

Introduction

Commercial viticulture in India is around six-decade old and is currently being considered as one of the most remunerative horticultural enterprises. Systematic grape cultivation has been under progress especially in the western and southern states of the country. Today, Maharashtra leads in acreage and production in the country. In productivity, India ranks the highest in the world.

Viticulture in India is unique as it can be practised in almost all the climatic conditions ranging from tropical to temperate. Though most of the commercial cultivation (85% area) takes place in the tropical region (Maharashtra, Karnataka, Andhra Pradesh and Tamil Nadu), sub-tropical grapes grown in the northern states are of special significance. In the month of June, fresh grapes are not available from the tropical regions of the country. The subtropical viticulture is practised in the states of Punjab, Haryana, western Uttar Pradesh and a small portion of Delhi and Rajasthan, which are able to provide grapes during June.

IARI's Initiative

Research work on grape was initiated in 1956 at the Indian Agricultural Research Institute, New Delhi on collection of germplasm, breeding of new genotypes, use of growth regulators, standardization of agro-techniques (including training, pruning, rootstocks, water and nutrient requirements, etc.) and post-harvest technology. Several grape varieties were introduced for evaluation. After a few years, cultivars like Perlette and Beauty Seedless and a selection, Pusa Seedless were recommended for commercial cultivation in the north-western plains. Presently, these cultivars are being grown commercially though each one lacks in some or the other economic traits for becoming the ideal cultivar for the region. A comprehensive breeding programme was initiated at the Institute for evolving early maturing, high yielding genotypes with good berry quality. Two successful hybrids, namely, Pusa Urvashi and Pusa Navrang were evolved at IARI and released during 1996-97 after several years of multi-location trials. The salient features of grape varieties recommended for growing in sub-tropical regions are described below.

Varieties Released/Recommended by IARI

Beauty Seedless

An introduction from California (USA), Beauty Seedless is an early maturing variety with well-filled conical bunch, small to medium in size. The berry is small, round and deep red to almost black with thick bloom; the pulp is tender and slightly acidic with one or two empty, hollow rudimentary seeds and the peel is medium thick. The TSS of the variety is 18-19%. It ripens by mid-June and is suitable for table purpose.

Perlette

Perlette is an introduction from California, and has been recommended for growing under north-Indian conditions. It is an early maturing, medium vigorous, seedless and sweet variety. The bunch is medium to large, conical and compact. The berry is small green, thin skinned with soft pulp. The TSS of the variety is 20-22%. Highly responsive to GA₃ (30 ppm) at half bloom stage, it starts ripening in the 2nd week of June.

Pusa Seedless

A popular variety, Pusa Seedless is grown in northern India. It matures in the 3rd week of June. The vines are vigorous with medium to large compact bunches. The berries are small, seedless and greenish-yellow in colour. The pulp is tender and sweet with TSS going up to 22%.

Pusa Urvashi (Hur x Beauty Seedless)

Pusa Urvashi is an early ripening, basal bearing grape hybrid. Its bunch is loose and medium in size with medium sized, oval, greenish-yellow seedless berries. It is good for table purpose and raisin making. The TSS of the hybrid ranges from 20 to 22%. It is fairly resistant to diseases and is ideal for growing in sub-tropical regions where pre-monsoon shower is a problem.



A bunch of Pusa Urvashi



Pusa Navrang Grape

Pusa Navrang (Madeliene Angevine x Rubired)

Pusa Navrang is a teinturier grape hybrid with early ripening and basal bearing. Its bunch is loose and medium in size with medium round berries. It is good for juice and coloured wine. This hybrid is resistant to anthracnose disease and is ideal for growing in sub-tropical regions where pre-monsoon shower is a problem.

Adoption of Pusa Grape Varieties

Since their release, the two varieties, Pusa Urvashi and Pusa Navrang have attracted the grape growers of the region. Under the germplasm exchange and distribution, cutting derived plants were supplied to different research centres including the National Research Centre on Grapes, Pune, the PAU, Ludhiana, the CSA University of Agriculture and Technology, Kanpur, etc. Cuttings were also supplied to several progressive farmers in Sinauli, Meerut, (Uttar Pradesh), Sangli (Himachal Pradesh), Indore (Madhya Pradesh) and Rajnandgaon near Raipur (Chhattisgarh), Raigarh (Orissa), etc., where they performed well. Many of the regions listed above are designated as non-traditional areas for growing grape. Hence, to popularize Pusa grapes and to explore the possibility of growing grapes in different regions, a collaborative research programme was initiated with the help of progressive farmers.

Successful Introduction of Grapes in Non-traditional Areas

This story highlights the technique of successful grape growing in Chhattisgarh. The Institute established an active collaboration with Dr. B.N. Paliwal, a progressive farmer and a resident of Rajnandgaon, Raipur district. Initially, fifty



Grape nursery raised through cuttings



A training session on pruning of grape vines

cuttings each of Pusa Navrang and Pusa Urvashi along with other varieties like Thompson Seedless, Perlette, Himrod, Sonaka, Tas-e-Ganesh, etc., were planted at his farm in Bhalukonha village. The required

package of practices was also provided. The vines came into bearing in 1999 and the farm created national news with the successful cultivation of Pusa grapes. The different packages of practices were standardized for the region with the active consultation and field visit of IARI scientists. With the success becoming an eye opener for the entire region, the hardwood cuttings of Pusa Navrang and Pusa Urvashi were supplied to other farmers of the region. At present, about 15 ha area has come up, which is exclusively under the cultivation of Pusa grapes. The success caught the attention of the farmers of the state and the State Agriculture Department has declared Raipur as the grape district of Chhattisgarh. During the last couple of years, grape growing has spread to the neighbouring districts, namely, Durg and Kawardha with the efforts of a local NGO, namely, Paliwal Grape Research and Training Institute, Bhalukonha, Rajnandgaon. At present, there are over fifteen progressive farmers, who are into commercial grape growing, forming a cooperative.



First fruiting of Pusa Navrang



First fruiting of Pusa Urvashi

and Pusa Navrang were significantly improved on Dogridge rootstock. The cost:benefit analysis of grape growing in the region showed a profit of Rs. 1,00,000 per acre for the production of fresh grapes while the production of raisin increased the profit up to Rs. 1,50,000 per acre.

Production Technology of Sub-tropical Grape

The grape production technology standardized and recommended for the region is as under.

Soil and climatic requirements

Grape requires warm, dry, rainless summer and cool winter. Rain during the ripening season (May-June) is harmful resulting in loss of sweetness, uneven ripening and cracking of berries. Well-drained soils are ideal for grape cultivation.

Grape can be grown on a wide range of soils. Even sandy and gravelly soils have yielded good crops with adequate fertilizers and good management. Under Madhya Pradesh and Chhattisgarh conditions, grape cultivation is possible on a wide variety of soils,



Bearing of Pusa Urvashi on Dogridge root stock

i.e., gravelly red soil, regions with *kankar* and hard pan, etc. Though the majority of soils in the area have red gravelly and even sandy soils,



Bearing of Pusa Navrang on Dogridge root stock

the results have shown that a good crop can be harvested with adequate nutrient and irrigation application. Usually, a soil depth of 2.5 m is ideal, while the pH should range from 6.5 to 8.0. Exchangeable sodium should not be more than six per cent.

The growers should avoid soils having salt concentrations of 0.3% or more. Cultivation of grapes in problematic soils on different salt tolerant rootstocks, namely, Salt Creek, Dogridge and 1613, is suggested for *in situ* grafting of the above varieties.

Propagation

Grape can easily be propagated by hardwood stem cuttings prepared from mature, one-year-old canes removed as pruning wood. Each cutting should be 20-25 cm long with 3-4 nodes and of pencil thickness. Cuttings are planted at an angle of 45° either in bed or on ridge. Recently, *in situ* grafting has been done on one-year old established rootstock during February -March (i.e., before sprouting of dormant buds) and during July -August (after rains) using wedge grafting.

Planting

Before planting, the growers should make a layout plan as spacing between the plants depends upon the training system to be followed after plant establishment. Generally, the spacings followed are Head system: 2 m x 2 m; Trellis system: 3 m x 3 m; Bower system: 4 m x 4 m; and Y system : 3 m x 4 m.

Pits of 75 cm x 75 cm x 75 cm size are dug in November-December and filled with 1: 1 mixture of top soil along with farmyard manure and 1000 g neem cake. One kg of single super phosphate and 500 g of sulphate of potash should then preferably be added to it after thorough mixing. In the areas with high infestation of termite, chlorpyrifos (0.2%) drenching of the pit must be done with 30 to 50 l of irrigation water. The soil is then allowed to settle by giving one heavy irrigation. One-year-old rooted cutting is planted in each pit in the last week of January in evening hours. After a fortnight, the plant is headed back to a single, stout and mature stem. The vines should be transplanted at proper spacing.

Training of vines

Both vigorous and semi-vigorous varieties are grown through basal bearing varieties are ideal for sub-tropical region. Head system is the cheapest method as it requires low investment and hence suitable for resource scarce farmers. Under this system, the vine is trained to a single stem and at a height of 1.2 m, four to six well distributed arms are allowed in different directions. These arms later tend to become woody and bearing (8-10 in number) and renewal shoots for the next year are maintained while pruning. The following different training systems can be practised:

Trellis system: Though it is slightly costly, it can be practised with all the semi-vigorous cultivars. The plants are set out 3 m × 3 m apart and the arms of the vine distributed at 2 levels on the parallel wires. Two horizontal wires are stretched with the help of a single iron pole, the first at 3/4th metre above the ground and the second at 25 cm above the first one. The arms are trained on both sides of the trunk.

Bower, pergola or *pandal* system: The plant is allowed to grow a single stem up to a height of 2 m and then to spread in all directions over the bower, which is made with criss-cross netting of galvanized 12-gauge wire supported on angle irons or stones or wooden poles. The main branches of the vine are trained in such a way that they are almost at equal distance from each other. Fruiting canes are allowed to grow on these main arms, which are further pruned every year.

Y trellis system: The vines are trained on to divided and open canopy. A pair of cordons is allowed at a height of 120 to 130 cm of stretched wires on Y shaped angle trellis. The angle is generally of 100 - 110° with the arm extending up to 90-120 cm. The greatest advantage with this system is the protection of bunches from direct sun light.

Pruning: In northern India, pruning of mid vine can be started from mid-December to mid-January when the vines are in the dormant stage while in central India (e.g., Chhattisgarh), double pruning can also be practised. Pruning of bearing vines is generally done 2 or 3 years after planting to train the plant to the desired shape and according to the training system. Since grape bears bunch

on the current season's shoots, it is important to prune the previous year's cane to a definite length. The node up to which a vine is pruned depends upon the vigour of the variety.

Pruning intensity in some grape varieties

No. of buds per cane	Variety/Varieties
2-3	Beauty Seedless
3-4	Perlette, Delight,
4-6	Pusa Urvashi, Pusa Navrang, Himrod
9-12	Thompson Seedless, Pusa Seedless, Kismish Charni

After pruning, the vines should be sprayed with 0.2% Blitox. All the sprouts appearing on the base of the plants should be manually removed.

Manuring and fertilization

Application of nutrients to the bearing vine is absolutely necessary. Generally, half of their requirement is applied through soil and the remaining half through foliar sprays. The spray of urea (2%) is suggested in morning hours, particularly to young leaves. Well rotten farm yard manure (@ 25 kg/plant) should be added in February. Thereafter, the vines should be fertilized with a mixture of 200 g of potassium sulphate, 400 g of single super phosphate and 250 g of ammonium sulphate per vine in February immediately after pruning. A second application of 200 g potassium sulphate is done in April after fruit set. Micro-nutrients like iron and zinc salts are sprayed @ 0.2% to mitigate deficiencies.

Manurial schedule for bearing sub-tropical grapevine

Nutrient (kg/ha)	Month			
	February	March	April	May
N	250	350	-	100
P ₂ O ₅	800	400	-	-
K ₂ O	-	200	200	200

Irrigation

New vines are irrigated soon after the planting. Irrigation is also necessary after the application of manures and fertilizers. With the rise in temperature, irrigation should be given at 10 to 15 days intervals and this is particularly important when berry development is in progress. As the berries show the sign of maturity by a change of colour, irrigation can be less frequent so that the berries may accumulate more sugars. Irrigation can be continued even after harvest when there are no rains. No irrigation is required during dormant period (November to January). Drip irrigation has also shown promise. At a soil moisture tension regime of 0-0.25 bar, irrigation at an interval of 5-7 days in spring and summer is required. In spring and summer, around 15 irrigations each with 3.5 l water are needed per plant.

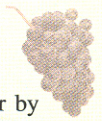
Improving fruit quality through plant bio-regulators and cultural practices

A technology for achieving early harvest of grapes before the onset of the monsoon rains has been developed by IARI. A single spray of Dormex or Dorbreak (30 ml per litre) is given on the vines immediately after pruning in the first week of January. This treatment helps in hastening ripening by 2 to 3 weeks. Similarly, three sprays of thiourea at the rate of 20 g per litre of water, on the dormant buds after pruning in January also enhance the bud-burst and ripening of grapes by one week.

Gibberellic acid dipping of the panicle at 50% bloom followed by bunch dipping at set stage is recommended to get elongated berries. Beauty Seedless responds to 45 ppm GA_3 , while Perlette, Pusa Urvashi, and Pusa Seedless respond to 25 to 30 ppm GA_3 .

Bunch dipping in ethrel or ethephon (@ 1 ml in 4 litres of water) at "pea stage" can improve the berry quality in terms of colour and sweetness and also hasten the ripening.

Apart from these, practices like trunk girdling and berry thinning have also been found beneficial for improving fruit quality. After 4-5 days of fruit set, a narrow ring of bark (0.5-1.0 cm) is removed around the trunk up to a height of 30 cm above the ground level with the help of a girdling knife. Berry thinning is



achieved by removing one side of the panicle completely by scissors or by brushing. Girdling alone can increase the berry weight and size but in combination with thinning, TSS can be increased by 2-3 per cent apart from enhancing the earliness by a week.

Control of pests & diseases

The leaf roller caterpillars roll up the leaf margin towards the mid-rib and feed on the lower epidermis of the leaves. Spraying with Malathion or Dimethoate at the rate of 2 ml per litre of water, has been found to be effective in controlling this pest. Similarly, leaf hopper can be controlled by spraying with Dimethoate or Malathion at the rate of 2 ml per litre of water. Scales are also seen on the vines and spraying with Diazinone at the rate of 1 ml per litre of water just after pruning, can successfully check the scales. For termite attack, soil drench and trunk spray with Chlorpyrifos (5 ml per litre of water) once at 15 to 20 days interval is recommended.

Powdery mildew and anthracnose incidences are generally escaped by the grapes growing in the sub-tropical region as their infestation is noticed only after severe rains. Spraying with Blitox or Bavistin @ 3 g per litre of water during June to September at fortnightly interval keeps the diseases under check.

Harvesting

Fully ripe bunches should be harvested at maturity. Ripening is determined by a desired TSS:acid ratio, which varies with varieties and ranges from 25 to 35 (e.g., 29.24 in Pusa Seedless). Pusa varieties start ripening in the first week of June and with different treatments, i.e., spraying Dorbreak and girdling, it can be enhanced. The bunches should be harvested in plastic trays, without staking. The lots are kept in shade for some time to remove field heat, followed by clipping of damaged berries, etc. The produce can then be sent to the local market or to distant markets in corrugated fibre board (CFB) boxes.



Storage & utilization

Grapes can be stored at zero degree Celsius and 80-90% relative humidity for a period of 4 weeks as such. Early grapes give good price in the market in June. The technique of raisin and wine making can also be undertaken after getting training on these aspects.

Calendar of Operations in Sub-tropical Grape Cultivation

January 1st to 2nd week: Pruning of mature vines and training of the young vines. Manuring of the young as well as matured vines at the rate of 25 kg of well rotten farm yard manure per vine followed by the application of thiourea or Dormex spray.

January 3rd to 4th week: Fertilization at the rate of 250 g ammonium sulphate and 250 g potassium sulphate per vine.

April 1st week: Fertilization of fruiting vines with 200 g potassium sulphate per vine for enhancing berry development and better fruit quality.

April 2nd to 3rd week of May: Irrigation at 10 to 15 days interval depending upon the soil condition.

May 4th week to end of June: Irrigation at oneday interval (stop irrigation one week before maturity). Spray Blitox/Bavistin at the rate of 3 g per litre of water against anthracnose immediately after harvest.

July-August-September: Spraying with Blitox @ 3 g per litre of water at 15-20 days interval immediately after harvest up to September.

November-December: Last spray of Blitox at the rate of 3 g in one litre of water.