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FACULTY OF AGRICULTURAL SCIENCES & ALLIED INDUSTRIES

Cultivation of Grapes

- Botanical Name: *Vitis vinifera*
- Family: Vitaceae
- Chromosome Number: 2n=38

Preamble

Grape is an important sub-tropical fruit crop in India. The average productivity of grape in India is 16.95 tonnes/ha, the highest in the world.

Origin and distribution

- Asia minor- it is between Caspian & black sea. Major world producers of grape are Spain, Italy and France
- In India, grapes are grown in about > 63,000 ha with a production of about 16.67 lakh tonnes.
- Major grape growing states are Maharashtra (21,000 ha) Karnataka (5500 ha) TN (2475) Punjab (2400 ha), AP (2500 ha) Haryana, UP & M.P.

Soil and climate

- Grapes can be grown in wide range of soils if climate is suitable. Sandy loam with good drainage, fairly fertile with good organic matter are best suited.
- Optimum pH with good organic matter are best suited. Optimum pH range is 6.5-7.5.
- Heavy soils, very shallow soils, ill drained alkaline soils are not at all suitable.
- Grape grows well in all areas with warm to hot dry summers and cool winters.
- Showers or rain flowering is very dangerous to grapes and reduces yield to a greater extent.
- Optimum temperature range is 28-32^{0}C.

Uses of grapes

Grapes are used for

1. ***Table purpose***

- Table grapes are meant for use as fresh fruit consumption.
- These grapes are attractive in appearance and eating quality and with good shipping and keeping qualities.
- Most of the varieties grown in India are table fruits.
- The important table grape varieties are Muscat Humburg, Cardinal, Perlette, Thompson seedless (Sultanina), Tokay, Concord, anab-e-shahi, pusa seedless, Delware, Catawba, Ohanez, Red Malaga, Emperor, Italia, Muscat of Alexandria, etc.

2. ***Raisin making***

- These are th grapes intended for making dried grapes.
- The raisin variety of grapes should have soft texture, selflessness with good sugar content, marked pleasing flavour, large or very small size; and little tendency to become sticky in storage.
- The varieties most extensively used in the commercial production of raisin include Thompson seedless (Sultania, Oal Kishmish), Seedless sultana, Red Corinth, Cape Currant and Black Monukha.

3. ***Juice making***

- The varieties of sweet juice grapes produce juice of acceptable beverage.
- The juice should retain the natural fresh grape flavour throughout clarification and preservation.
- In United States of America the Concord grapes are in general for Juice.

- The varieties White Riesling and chasslas dore are used for juice in the central Europe.
- The varieties Aramonand Carignan are utilized for sweet juice in France.

4. ***Wine making and canning***

- Most of the vineyards in Europe, North Africa, South Africa, and South America, Australia and United States of America produce wine grapes.
- Wines are classified as table wines and desert wines.
- Table wines contain less than 14 per cent alcohol while the desert wines have more than 14 per cent alcohol, usually 17 to 20 per cent sugar acid ratio, total acidity and tannin content etc., will determine the wine quality.
- The varieties such as White Rieslin, Chardonnay, Cabernet Sauvignon, Tinta Maderi and Muscat Blanc (*Muscat canelli*) produce wines of high quality, outstanding in bouquet, flavour and general balance (Winker, et al. 1974).

5. ***Canning Grapes***

- Seedless varieties like Thompson Seedless and canner are generally canned in combination with other fruits. The varieties grown in Tamil Nadu belong to 'table' grapes. Pachadraksha, Muscat ("Panneer"), Anab-e-shahi & Bangalore Blue are the main varieties
- The genus vitis is sub-divided into two sub-Genera, Muscadinia and Euvitis. The Muscadina have 40 chromosomes while that of Euvitis have 38.
- *Vitis vinifera* is the most popular species of grapes grown in the world. Venifera grapes have forked tendrils and shiny leaves.
- *Vitiis riparia*, rupestries, berlandieri, candicans, rufotomentosa and solanis are popular rootstocks for phylloxera and nematode resistance.

Cultivars

There are thousands of cultivars of grapes.

Most popular ones are:

Coloured seeded grapes:-

B. Blue- a cross between

- V. vinifera X V. labrusca- table, juice, wine

Characters of Vitis and Muscadinia

Characters	*Vitis*	*Muscadinia*
Shoots	Bark is longitudinally striate, fibrose	Tight bark, non-shedding, with prominent lenticels
Pith	Interrupted in nodes by a diaphram	Without diaphram
Tendril	Forked	Simple
Flower clusters	Elongated	Short, small
Berries	Adheringtothe cluster at	Detach one by one they mature

	maturity	
Seeds	Pyriform with long or short beak	Oblong without beak

- Gulabi, Abyad- table, juice- early type.
- Banaqui Abyad- table, wine- early,
- Kishmish charni Black champa- processing & for hybridization purpose only.
- ***Coloured Seedless***: Beauty seedless (blue black)mid-season,
- Krishmish Charni (brick red) Mid-season (sharad seedless).
- Flame seedless (Purple) late.

White seeded

- Anab-e-shahi-late
- Dilkush-clone of AES
- Cheemasahebi (Selection from Pandari sahebi) late.
- ***White seedless***: Perlette (Scolokertekhirolaynoje X Sultania marble)
- ***Pusa Seedless***: Superior than perlette- Mid.
- Thompson Seedless mid- Tas-e-Ganesh, Manik Chaman, Sonaka are clones.
- Arkavati- BlackChampaXThompson Seedless-late.
- Delight-Sister seedling of perlette- early.
- Homorod- ContarioX Sultania.

Propagation

- Propagation by hard wood stem cuttings, Treating cuttings with IBA improves rooting.
- Single bud cuttings also can be rooted by keeping the base of the cutting at a constant temperature of 18-200C for 2-3 weeks.
- While, using root stocks, grape can be propagated by chip budding or grafting.

Phylloxera resistant rootstocks

- Riparia Gloire- Selection from V. riparia.
- St. George - Cultivar of V. rupestris
- 4x2 (Ganzian)- (V.vinifera (Aromon) X V. rupestris (Gonzin).
- 1202- (V.rupestries and V. mataro).
- 99- (V. berlanderi X V. rupestris).

Nemotode resistant rootstocks

- Dogride- cultivars of V. champin.
- Salt creek, 1613- 1616- (V. solonis X V. paria).
- Telecki 5A- (V. berlandarix X V. riparia 5A 1616).
- Solonis 1616- suitable for saline & wet soils.

Planting

- Pits can be of 1 m cube and filled with mixture of soil and manure.
- One year old plants are planted pruning the stem to 2-3 buds.
- Spacing varies according to the method of training and variety from 1.2 to 5.0 m X 2.5 to 6.6m.
- Pandal system requires maximum spacing. As the plant grows staking should be provided.

- Best time for planting is Jan-Feb for rooted cuttings and October for unrooted insitu planting.

Manures and fertilizers

Average crop of grape removes 40-60 Kg N, 10-15 Kg P and 50-70 Kg K per ha from the soil.

Manorial schedule for grapes is Anab-e-shahi:-

- N-150kg /ha during April, 50 Kg (May) + 100 Kg (Oct) + 100 Kg (Nov) 100 kg (December).
- P-1200 Kg/ha (April) 100 Kg (May) 200kg Oct.
- K -300 kg (June), 100 kg Oct, 200 kg Nov, 200 kg December, 200 Kg January.

Thompson Seedless:

- N-100 kg (April) + 100 kg Oct+ 50 Kg (Nov)+ 50 kg December.
- P- 200 Kg (April) + 100 (May) + 200 Kg October.
- K-300 kg June+ 100 Kg 0ct+200 Kg Nov+200 Kg December +200 Kg January.

Fertilizer schedule for North India:

- N-250 Kg Feb+ 350 Kg March + 100 Kg Oct/ha.
- P-800 Kg April + 400 Kg May.
- K-400 Kg May + 400 Kg June+200 Kg October.
- 60 g urea + 125g MOP are recommended for newly planted plants in April & June.

April Pruning	**October Pruning**
Anab-e-Shahi-200:300:300kg / ha	300:200:700 kg/ha
Thompson Seedless-100:300:300 kg/ha	200:200:700 kg/ha

Application of fertilizers should be done starting from 1 month after pruning only as the roots will not be active till such time.

Foliar application of micronutrients specially Iron, Zinc, Boron, Manganese at Pre-bloom and bloom stage were reported to improve quality and quantity of yield.

Irrigation

Grape requires less water during fruit bud formation and more water during berry growth. Reduced irrigations during ripening improves the quality.

Drip irrigation is becoming more popular.

Water requirements under drip are:

- 1-40 days after summer pruning -48000-60,000 liters/day
- 41-100- days after summer pruning-24000-32,000/litres/day
- 101-winer pruning days after summer pruning- 15000-20,000 liters/day
- 1-45 days after winter pruning 20,000-24,000 liters/day
- 46-75 days after winter pruning -20,000-24,000 liters/day
- 76-100 days winter pruning 48,000- 60,000 liters/day
- 101- harvest summer pruning 36000-48000 liters/day

Intercultural operations

- Daincha and sun hemp can be grown as intercrops to check weed growth paraquat (7.5lit/ha) as post emergence application controls weeds effectively.
- Pandal system discourages weed growth to maximum extent. Mulching with paddy husk will reduce weed growth, water requirement and improves the quality of yield.

- Spraying CCC at 500PPM at five leaf stage after back pruning increases fruitfulness.
- GA at 10PPM spray 22-25 days after for pruning elongates the clusters.
- Dipping of clusters in 60PPM GA at bajra grain to red gram sized berries increases berry size.
- Girding the fruit bearing shoot also improves berry size.
- 1 g of grape production requires 16-26 cm2 leaf area.

Weed management

- It is critical to have minimum or no weed competition at the time of planting new vines so weed control before planting is important.
- Take measures to deplete the soil weed seed bank. A summer fallow treatment of irrigation followed by tillage and then drying can reduce weed seed numbers in the soil. Repeat this cycle several times to further deplete weed seeds in the soil. Weed seeds located in the surface 4 inches of soil can be buried to depths where they cannot emerge with a soil-inverting plow such as a Kverneland plow; a moldboard plow will not sufficiently invert the soil to be effective.

Soil solarization

- Soil solarization of the planned vine row can also significantly reduce weed populations. The soil must be moist and the width of the solarized area should be at least 6 feet. Bury all sides of the plastic to create a seal on the soil; this also helps prevent the plastic from being blown away by wind. Machines that lay down the plastic are available to automate the process.
- Solarization must be done during summer and should be started at least by the beginning of August to have sufficient time (4 to 6 weeks) to complete the process. Clear plastic or a plastic with a coating that suppresses weed seed germination can be used. Black plastic suppresses weed seed germination but will not heat the soil sufficiently for solarization. Plastic mulches may not be successful in suppressing species like nutsedge.

WEED MANAGEMENT AFTER PLANTING

Cultivation

- Mechanical cultivation uproots or buries weeds. Weed burial works best on small weeds, while larger weeds are better controlled by destroying the root-shoot connection or by slicing, cutting, or turning the soil to separate the root system from the soil. Keep cultivation shallow to minimize damage to crop roots and to avoid bringing more weed seeds near the surface to germinate.
- Perennial weeds with established root systems are difficult to kill with a single tillage operation. With tillage, the top is removed and a new top is generated using the underground reserves. For perennials, tilling 3- or 4-inches deep reduces the reserves, forcing the weeds to use a greater portion of the reserves available to regenerate. Several companies make cultivation equipment. Trip mechanisms on vineyard cultivators prevent damage to the vines. Even the best cultivators will not eliminate all weeds, thus hand hoeing is often needed. Hand cultivation alone may be effective on a small scale.

Mulches

- Mulches can also help with weed control in the vineyard. The mulch blocks light, preventing weed germination or growth.
- Many materials can be used as mulches including municipal yard waste, wood chips, straw, hay, sawdust, and newspaper.

- To be effective, mulches need to block all light to the weeds; therefore different mulch materials vary in the depth necessary to accomplish this.
- Organic mulches must be maintained in a layer 4 or more inches thick.
- Organic mulches breakdown with time and the original thickness typically is reduced by 60% after one year. Cover crops can be grown in the middles; in the spring "mow-and-throw" the mulch in around the base of the vines.
- Weeds that emerge through the mulch can be controlled using an organic contact herbicide or with hand hoeing.
- Do not plant cover crops under the vine row because excess competition may occur, possibly reducing grape yields.

Herbicides

- Several organic, contact-type herbicide products are registered for use.
- These soap-based (Scythe), clove oil based (Matran 2), or acetic acid based (All-Down) products all damage any green vegetation contacted, including the leaves and young stems of grape vines.
- Apply these products as directed sprays against woody stems and trunks. Because these herbicides only kill contacted tissue, good coverage is essential. Thus, adding an organically acceptable surfactant is recommended. Because these materials lack residual activity, repeat applications will be needed to control new flushes of weeds.

Training

- The training of the vine depends on two fundamental factors namely, the growth characteristics of a variety and the influence of the local climate on the growth of the variety. In addition, the training system selected should take cognizance of economic aspects also, such as the initial outlay on erection, subsequent maintenance and cost of production of the crop. Defective training may result in delayed bearing and irregular development of vines resulting in reduced yields. The reduction, in yield may also be due to the failure to utilize properly the full vigour of the vines.
- Training system adopted widely in India is the bower systems.
- Ever since the introduction of grapes in Tamil Nadu, the grape has been trained in overhead arbours or Pandals. This system predominates in this State. Other systems of training are practically unknown to the commercial grape growers of this region. In some areas (Madurai district) live stakes of Commiphora species (Kiluvai) available in the forest areas nearby are used for erecting pandals. The height of the bowers is however very low and the root effect of the stakes is an objection. Recently, growers are going in for stone and cement pillars or even G.I. tubes. The overhead canopy is made of either thin bamboos (2 to 2.5 cm) or G.I. wires of different thickness, (8 to16 in guage). The cross piece connecting the pillars are made of thick bamboos or trek-wood or palmyra rafters or iron tubing. The wires are spaced (30 x 45 cm) or 30 x 30 cm. apart forming a network.
- The rooted cutting planted in the field reaches a height of 180 cm. (6 feet) in about three months. When the main stem is pinched at the top that is about 15 cm below bower. Two to four side shoots are allowed to grow and are trained on either side of the trunk or on four sides to from the arms subsequently. These side shoots or main arms as they are called are allowed to reach the periphery of the pandal and they are then tipped. On these arms secondaries are produced and allowed to grow on the main arms at intervals of 45 cm from each other alternately in opposite directions. These branches are trained to cover

the framework uniformly. These secondaries in turn give rise to 'tertiaries' on which canes develop and produce the shoots carrying, bunches. Some growers allow only one arm to develop in one direction with the secondaries spaced at convenient intervals. Many of the growers allow the arms to grow long and unchecked, twist them back so that the vine is full of wood of all kinds and it is difficult to train the vine properly.

The advantages of the Pandal system of training are as follows:

1. The climate prevailing in India affords full scope for the vine to grow as luxuriantly as possible. Consequently, it facilitates harvests of a succession of crops at intervals of 4 1/2-5 months.
2. The crop gets enough sun shine uniformly for their proper development.
3. Plant protection measures are more effective in this system, especially against mildew.

- To compare different systems of training, investigations were undertaken at the Agricultural College and Research Institute, Coimbatore and at Fruit Research Station, Periyakulam, with the varieties Anab-e-Shah and Pachadraksha. In the variety Anab-e-Shahi the pandal system produced maximum number of shoots per vine and per acre. The proportion of well-developed shoots to weak ones was higher in the pandal and the signal stake system than in the kniffin system. The vine vigour as shown by the weight of prunings per acre was the highest in the pandal system followed by the kniffin system. Pandal system produced more than three times as many fruiting canes per vine as other two systems: The percentage increase of fruiting canes over the single stake system, when calculated per acre, for the pandal and kniffin systems is 79 and 19 respectively as shown below.

Effect of different systems of training on fruiting canes

System of training	Vine density per acre	Mean No. of spurs calculated per acre		% increase over single stake system	
		Fruiting	Renewal	Fruiting	Renewal
Pnadal	268	27,952	13,427	179	124
Kniffin	806	18,407	20,392	119	188
Single stake	537	15,519	10,847	100	100

- From the point of view of fruit production, the pandal system was found to be superior both in vine yield and acre yield to the kniffin and single-stake systems and the single stake system was slightly more productive than kniffin system. The percentage increase of crop production over kniffin training is 263 for pandal and 40 for single-stake. It was also observed that the pandal system encouraged maximum development of berries, bunches and ultimately yield than the other systems.
- Fruit quality was not influenced by the system of training and the duration of the crop was also not changed by the system of training.

Efficacy of different system of training on productivity of grapes

System of training	Spacing (m)	No. of vines per acre	Yield per acre (kg)	%. increase over kniffin system
Pandal	6 x 3	268	6,531	363
Single Stake	3 x 3	537	2,550	140
4-arm Kniffin	3 x 2	806	1,313	100

A similar trial was conducted at the Fruit Research Station, Periyakulam on the different training methods with the variety Pachadraksha. It was observed that the vines trained in pandal system of training recorded the maximum yield (3164 bunches weighing 675.4 kg per plot), followed by double horizontal cordon system (2,432 bunches weighing 526.5 kg). The head system of training recorded the minimum yield. With regard to the quality of the fruits the bunches from the pandal system of training recorded the highest total solid content.

Yield (No. of bunches) in different sections of pandal in the variety *Anab-e-Shahi*

Section No.	Feet from center	I crop	II crop	Total	% of total yield
1.	0-8	31	19	50	7.58
2.	9-16	76	36	112	16.8
3.	17-24	115	77	192	28.8
4	25-32	167	146	313	46.9
Total		**389**	**278**	**667**	**100**

- In the pandal system, the productivity of the vine varies with the different segments on the arbour. Under the system of continuous pruning adopted by the growers in Tamil Nadu with no provision for found at in or back pruning, the bearing area is carried closer to the periphery leaving the center of the vine barren. In an experiment conducted on this aspect it was found that the productivity was the highest (47 per cent) in the last eight feet of the pandal in the peripheral side, when the vine had a spread of 32; on either side of the trunk. The first eight feet from the trunk accounted for only 7 per cent of the crop.
- Bindra and Brar (1978) studied the yield and quality of Beauty Seedless as influenced by the various training systems. Six years studies revealed that the bower trained vines gave about three fold increased yield than those trained on head system. Kniffin and telephone systems were in between the two but kniffin trained vines out yielded the telephone trained vine. Bilateral cordons produced more yield as compared to unilateral cordons especially in telephone system. Experiments carried out at Tamil Nadu Agricultural University, Coimbatore, Punjab Agricultural University, Ludhiana, and Haryana Agricultural University, Haryana to evaluate the suitability of different training systems of various commercial cultivars revealed the superiority of bower system over other systems of training. Experiments carried out at Tamil Nadu Agricultural University, Coimbatore with Muscat Hamburg on pandal (bower),

telephone, kniffin and head systems of training revealed that pandal system was more economical with the highest cost benefit ratio of 1: 2.09 followed by 1:1.71 in telephone, 1:1.42 in kniffin and lowest being in head system with 1:0.05 (Anon. 1982).

- Tolmer and brar (1982) studied the efficacy of four training systems viz. bower, telephone, kniffin and head in four cultivars namely Perlette,
- Thompson Seedless, Beauty Seedless and Himrod. Among the training systems, bower gave higher yield which was .146, 1.70 and 3.05 tonnes more than telephone, kniffin and head systems respectively.
- Chadha (1984) remarked that research on training in other country has been given a major emphasis, whereas in India only conventional systems are evaluated and no innovations in this regard have been tried.

This aspect therefore needs priority attention and newer systems of training are required keeping in view the following points.

1. Adequate ventilation and light interception.
2. Orientation of the shoots either vertically or diagonally for greater exposure to light.
3. Economy and vine productivity.
4. High density planting.

Types of training

The different training systems are described hereunder.

Single-stake System

- A single shoot is allowed to develop from the vine of rooted cuttings and is trained vertically by staking to a support.
- When this shoot reaches a height of 120 cm. it is tipped and allowed to produce 4 to 5 secondary branches or canes, which are pruned after every bearing season.
- The main stem and the primary laterals are supported by a bamboo post planted nearby.

The Four-arm Kniffin System

- In this method, the vine is allowed to put forth a single shoot which is trained erect and tipped at a height of about 45 cm from the ground level.
- Only three shoots are allowed to grow from this point, all others being removed.
- Two of the retained shoots are trained horizontally and the remaining is trained vertically to a height of another 60 cm.
- When it is tipped to a height of another 60 cm. When it is tipped again to produce two more shoots, which are trained horizontally.
- All the four horizontal arms are supported by bamboo poles or wire tied horizontally to posts fixed at regular intervals of 3 metres.
- Primary laterals are allowed to develop from these four main arms at fairly regular intervals and these are pruned to produce the crop every season.
- For every fruiting cane, a renewal spur of 2 to3 buds is left. Normally only four canes are allowed in the 4-cane kniffin system and 6 canes in the 6-cane system.
- Under tropical conditions it is possible to have doubled the number.

Wire Trellis System

- In this system two or three wires are strung in rows from vertical posts. A single stem in between the posts is trained as far as the top of the wire 2.1 m. and two arms are allowed to develop along the wire on either side. Each arm will meet the arm from the adjacent

vine and will have two arms with six tertilaries. The spurs on the fruit bearing shoots growing on these canes are seasonally pruned for fruit every year.

- Because of its resemblance to the telephone pole with its flat topped mast bearing the supporting wires, this is called as Telephone Trellis system. In this system there is large flat-topped T-Trellis above ground level. The horizontal cross is 120 to 150 cm wide with wires strung on the top 30 to 45 cm apart. The vines are trained along the wire in the direction of the row. Steel angle iron or waste structural steel is used when available and the cross arm is welded to the upright. In a few vineyards the flat top is modified by bending each half of the mast upwards about 30° so that a trough shaped or 'H' shaped form is obtained. The disadvantage in this system is that there are no cross-supports to the rows to withstand strong winds. Cultivation and movement is limited tone direction. But they are provided with better exposure to light.

Pruning

The grapevine is a vigorous climber. If it is not properly trained and pruned, it does not bear fruit properly. Pruning is one of the most important operations in grape culture.

The objectives of pruning are as follows:

1. To reduce the amount of old wood in order to keep the vine within manageable limits.
2. To secure fruit bearing branches in predetermined places.
3. To expose the fruiting branches to sufficient sunshine. 4. To reduce the excessive vegetative growth.

It is essential that one should be familiar with the various parts of the vine and their functions for successful pruning. The following are some of the technical terms used:

- ***Shoot***: Young growth of green stem of the current season, which bears the grape cluster.
- ***Cane***: A well mature and ripened shoot of the past season or that of the previous year which gives rise to shoots.
- ***Spur***: A portion of the cane or ripened shoot left behind on the plant after pruning.
- ***Fruiting spur***: A cane or well ripened shoot leaving 304 buds, producing a bunch after pruning.
- ***Foundation spur or Renewal spur***: A well-ripened shoot or cane bearing bud. This normally remains after the shoots are pruned in March-April or summer in Hyderabad. It is called a foundation spur as it forms the base of the foundation wood on which next year's canes and fruiting spurs are formed or on which both growth of the year are borne.
- ***Trunk***: Main stem of the plant.
- ***Long spur***: A ripe shoot, carrying more than five buds. Normally it is 25-30 cm long with about 5-10 buds on it.
- ***Medium spur***: It is a cane cut back keeping 3-5 buds.
- ***Spur***: It is cane pruned to 1-2 buds.

In India, being a tropical country, there is a marked apical dominance of growth of the vine, because of the failure of the most of the buds to sprout and grow after the pruning. On the other hand, in temperate zones the Thompson Seedless when pruned to 15 buds, there is 60 to 100 per cent bud burst as against 6-9 per cent in India. Therefore, the stimulus nearby pruning wound is the important factor in forcing bud burst. Usually the only bud that may grow on a long cane of 6 to 15 buds is the bud left in the terminal position. This factor of extremely low frequency of bud burst confined almost entirely to the terminal position. The tendency of only the terminal buds to

grow on the pruned canes has an important bearing on the form and eventually the cropping and longevity of the vine.

The problem of rapid elongation of the arms or other more permanent frame work of vine is of course most acute when one is forced to leave long canes to ensure that enough crop will be obtained, such as is necessary in Anab-e-Sliahi and to a greater degree in Thompson Seedless. In varieties such as Muscat Hamburg or Perlette, where the basal buds are often fruitful than that pruning will ordinarily not present this difficulty.