy in this system. Proper aeration in the vine canopy prevents the disease spread.

Table1: Comparison of fruitful canes in bower and Flat roof gable system of training.

Sl. No.	Characters	Bower	FRG
1.	No. Of canes/vine	More	Less
2.	Canopy architecture	Horizontal	Vertical
3.	Percent green shoots	More	Less
4.	Percent mature shoots	Less	More
5.	Per cent fruitful canes/vine	Less	More

6.3 Canopy

Canopy plays an important role in bud fruitfulness. Environmental factors such as the soil, available water and climate as well as cultural practices have a great impact on the vigour of vine. The well-balanced

canopy results in better bud differentiation and productivity. Any lapses during the critical stages of growth may lead to barrenness of the vine. Therefore number of shoots, its orientation, partial defoliation, tipping and use of growth retardants are some of the important considerations need to be followed in the canopy management.

6.3.1 Number of shoots/vine

After back pruning, about 70 to 80 shoots sprouts on each vine. If all the shoots are allowed to grow, there will be competition for nutrients, water and sunlight. Fruitfulness of bud depends on their exposure to the sunlight during bud differentiation stage. Excess shoots create the shading effect thus reducing the photosynthetic activity. The leaves of such shoots become yellow and drops down leading to immature canes. Such canes do not contain fruitful buds and hence they are removed at the time of fruit pruning. To avoid green canes during maturity stage, shoot thinning is recommended at 4 to 5 leaf stage after back pruning. This helps to avoid crowding of shoots, proper aeration and maximum sunlight harvest for bud differentiation. This type of canopy also avoid the incidence of disease. For export market cane density should be 0.7-canes/sq.ft areas during the period of back pruning and one cane for domestic market.

6.3.2 Shoot vigor

The growth arising from the sprouted bud is called shoot. The shoot growth is by cell division and cell elongation. Increase in the shoot length per day is termed as rate of shoot growth. The shoot grows faster during the first 30 days of back pruning. This period is called as grand growth period. Vigor of the shoot or the rate of growth is considered more when the time required to produce an extra leaf is less (Shikhamany, 1999). During the grand period of growth, the rate of shoot growth on the renewal spurs is more than that on the fruiting canes. The duration of shoot growth also varies with the variety and the climatic condition prevailing in the area. During the grand growth period, if the growth is not controlled, there will be an increase in inter nodal distance and shoot length. Vigorous shoot growth leads to

reduced fruitfulness that results in fillage ie. conversion of fruitful bud into tendril (Fig. 3).

Fig.3 Conversion of bunch into tendril

6.3.3 Position of shoot (horizontal vs. vertical)

Shoot orientation should be in such a way that each bud on shoot gets maximum available sunlight. Training grapes to trellis such as Geneva Double Curtain (GDC), T, Y, Tatura result in open canopies with diagonal shoot orientation to harvest more sunlight by individual buds on the shoot.

Besides the foliar density, the angle of the shoot with the horizontal surface influences the light interception. Long and thin shoot bend by its own weight narrowing the angle while the short and thick shoot tend to be erect increasing the angle and thereby more light interception in the canopy. The vertically grown shoot is exposed to the full sunlight uniformly (Fig. 4). On the other hand horizontally positioned shoots will not receive the light equally for bud differentiation and it's maturity (Fig. 5). To harvest maximum sunlight for uniform bud differentiation, the shoot should be short, medium in size and erect in position on the cordon (Fig. 6).

Fig. 4 Vertical canopy (FRG)

Fig. 5 Horizontal canopy (bower)

Fig. 6 Well-exposed shoots to sunlight

6.3.4 Cane thickness

There is a positive correlation of fruitfulness with cane diameter and position of shoot on the training system. The thick cane at the beginning becomes erect and thus helps in receiving the required sunlight uniformly on every buds of the shoot. With the increase in the cane thickness, the bud size increases but the time taken for bud sprouting also increases. More than the size of the cane, the quality of cane is important. The selected or retained canes on the vine should be of medium in diameter, round in shape and brown in color (matured). The buds on the canes should be plump. The canes of the shorter length are good for management and also have better fruitfulness (Fig. 7). The canes become flat if there is excess or deficit of nutrition like nitrogen in the vine during the vegetative stage (Fig. 8). Such canes are not useful. The length of the shoot or the cane depends on inter nodal length and number. More the inter nodal length, more will be the vigor of the vine (Fig. 9). The vigour in vegetative growth of plant is directly related to

the reduction in the yield of a vine.

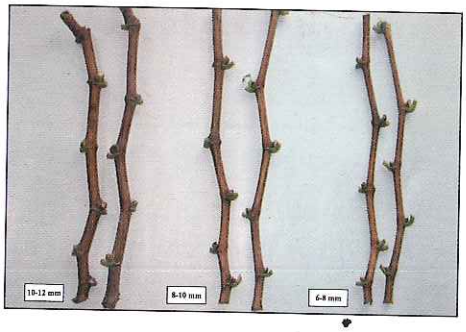


Fig. 7. Cane diameter (6-8 mm, 8-10 mm, 10-12 mm)

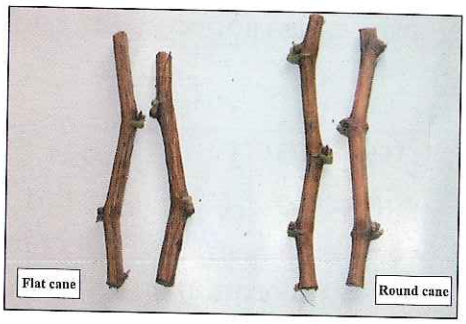


Fig. 8. Flat and round cane

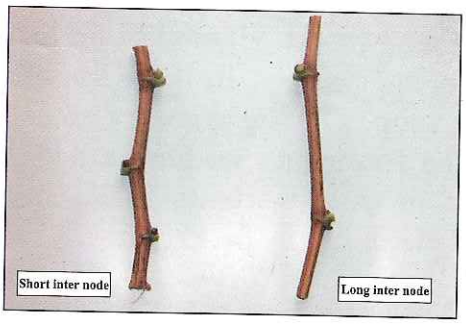


Fig. 9. Short & long inter nodes

6.3.5 Sub cane vs. straight cane

Sub-cane Development

Sub-cane is the lateral cane developed on main cane after shoot pinching. To develop sub-cane, the actively growing shoot after back pruning is to be pinched back to seven leaves by removing growing tip along with leaves. The cane developed from terminal bud is called apical sub-cane and the one developed from lower buds are lateral sub-canes. Sub-cane developments through shoot pinching improves fruitfulness of buds and also indicate the position of fruitful buds. This helps in minimizing the error in identification of fruitful buds at the time of forward pruning and the uncertainty of getting flower clusters from sprouted buds.

Another advantage of sub-cane development is reduced thickness and vigor of main cane and hence more productive, because thick and vigorous canes suppress the buds, which do not sprout easily even if it is fruitful.

6.4 Variety

In India, several varieties are available for cultivation. But, the grower has to restrict to only few varieties suited for his locality. Some varieties are location specific and do not perform well when grown in other region. Bangalore Blue for example grows well in Karnataka region, but when grown in north Indian conditions, fruit ripening is delayed. Pusa Seedless, a short duration variety is another example suited for north Indian condition only. Bud fruitfulness is very high in some varieties such as Muscat Hamburg and Arkavati, which is hereditary character of the variety. In these varieties, pruning at any level gives sufficient crop. On the contrary, the bud fruitfulness is variable in varieties like Thompson Seedless and its mutants. Therefore, the cultural practices in these varieties make sizeable difference in determining potential yield.

6.5 Rootstocks

The introduction of rootstock in grape cultivation is of recent origin. The increasing problems of soil salinity and drought felt the need of rootstock. The rootstock has the potential to sustain under adverse situation and also manipulation of vine growth and production. Rootstock plays an important role in maintaining equilibrium between growth and yield. Increase in yield is mainly due to the increase in fruitfulness of the vine under given set of condition. Direct effect of rootstock on fruit-bud differentiation and consequently on yield is attributed to the capacity of rootstock to synthesize the cytokinins (Shikhamany, 1999). It is well known fact that cytokinins are synthesized in roots and high cytokinin/gibberellins ratio was found to be favorable for fruit bud formation (Mullins, 1967). The study conducted at this centre on fruitfulness in relation to different rootstock showed that the variety Thompson Seedless grafted on 110-R rootstock

produced more fruitful canes than other rootstocks (Table 2).

Table 2: Fruitfulness of Thompson Seedless in relation to different rootstocks

Sl. No.	Rootstocks	No. of canes/vine	Average fruitful canes/vine	% fruitful canes/vine
1.	Dog Ridge	44.56	37.59	84.35
2.	110-R	43.37	37.62	92.69
3.	99 R	44.68	38.10	85.27
4.	St. George	39.37	30.12	76.50
5.	B - 2/56	43.37	37.56	86.60
6.	1613 C	41.31	34.81	84.26
7.	Salt Creek	42.62	36.81	86.36
8.	Own root	40.0	34.18	85.45

6.6 Irrigation

Excessive vegetative growth of vineyard commonly occurs in many cases due to injudicious use of fertilizer and irrigation. Poor viticulture practices such as excessive use of nitrogen fertilizers and irrigation contribute to excessive vegetative growth and canopy density at a given locality, resulting in decreased fertility of the buds. Excessive irrigation results into excess vegetative growth during the first phase of growth by increasing inter nodal distance. As a result, the differentiating bud gets converted into the tendril. Hence reduction of irrigation water during fruit bud differentiation stage to 1/3rd of the irrigation applied in the beginning of growth stage is generally recommended in heavy soil. This helps in better fruit bud differentiation.

6.7 Nutrient management

Nutrition is considered as the major factor in determining th productivity of vines. Phosphorous induces the flower initiatio through synthesis of proteins and nucleic acids favorable fo inflorescence formation. It determines carbon dioxide fixation, ce membrane development and movement of essential structures. Its rol also has bearing on energy storage and transfer (Adam Jacobs, 2002) Phosphorous application at 30 days after foundation pruning is know to increase the bud fruitfulness. Apart from phosphorous, zinc is als an important nutrient for fruit bud differentiation. Application o phosphorous during this stage appears to promote fruitfulness throug the synthesis of higher rates of ribonucleic acid (RNA) in the buds. A per Madhavarao and Srinivasan (1971) the rate of RNA synthesis an the ratio of RNA/DNA was higher in fruitful buds.

More vegetative growth due to excess nitrogen results in fla cane. These types of canes become unfruitful. Hence, application o nitrogenous fertilizer during 30 to 60 days after foundation pruning i generally avoided. Nitrogen plays an important role during first phas of vegetative growth for the formation of anlagen which is a protei mass. Hence, application of nitrogen in a proper quantity should b restricted up to first 30 days after foundation pruning. However, excess nitrogen during this period delays the flower bud initiation by increasing vegetative growth and shading effect. Application of potash is generally recommended from 60 days onwards. This helps in proper growth of differentiating bud in the cane and also advancing the maturity of canes. However, location specific adjustments with respect to soil fertility are to be made.

6.8 Growth regulators and retardants

There is negative correlation between cane vigor and bud fruitfulness. Curtailing the growth of vigorous shoots during grand growth period helps to reduce the growth rate and increases chance of

bud fruitfulness at the lower level of buds than in more vigorous shoots.

During this phase, if the vegetative growth continues, the shoot length increases bending the shoot down due to its own weight. Such shoots will not receive uniform sunlight required for photosynthesis thereby hampering the carbohydrate formation and also the cane maturity. Reducing the shoot vigor is therefore an important operation during this stage. Some of the growth regulators play an important role for fruitfulness in vines. Application of 6 BA @ 10 ppm at 40 and 50 days and Uracil @ 50 ppm at 45 days after foundation pruning helps in bud differentiation in the cane. Gibberellic acid (GA_3) at pre bloom stage helps in proper bunch elongation. However, excess use of growth regulators lead to the unfruitfulness in the next season. It was observed that the excess GA_3 applied on Thompson Seedless grapes during pre bloom stage had adverse effect in the next season. The fruitfulness in such vines was reduced tremendously during the next year. Spraying growth retardants like CCC @ 500 ppm after April pruning can increase cane thickness and increase bud fruitfulness through

1) Reduced vegetative growth
2) Increased shoot thickness
3) Reduced inter-nodal length by counteracting the endogenous level of gibberellins
4) Increased endogenous cytokinin levels and consequently ratio of cytokinin / gibberellins congenial for formation of inflorescence primordia

7. Cultural means to increase the bud fruitfulness

7.1 Increasing number of clusters to cane ratio

As stated earlier, productivity per unit area is not a problem in India. But, the cluster to cane ratio is far less than temperate countries. Hence, proper cultural operations should be followed after April pruning to increase the cluster to cane ratio.

7.2 Promotion of cytokinin / Gibberellin ratio

Application of 6 BA @ 10 ppm at 40 and 50 days after back pruning to shoot apices will prevent tendril primordial and favors the formation of inflorescence primordial since cytokinins plays a vital role in influencing the process of inflorescence formation, differentiation of flowers and pistil development.

Skoog and Tusi (1951) reported that certain purines could favors bud formation and increase the nucleic acid content of cells. Cheban (1968) reported the effect of purine is consonant on the positive correlation between nucleic acid contents of the buds and the fertility in different varieties of grapes.

7.3 Level of pruning

Level of pruning during October (fruit pruning) is of prime importance in obtaining good yield. The level of pruning in a cane depends on position of fruitful buds. The position of fruitful buds varies with the variety and vigor of cane within a variety.

If sub-cane system is practiced after April pruning the sub canes can be pruned leaving 1-2 buds above the knot. Under straight cane, one should determine the position of fruitful buds by dissecting the buds under microscope before October pruning for detecting the level of pruning.

For this purpose, about 45 - 50 canes should be taken randomly from one-acre vineyard and tested under the microscope carefully to observe the presence of flower clusters. Based on the results of this test decision relating to the level of pruning be made.

7.4 Cluster thinning

Under good cultural management practices, a grape vine tends to have more clusters. Retaining all the flower clusters adversely affects the quality and in colored varieties it results in poor development of color. Hence, cluster thinning is required to a desired level depending on the market or purpose for which crop is produced.

8. Summary

Grape is one of the major fruit crop grown in India. In peninsular India, grapes are pruned twice in a year. The vines are pruned in April for shoot formation and cane development which also leads to fruit bud formation and storage of reserve in the cane. The pruning is again done in October for yield. Number of bunches are the indicator of yield in a particular vine which depends on the fruitfulness of the canes. Yield is a product of number of flower clusters over unit area and the mean weight of the cluster. Fruitfulness of the canes is decided during the same period after back pruning. Yield in grape is dependent on the cultural practices followed after back pruning (April to September).

Productivity refers to the inherent capacity of grapevine to produce maximum yield. The productivity of grape varies from variety to variety. There is a large gap between the productive potential of vine and the actual yield obtained under field conditions, hence, there is scope for reducing the gap between productive potential of vine and the actual yield by adopting various cultural practices. These include crop regulation, use of growth regulators, training and canopy management and disease and insect control, etc.

Pruning is considered to be the most important operation in grape cultivation. The purpose of pruning in grapes is to concentrate the activity of a vine in the parts left after pruning and to regulate for ensuring the production through fruitfulness every year.

In grape, pruning is essential for fruit bud differentiation since the clusters are born on the new growth emerging from the past seasons growth. The fruitful buds are located at different zones. If the canes are not pruned, the buds from main productive zone may not sprout leading to poor bud fruitfulness.

Single pruning is followed in temperate regions of the country since only one growing season is available to the crop, it is pruned once with the onset of spring or during late winter in North Indian condition. However, double pruning system is followed in Maharashtra, Karnataka and Andhra Pradesh.

Fruitfulness is the result of transformation of vegetativ primordial into reproductive primordial. This transformation is carrie out in three different stages ie., anlagen formation, formation o inflorescence primordial and formation of flower.

Formation of inflorescence primordial is the most sensitive stag though formation of anlagen itself is considered to be the stage o initiation of inflorescence axis. Any imbalance among the facto responsible for floral differentiation would make the anlagen t differentiate into either tendril or vegetative shoot.

It is important to know the various growth stages to follow suitable cultural practices to increase fruitfulness since fruitfulness i grape involves the factors prevailing after both the foundation and frui pruning.

The vegetative growth starts from bud sprouting till fruit bud differentiation. During this stage, correct application of nutrient especially nitrogen and enough quantity of irrigation water is essentia for proper shoot development. Excess bud sprouts should be thinne out to facilitate development of optimum number of shoots with good vigor.

At the end of vegetative growth stage of the vine, the reproductive stage starts in which the bud on a shoot grows in size and shape and the bud differentiation starts. The anlagen are capable of differentiating into inflorescence or tendril primordial. This is generally completed between 45 to 60 days after pruning.

At the end of bud differentiation, the process of cane maturity takes place. The change of green color to brown is the indication of cane maturity. Depending on the weather conditions after back pruning, the maturity starts after 60 days.

Light is essential for the photosynthesis of grapevine. The rainfall in the grape growing area has direct impact on the fruitfulness. A rain during the stage of fruit bud differentiation (40 to 60 days after back pruning) is not favorable for grape since the excessive shoot growth will hamper the initiation of floral primordial.

Light and temperatures are the contributing factors for increasing bud fruitfulness. Temperature Less than 15° C and more than 45° C affects the fruitfulness.

Training system plays an important role in the fruitfulness. Upward growing shoots are normally more fruitful than the downward shoots. In Flat roof gable the canopy is trained vertically and therefore there is a scope to harvest maximum sunlight by individual shoot uniformly. The percentage of mature and the fruitful canes are always more than the bower trained vines. Excess shoots in the canopy create the shading effect thus reducing the photosynthetic activity. The leaves become yellow and drops down making the cane immature.

Besides the foliar density, the angle of the shoot with the horizontal surface influences the light interception. Long and thin shoot bend by its own weight narrowing the angle while the short and thick shoot tend to be erect increasing the angle and thereby more light interception in the canopy.

There is a positive correlation for fruitfulness with cane diameter and position of shoot on the training system. The thick cane at the beginning becomes erect and thus helps in receiving the sunlight uniformly on every buds of the shoot.

Bud fruitfulness is very high in some varieties such as Muscat Hamburg and Arkavati, which is hereditary character of the variety. In these varieties, pruning at any level gives sufficient crop. On the contrary, the bud fruitfulness is variable in varieties like Thompson Seedless and its clone. Therefore, the cultural practices in these varieties make sizeable difference in determining potential yield.

Rootstock plays an important role in maintaining equilibrium between growth and yield. Increase in yield is mainly due to the increase in fruitfulness of the vine under given set of condition.

Phosphorous application at 30 days after foundation pruning is known to increase the bud fruitfulness. Apart from phosphorous, zinc is also an important nutrient for fruit bud differentiation.

Poor viticultural practices such as excessive use of nitroge fertilizers and irrigation contribute to excessive vegetative growth an canopy density at a given locality, resulting in decreased fertility of th buds.

Curtailing the rapid growth of vigorous shoots during gran growth period helps to reduce the growth rate and increases chance o bud fruitfulness at the lower level of buds than in more vigorou shoots.

Application of growth regulator i.e. 6BA @ 10 ppm at 40 and 5 days after pruning and Uracil @ 50 ppm at 45th day helps in increasin the fruitfulness.

9. ANNEXURE

Different growth stages and the schedule of cultural operation followed.

Days after pruning	Stage	Cultural operations to be followed
APRIL PRUNING		
25-30	5-7 leaf	Sub cane development (Pinching) is required.
31-60	Fruit bud differentiation	Phosphorous, Cytokinin Uracil, application is required
61-120	Cane maturity begins	Potash application
121-135	Cane maturity and leaf senescence	Dissection of buds under microscope
150-180	Forward pruning	Before October 15th (Night temp. >150C)

10. Do's and don'ts to ensure fruitfulness in grapes

Do's

a) Retain appropriate number of shoots as per area available to the vine and remove the excess shoots.

b) Train the shoots properly so as to harvest maximum sunlight for photosynthesis.

c) Spray CCC @ 500 ppm at 5 leaf stage after back pruning and subsequently as per the requirement.

d) Spray 6 BA @ 10 ppm at 40 and 50 days after back pruning.

e) Spray Uracil @ 50 ppm at 45 days after back pruning.

f) Reduce the irrigation to 1/3 level of the normal requirement during the bud differentiation stage.

g) Apply phosphatic fertilizers and zinc during 40 to 60 days after back pruning.

h) Check the buds under microscope before pruning the vine.

i) Adjust the pruning time so that the period of fruit bud differentiation does not coincide with high humidity and rainfall.

j) Apply nitrogen fertilizers judiciously to have appropriate vegetative growth.

k) Irrigate the vines as per its requirement.

l) Take appropriate control measures for pest and diseases.

Don'ts

a) Avoid use of excess nitrogenous fertilizers

b) Avoid the shading of shoots.

c) Do not allow the excess vegetative growth.

11. References

1. Adam Jacob, 2002. A balanced approach to vine nutrition. Australian & New Zealand Grape grower & Winemal November 2002. Pp.22.
2. Bessis, R. 1968. On the occurrence and nature of the loss floral primordial in the vine. C.R. Acad. Agric. Fr. 53:14 36.
3. Buttrose, M.S.1969. Fruitfulness in grapevines: Effect of li intensity and temperature. Bot. Gaz. 130: 166-73.
4. Chadha, K. L. and Shikhamany, S. D. 1999. The Gra Improvement, Production and Post harvest managem Malhotra Publishing house, New Delhi, India. Pp. 193-1
5. Chadha, K. L. and Shikhamany, S. D. 1999. Climate. Grape-Improvement, Production and Post harv management. Malhotra Publishing house, New De India. Pp. 11.
6. Cheban, A.I.1968. Content and accumulation of nucleic ac in buds of wintering grape eyes at various stages of th seasonal development. Sov. Plant Physiol. 15: 276-81.
7. Hunter, J.J.1999. Present status and prospect of wine gr viticulture in South Africa focus on canopy rela aspects/practices and relationship with grape and w quality. In Proc. 11th Meeting of study group for V Training System (GESCO), 6 12 June 1999, Sicily, Italy. 70-85.
8. Kriedmann, P.E. and Smart, R. E. 1971. Effect of irradiar temperature and leaf weather potential on photosynth of vine leaves. Photosynthetica, 5: 6 15.
9. Madhavarao, V.N. and Srinivasan, C. 1971. Nucleic a composition in the developing buds and petioles grapes. Vitis, 10: 103-6.
10. Mullins, M.G.1967. Morphogenetic effects of roots and sc synthetic cytokinins in Vitis vinifera L. J. Exp. Bot. 18: 2 214.

11. Pandey, R.M. and S.N. Pandey, 1993. Physiology of flowering and fruit growth in Grapes. Advances in Horticulture. Vol.3 Fruit Crop. Malhotra Publishing House. Pp. 1205-1216.

12. Satyanarayana, G. and Shikhamany, S. D. 1986). Fruitfulness in grapes A review. Indian Grapes. J. 2 (2 & 3): 1-29.

13. Skoog, F and Tusi, C. 1951. Growth substances and the formation of buds in plant tissues. (in) Plant Growth Substances (Skoog, F. Ed.,), University of Wisconsin Press, Madison.

14. Smart, 1982.Vine manipulation to improve wine grape quality. In: Webb, A.D.(ed.) Proc. Grape and wine Centennial Symp., 18-21 June, 1980, Davis. California. Pp. 362-375.

15. Smart,R.E., 1988. Shoot spacing and canopy light microclimate. Am. J. Enol. Vitic. 39: 325-333.

16. Smart, R.E., Dick,J.K., Gravett,I.M. and Fisher,B.M. 1990. Canopy management to improve grape yield and wine quality principles and practices. S.Afr.J.Enol. 11: 3-17.

17. Terry Bates, Christine Cummings and Staff (2001) Grape Cultural Practices. Lake Erie Regional Grape Program Crop Update. Pp. 3-6.