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A retrospection of Indian grape varieties

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Abstract

Grape (*Vitis vinifera* L.) is largely processed for wine beside it is used for fresh consumption, for making raisins, juice, and grape oil. The existence of grapes in India dates back about 4000 years ago as per the historical evidences. Grape cultivation on a commercial basis is about seven decades old in India and now considered as most remunerative amongst all fruit cultivation in the country. Indian Viticulture is unique as it is being practised in almost all climatic conditions from tropical to temperate and spread over different states of the country. During the 1930s a large number of exotic grape varieties were introduced to the country. Since then various Indian research institutes were involved in the varietal improvement. Besides Indian grape growers also contributed significantly to the varietal improvement by identifying various clones especially from Thompson Seedless and Kishmish Chernyi. A brief account of indigenous grape varieties prevailing in the country is presented here.

Keywords: *Vitis vinifera*, table grape, viticulture, clonal selection

Introduction

Grape (*Vitis vinifera* L.) is a high valued fruit crop and being grown worldwide mostly for wine, raisin, juice, and fresh consumption. Primarily grape is a crop of the temperate region but widely adopted in tropical and subtropical conditions across the globe. Indian viticulture is unique as it is being practiced in almost all climatic conditions from tropical to temperate. In India around 78-80% of grape is produced for fresh consumption and about 17-20% for raisin making and around 2% collectively for juice and wine production. Indian Viticulture is unique as it is being practised in almost all climatic conditions from tropical to temperate spread over different states of the country. Grape has gained significance in India due to its location specific suitable modifications. Tropical viticulture is practised in Maharashtra, Karnataka, Andhra Pradesh, and Tamil Nadu while subtropical viticulture is usual in Punjab, Haryana, western Uttar Pradesh, and even in some parts of Rajasthan and Delhi. Even grape orchards can be seen in the hilly northeast region like Mizoram. Maharashtra is at the forefront in respect of scientific grape cultivation and contributes around 78% of the total grape production of the country. Nashik, Solapur, Sangali, and Pune are the major grape-growing districts of Maharashtra.

Origin and worldwide distribution

Grape (*Vitis vinifera* L.) is a perennial vine that belongs to the family *Vitaceae*. The comprehensive classification of family *Vitaceae* was given by Planchon in 1887. He has identified 10 genera and several subgenera belonging to this family. Now with subsequent revision over the period the family *Vitaceae* expanded to 17 living and two fossil genera viz., *Cissites* and *Paleovitis*. Genus *Vitis* produces edible fruit and two species namely *V. vinifera* and *V. labrusca* are widely grown over the world for their quality fruits. Earlier *Vitis* was known as *Euvitis* encompassing two subgenera *Vitis* and *Muscadinia*. Now, *Muscadinia* is a separate genus and can be distinguished clearly from *Vitis* in respect of morphological differences as well as chromosome number (i.e. *Muscadinia* has $2n=40$ in whereas $2n=38$ in *Vitis*) (Olien, 1990) [17]. Grape (*Vitis vinifera* L.) is supposed to be originated in the adjoining region of the Mediterranean basin and the Caspian Sea which is called Armenia and from there it was spread to Asia Minor, Europe, and other countries where viticulture is evident today (Olmo HP, 1976) [18]. *V. vinifera* is evolved from the wild type *Vitis sylvestris*, thus *Vitis sylvestris* is claimed to be its progenitor (Rossetto *et. al.*, 2002; Sefc *et. al.*, 2003; Crespan, 2004; This *et. al.*, 2004) [22, 23, 8]. The members of the family *Vitaceae* spread over to the temperate, subtropical, and tropical climate due to their wider adaptability. *V. vinifera* alone has more than ten thousand cultivars being grown in different parts of the world which shows

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that *V. vinifera* has a wide genetic base. Domestication in grape is started in the geographical region between the Black Sea and Iran thereafter its cultivation expanded towards eastern parts of the world and those areas are now considered as the secondary domestication centres of grape (Cha'taignier, 1995; McGovern *et al.*, 1996; McGovern and Rudolph, 1996; Zohary, 1996; Zohary and Hopf, 2000, Grassi *et al.*, 2003; Arroyo-Garcia *et al.*, 2006) [5, 14, 29, 10, 4].

Grape cultivation in India

The existence of grapes in India dates back about 4000 years ago as per the historical evidence. Medical treatises of India like Charak Samhita and Shushrut Samhita written between 1356-1220 BC had mentioned grapes and their utilization in the preparation of medicines. Aryans were well versed with grapes and they knew its cultivation and how to prepare different kinds of beverages from it as well. A Buddhist pilgrim from China who visited India during 629-645 A.D., reported that grapes were found in India right from Kashmir to everywhere in the country. Grape cultivation in south India was introduced in the 14th century by Emperor Mohammad Bin Tughalak when he shifted his capital from Delhi to Daulatabad. A Moorish traveller Ibn Batuta (1430) mentioned in his travelogue about the well-maintained vineyards in India. Due to the wider adaptability attribute grape was acclimatized to the sub-tropical climate of South India. In the 17th century, grape cultivation reached its height of progress in Deccan. Now, it has become a premium fruit crop of India (Chadha, 2019; Todkari, 2012) [6].

In India, a large number of grape varieties were introduced firstly under the leadership of S.B.S. Lal Singh, then Professor of Horticulture at Punjab Agricultural College, Lyallpur in 1928 (116 grape varieties) and late 1950s by Dr S. G. Randhawa (about 1002 grape varieties) of Indian Institute of Agricultural Research, New Delhi especially from USSR, Yugoslavia, Australia, France, Germany, Italy, Bulgaria, and many other countries. The grape gene pool thus created through introduction contained the various commercial grape varieties for the table, wine, and raisin from all over the world. The introduction of the exotic varieties *viz.*, Abi or Bhokari, Fakiri, Habshi, Sahebi, Anab-e-Shahi in the Deccan region of the country was an important event in Indian viticulture. But the grape cultivation in a commercial manner was started in the 1960s when grape growers started the cultivation of Thompson Seedless (Chadha, 2019) [6]. In India grape is being grown over an area of 1.40 lakh hectares with a production of 31.25 lakh tonnes (NHB, 2021) [16]. In India, around 78-80% of grape is produced for fresh consumption and about 17-20% for raisin making, and around 2% collectively for juice and wine production. India ranks first in the world for grape productivity and secured 8th position in the world for table grape export with the quantum of exported fresh grapes 2.22 lakh metric tonnes. India is a major exporter of fresh table grapes and contributes 4.32% of world grape export (APEDA, 2021) [2].

India is an emerging leader as a table grape producer and amongst the major grape exporters in the world arena. The majority of commercial varieties grown in different regions of India are introductions from countries like the USA, France, Italy, Australia, etc. The exotic varieties like Thompson Seedless, Kishmish Chernyi, Perlette, Clone 2A, Muscat Hamburg, Centennial Seedless, Red Globe, Flame Seedless, Fantasy Seedless, Crimson Seedless etc. are being cultivated by Indian growers due to their distinctiveness. Recently a

Farmer Producer Company (FPC) 'Sahyadri Farms' has imported three patented grape varieties *viz.*, ARRA-15 (white), ARRA-19 (red coloured), and ARRA-32 (black coloured) for commercial cultivation (Grapa, 2021) [9]. Besides, various Indian institutes and Indian grape growers developed noteworthy grape varieties for fresh consumption, juice making and raisin purpose are reviewed here.

I. Grape varieties evolved at Ganeshkhind Garden, Pune

During the 1930s, Dr. G. S. Cheema then Director of Agriculture, Bombay State (Maharashtra) attempted to breed superior varieties from the indigenous types. He made a selection from the open-pollinated progeny of the Pandhari Sahebi raised at Ganeshkhind Garden, Pune in 1928. Pandhari Sahebi was one of the best-adapted table varieties of that time but did not achieve commercial popularity because of poor cropping. The poor cropping of Pandhari Sahebi was reported to be due to self-sterility. Dr. Cheema raised a large number of seedlings of the Pandhari-Sahebi and from that, he made two selections i.e. Selection No. 7 and No. 94 (Phadnis *et al.* 1968) [20].

- **Selection No. 94:** It was a prolific bearer with high yielding potential (30-37 tonnes per hectare). It is a late variety and has uniform ripening. Soft pulp was the major problem in its transportation to the long-distance market.
- **Cheema Sahebi:** Originally it was known as Selection no.7. It has large size berries with oval to cylindrical shape. The skin was thin and crisp with pale yellow in colour and moderate bloom on it. Adherence of pulp to the skin was strong in this variety. The pulp was crisp, sweet, and superior in quality to other commercially grown varieties.

II. Grape varieties developed by ICAR-Indian Institute of Horticulture Research, Bengaluru

Indian Institute of Horticulture Research (IIHR), Bengaluru is the first horticultural research institute in the country established under the Indian Council of Agricultural Research (ICAR) on 5th September 1967. In the 1980s crop improvement work in the country was at its peak looking into the increasing demand of the grape industry. As a result, IIHR released four hybrids namely Arkavati, Arka Kanchan, Arka Shyam, and Arka Hans for commercial cultivation in 1980. Similarly, during 1992, hybrid Arka Neelamani and in 1994, six other hybrids *viz.*, Arka Chitra, Arka Trishna, Arka Soma, Arka Krishna, Arka Majestic, and Swetha Seedless were released by IIHR for various purposes. The detailed account of these cultivars is as follows (IIHR, 2021; Chadha and Shikhamany (1999) [7];

- **Arka Chitra:** It is a hybrid of Angur Kalan x Anab-e-Shahi. It is a table grape variety with slightly elongated golden yellow berries with a pink blush. The sugar accumulation in this variety is observed in the range of 20-21° Brix. This variety has good yield potential which produces 38 tonnes of fruits per hectare.
- **Arka Majestic:** It was developed by crossing Angur Kalan x Black Champa. It is a table grape variety with bold roundish berries weighing on an average of 7.7 g. All the buds in this genotype are fruitful and therefore variety has no specific pruning requirement. It is possible to take double-crop in a year with this variety. It shows anthracnose disease tolerance. Arka Majestic produces around 34-35 kg of fruits per vine.

- **Arka Neelamani:** It is a cross between Black Champa and Thompson seedless. It is a good table grape variety. It takes 150-155 days from fruit pruning to harvesting. It has shown tolerance to anthracnose disease. The productivity of this variety is about 22-25 kg fruits/vine which in turn gives the fruit yield 26-28 tonnes/hectare.
 - **Arkavati:** Arkavati is a cross between Black Champa x Thompson seedless. It is a very good cultivar for raisin making. It has a soft rudimentary and imperceptible seed. Berries are spherical with yellowish-green skin colour. Bunches are medium-large and well filled. It is a medium yielder and late-maturing variety taking more than 150 days to mature from fruit pruning.
 - **Arka Shweta:** The hybridization of Anab-e-Shahi x Thompson Seedless leads to produce Arka Shweta. It is a seedless variety released for fresh consumption. The berries are uniform with greenish-yellow skin and oval in shape. Berries are sweet with T.S.S. in the range of 18-19 °Brix. It is a late variety that takes 153-155 days from pruning to harvest. The yield potential of this variety is 30-31 tonnes/ hectare.
 - **Arka Soma:** It is a cross of Anab-e-Shahi x Queen of Vineyards. It bears round to ovoid shape fruits and has greenish-yellow colour berries. Pulp is meaty with Muscat flavour. It is a late variety that needs 158-160 days after pruning to mature. Sugar content in the berries varies from 20-21° Brix. It is a high-yielding variety with a yield potential of 40 tonnes/ hectare.
 - **Arka Kanchan:** Arka Kanchan is a cross of 'Anab-e-Shahi' and 'Queen of the Vineyards'. It is a bold type variety with a maximum berry weight of 5.5g. Berries are golden yellow in colour and oval in shape. Pulp is meaty with Muscat flavour. It bears a medium-large cluster weighing up to 700g. It is a very late-maturing cultivar and has poor keeping quality.
 - **Arka Trishna:** It is a hybrid of Bangalore Blue x Convent Large Black. Berries are deep tan coloured and round to ovoid. Sugar content in fruit varies from 22-23° Brix. The time required by this variety from pruning to harvest is 145-150 days. It is resistant to anthracnose and tolerant to downy mildew diseases. The yield potential of this variety is 25-26 tonne/ha.
 - **Arka Shyam:** A cross of Bangalore Blue x Black Champa has produced this genotype. It has spherical berries with blackish-blue skin colour. It has seeded and medium-sized (maximum weight 3.8g) berries with mild foxy flavour. This variety is tolerant to anthracnose and suitable for double cropping. The variety is very good for making dry table and dessert wines and juice as Total Soluble solids (TSS) in this variety goes up to 25° Brix.
 - **Arka Hans:** It is a cross of Bangalore Blue x Anab-e-Shahi. It bears yellowish-green berries with spherical to ellipsoidal shape and with an average berry weight in the range of 3-4g. Fruit of this variety has good quality soft pulp suitable for the making of white wines. This is a seeded variety with medium-sized, well-filled, and conical clusters. Due to poor pedicel attachment this variety is not suitable for distant transportation. It is a medium yielder and mid-season variety.
- regulators, standardization of agro-techniques (training, pruning, rootstock, water, and nutrient management, etc.) for quality grape production and improving post-harvest technologies was started in the 1950s at Indian Agricultural Research Institute (IARI), New Delhi. After few years, cultivars like Perlette and Beauty Seedless and a selection 'Pusa Seedless' were recommended for commercial cultivation in the north-western plains. A comprehensive breeding program was initiated at IARI for evolving early maturing, high-yielding genotypes with good berry quality. Two successful hybrids viz., Pusa Urvashi and Pusa Navrang were evolved and released during 1996-97 after several years of multi-location trials. The contribution of IARI was noted in the form of the release of Pusa Navrang and Pusa Urvashi grape varieties The Grape varieties released by IARI at the institute level are as below (IARI, 2021; Verma and Usha, 2006)^[27];
- **Pusa Seedless:** It is a clonal selection from Thompson Seedless. This variety is suitable for fresh consumption and raisin making. Pusa Seedless was released by IARI for North Indian Plains in 1970 at institute level. It bears elongated bunches with golden yellow coloured berries which ripen by the first week of June in northern India. Berries have high TSS (22-24 °Brix) and are highly responsive to GA₃ applications. The yield potential of the variety is 8-10 kg per vine under head system.
 - **Pusa Navrang:** It is the hybrid of Madeleine Angevine and Rubi Red. This variety was released by Institute Release Committee in 1996 for North Indian Plains and Central India. It shows early ripening i.e. 1st week of June in northern India. It is a teinturier (having flesh anthocyanin pigmentation) variety with high antioxidant content and is suitable for coloured juice and winemaking. It is a basal bearer (at 4-6 nodes) having medium size loose bunches with round and medium-sized berries. Pusa Navrang is resistance to anthracnose. It has good yield potential i.e. 10-12 kg per vine (head system).
 - **Pusa Urvashi:** Pusa Urvashi is a cross between Hur x Beauty Seedless. It is a table grape variety and also used for raisin making. It is released by IARI in 1996 for North Indian Plains and Central India at the institute level. It bears loose and medium size bunches with seedless greenish-yellow berries. Berries are sweet with sugar 20 to 22° Brix. It shows an early ripening i.e. in the 1st week of June in northern India. It is a basal bearer (4-6 nodes) and tolerant to anthracnose and powdery mildew. It produces 10-12 kg fruits per vine under the head system.
 - **Pusa Aditi:** It is a hybrid of Banqui Abyad x Perlette. The fruits are good for fresh consumption and making juice. It is also an early maturing variety that matures in the first week of June and escapes the rain during harvest. This is seedless variety producing large round berries (average berry weight 2.7g). The berries are yellowish-green in colour with firm pulp and good TSS (19.3°Brix). Pusa Aditi is GA₃ responsive variety. It is moderately vigorous and a spur-pruned variety. It is tolerant to anthracnose and powdery mildew. The average yield is about 12-15 tonnes/ hectare.
 - **Pusa Trishar:** It is a complex hybrid between [(Hur x Bharat Early) x Beauty Seedless]. The fruits are good for fresh consumption and juice making. It is early maturing, suitable for sub-tropical conditions, semi-vigorous and spur-pruned. Berries are round weighing up to 2.15g,

III. Grape varieties developed by the Indian Agricultural Research Institute, New Delhi

The grape improvement in the form of a collection of grape germplasm, breeding new genotypes, use of growth

yellowish-green in colour, with good TSS (18.4° Brix) and firm pulp. It is a highly GA₃ responsive variety. The average yield of this variety is in the range of 14-16 tonnes/ hectare.

- **Pusa Swarnika:** Pusa Swarnika is developed by crossing Hur x Cardinal. It has bold and golden-yellow colour berries with firm pulp. Berries are very sweet having high TSS (20-22 °Brix). It has natural loose bunches with natural bold berries. It produces medium-sized bunches with an average weight in the range of 400-500g. Being an early maturing variety the fruits became ready for harvest between 75-80 days after full bloom. It is suitable for table purposes and Manuka preparation

IV. Grape improvement initiatives at Punjab Agriculture University (PAU), Ludhiana

During the 1930s, Mr S.B.S. Lal Singh, then Professor of Horticulture at Punjab Agricultural College, Lyallpur initiated the introduction of grape varieties in Punjab. Under his leadership, 116 grape varieties were introduced from different parts of the world. In the 1960s a boost to grape cultivation in the state was given by then chief minister of the state Mr S. Pratap Singh Kairon consequently Ananb-e-Shahi was introduced to Punjab from South India. Besides one lakh cuttings of the variety, Perlette was imported into the state for commercial cultivation. Along with this varieties like Thompson Seedless, Khalili, Pusa Seedless were also introduced (Chadha, 2019) [6].

Punjab Agricultural University, Ludhiana has released one promising juice-purpose grape variety 'Punjab-MACS-Purple' developed by Agharkar Research Institute (ARI), Pune in the year 2008. Punjab-MACS-Purple is a selection from the hybrid progenies of a cross Catawba x Beauty Seedless. This variety is rich in anthocyanins (a source of antioxidants) and suitable for processing into juice, nectar, and ready-to-serve beverage. It contains 60-65% juice with total soluble solids of 17-18% and acidity of 0.50%. It has medium and loose bunches. The berry is seeded medium in size, and purple at maturity. It matures in the first week of June in the northern plain with an average yield of 25 kg per vine. This is the only notified grape cultivar in the country (Notification no.1714E) till date.

V. Grape varieties developed by Agharkar Research Institute, Pune

Agharkar Research Institute (ARI) is an autonomous institute of the Department of Science and Technology (DST), Government of India. It was established in 1946 as Maharashtra Association for the Cultivation of Science (MACS). Grapes Improvement Programme of ARI involves the collection and evaluation of wild relatives of grapes for their utilization as rootstock (for abiotic stress tolerance) and in hybridization (for disease resistance). Agharkar Research Institute, Pune has developed three grape hybrids viz., ARI-302 (for improved fruit quality, raisin making), ARI-27 (juice and wine fermentation), and hybrid ARI-516 for juice and winemaking (ARI, 2021).

- **ARI-516 (Punjab MACS Purple):** This is a selection from the hybrid progenies of a cross Catawba x Beauty Seedless. It is a juice-type grape variety with juice recovery in the range of 60-70%. It is an early variety that matures within 100-110 days after pruning. Bunches are elongated and show even ripening. Berries are bluish-black and spherical with rudimentary seeds. Variety has a

pleasant musky aroma with very good sugar content which reaches up to 22 to 24° Brix. This variety is resistant to Anthracnose and shows moderate resistance to Downy and Powdery Mildews. It has good yield potential i.e. 15-20 tonnes/ hectare.

- **ARI-302:** This is a seedless table grape variety. This is a mid-season variety that matures within 140 days after fruit pruning. The berry colour of this variety is golden yellow and sweet with a sugar content of 22-24° Brix. Even fruitfulness and bunch maturity is the important property of this cultivar.
- **ARI-27:** This genotype was developed for juice & wine making. This is a mid-late season variety that matures 135-140 days after the fruit pruning. This is a seeded variety with spherical berries having bluish-black coloured berry skin. Juice recovery up to 70-75% is observed in this variety with sugar content in the range of 18-20° Brix. It produces appealing dark red coloured juice. ARI-27 is moderately resistant to downy and powdery mildews and also shows resistance to anthracnose.

VI. Grape varieties developed by ICAR-National Research Centre for Grapes, Pune

ICAR-National Research Centre for Grapes, Pune was established on 18th January 1997 with the mandate of strategic and applied research for enhanced, sustained, and safe production of grapes. Since then the institute is a leading research centre for grape improvement in the country. The Centre has released four varieties with different quality traits viz., Manjari Naveen (scented table grape variety), Manjari Medika (juice variety), Manjari Kishmish (raisin variety), and Manjari Shyama (table grape variety) at the institute level. Out of which the release proposals of Manjari Medika and Manjari Shyama are under consideration at the state as well as central level. Manjari Medika is the only grape variety in the country released by a government institute and registered under the Protection of Plant Variety and Farmer's Right Authority (PPV&FRA), New Delhi.

- **Manjari Naveen:** It is a clonal selection from Centennial Seedless recommended for fresh consumption. It is released at instate level by ICAR-NRCG in the year 2008. It produces scented fruit with a unique Vanessa flavour. It is a white seedless variety with naturally bold, uniform berries and firm pulp. Owing to its self-thinning property it is a less labour-intensive cultivar. Without GA₃ application its fruit size goes up to 18mm with an average bunch weight in the range of 400-500g. It is an early genotype and which matures 25 days before Thompson Seedless. Manjari Naveen produces 10-12 tonne fruit yield per acre.
- **Manjari Medika:** It is developed by crossing Pusa Navrang x Flame Seedless. It is a well-known juice variety of the institute. ICAR-NRCG, Pune has released it in 2018. It is also under consideration for release by State Level Variety Release Committee and Central Variety Release Committee. Manjari Medika is now a registered cultivar under the Protection of Plant Variety and Farmer's Right Authority (PPV&FRA). It is a tannier variety having skin as well as flesh anthocyanin pigmentation. It has deep purple coloured juice with 65-70% juice recovery. Manjari Medika juice is rich in anthocyanin content (5-6 mg/g berry weight) and has high antioxidant properties. It matures within 125-130

days after fruit pruning. The yield potential of this variety is in the range of 15-16 tonne/acre. This variety is in demand due to its better juice quality and high anti-oxidant properties.

- **Manjari Kishmish:** It is a white mutant derived from coloured genotype 'Kishmish Rozavis'. This variety was released for raisin making at the institute level in the year 2019. It produces crisp berries with tender skin and has a light Muscat flavour. Berry diameter is 14-15 mm with an average bunch weight up to 200-300 g. The TSS of this variety goes up to 23-24° Brix which is highly desirable for raisin making. It has good yielding potential i.e. 16-17 kg fruit/vine. Moreover, Manjari Kishmish has recorded high raisin recovery i.e. 26 – 26.50% which established it as a premium variety for raisin making.
- **Manjari Shyama:** This hybrid was released by ICAR-National Research Centre for Grapes, Pune in 2019. This is a coloured hybrid variety developed through hybridization of Black Champa x Thompson Seedless. It has a medium berry size (16-18mm) with rudimentary and imperceptible seeds with an average bunch weight in the range of 300-400g. It matures within 125-130 days after fruit pruning. This variety has shown potential to fit into the double pruning and double cropping cultivation system. It is a regular and heavy yielder cultivar producing 12-15 tonnes of fruits per acre.

VII. Contribution of Indian grape growers and Maharashtra Rajya Drakshya Bagaitdar Sangh (MRDBS) in varietal development

The indigenous way of grape cultivation was adopted in Maharashtra before 1960, and at that time advanced viticulture practices were unknown to the grape growers. A great visionary and then Chief Minister of Maharashtra late Mr. Vasant Rao Naik envisaged that advanced technologies are required for Indian viticulture to flourish and he felt the need for a grape growers association that could guide them scientifically for the better prospectus. As a result in the year 1960, Maharashtra Rajya Drakshya Bagaitdar Sangh (MRDBS) was established. Since its inception, the MRDBS is growing at an exponential rate and has 27,000 registered members and striving hard to give a new vision and dimension to grape cultivation in the state. Taking into consideration the demand in the international market MRDBS, Pune imported some prominent grape varieties like Crimson Seedless and Victoria from South Africa. In the year 2008–09, the four varieties viz. Autumn Seedless, Blush Seedless, Marquis and Autumn Royal were imported from Davis University, California (MRDBS, 2021).

Clonal selection has played a pivotal role in varietal development in India. Major grape cultivation in India is under table grape. Thomson Seedless was the first variety under commercial cultivation during the 1960s in the country. Various clones were evolved from Thompson Seedless in respect of berry and bunch characters. Indian grape growers with their experience, knowledge, and efforts identified and developed several promising natural mutants from Thompson Seedless and Kishmish Chernyi. The first clone of Thompson Seedless named 'Tas-A-Ganesh' was released by a farmer in 1970. Again two popular clones of Thomson Seedless with elongated berries namely "Sonaka" (1977) and 'Manik Chaman' (1982) were developed by grape growers. These genotypes are still under cultivation in a large area. In India clones of Thompson Seedless and Kishmish Chernyi are

widely accepted for commercial cultivation. The contribution of the Indian grape growers to the Indian viticulture in the form of the novel grape genotypes developed by them is as below (Chadha and Shikhamany, 1999) [7];

- **Sharad Seedless:** It is a bud sport from the Russian variety Kishmish Chernyi. It is a promising table grape variety identified by Mr. Nanasahab Kale and named as 'Sharad Seedless'. Berries are ellipsoid with attractive dark blue skin colour. The berries have crisp pulp and are sweet with TSS 18-20° Brix. Fruit takes 125 days after pruning for ripening. It gives a good yield i.e. 20-25 tonnes per hectare.
- **Rao Sahebi:** Rao Sahebi is a natural mutant developed from Cheema Sahebi. This genotype was identified by Raosaheb Kadalag of Sangamner, Ahmednagar (Maharashtra) in his orchard. The clone has elongated berries compared to Cheema Sahebi with strong pedicel attachment.
- **Dilkush:** It is a bud sport of Anab-e-Shahi which was identified by Mr. Venkatratnam at Hyderabad. Dilkush has golden coloured berries which are more elongated than Anab-e-Shahi. The yield potential of Dilkush is *at par* with its parental genotype.
- **Nath Jambo Seedless:** It is a clone of Sharad Seedless developed by Mr. Vithal Nivrutti Thorat, Kalamb, Pune (Maharashtra) in 2006. It shows extensive bunch formation and bunches become ready in 120 days for harvest. Berries are uniform with bold berry size ranging from 22 to 26 mm. Berries are crispy berries with a good aroma.
- **Krishna Seedless:** It is a natural mutant of Sharad Seedless identified and developed by Mr. Narayan Sangapa Mali, Mhaisal station, Sangli (Maharashtra) in 2006. Krishna Seedless possesses uniform and deep purple colour berries like those of Sharad Seedless. The berries are oblong and 3-5 cm in length and resistant to fruit cracking. The variety is good to taste, sweet and crispy with a sugar content of 20– 22° Brix. It has a yield potential of 10-12 tonnes per acre.
- **Ambe Seedless:** Ambe Seedless was developed from Sonaka Seedless by Mr. Vithal Appana Mali, Bedag, Sangli, (Maharashtra) in 2007. Fruits are 3-5 cm long, curved, and tapering towards the end. Variety is sweet to test with a sugar content of 20 to 22° Brix. Berry has a thick pericarp and is highly crispy. The average yield is in the range of 10-12 tonnes/acre.
- **Mahadev Seedless:** It is a clonal selection from Kishmish Chernyi developed by Mr. Gausmohammed Saipan Shaikh, Boramani, Solapur, (Maharashtra) in 2007. It is a table variety with deep purple colour skin. The average berry weight is 10–12 g and size greater than 25 mm. The berries are crispy berries with a sugar content of 20–22° Brix. Bunches are round in shape with an average weight of 700–900g. The average yield of this variety is 9 to 12 tonnes per acre.
- **Tas-A-Ganesh:** It is a clonal selection from Thompson Seedless identified by Mr. Vasant Rao Arve, Borgaon, Sangali in the 1970s. It shows a good response to GA₃ application and girdling. Berries are ovoid-shaped and green to amber in colour. It has sugar content 20-22° Brix and acidity 0.50- 0.65%.
- **Sonaka:** It is also derived from Thompson Seedless through clonal selection by Mr. Nanasahab Kale, Nannaj, Solapur, (Maharashtra) in 1977. The berries are 1 to 1.5

inches long and gain a yellowish colour during veraison. The fruit has a very thin pericarp which is a desirable attribute as a table grape variety as well as for raisin making. Berries are sweet with sugar content in the range of 24 to 26° Brix. It shows a better response to Gibberellin-A3 (GA3) application than Thompson Seedless.

- **Manik Chaman:** It is also a very good table grape variety with elongated berries. Mr. T. R. Dabade from Solapur in Maharashtra has developed this variety through clonal selection from Thompson Seedless in 1982. It has high fruitfulness & shows uniform ripening of bunches. Bunches weigh around 400 to 500 gm. Berries are 1 to 1.5 inches long and turns yellowish during ripening.
- **Maruti Seedless:** This variety was developed by Mr. Maruti Ramchandra Mali Mhaisal, Sangli, (Maharashtra) in 1994. It is a clonal selection from Thompson Seedless. Bunches are triangular with an average weight in the range of 400 to 800 g. It bears greenish and uniform round berries with more pulp and a good aroma.

The grape varieties mentioned above are the prominent clonal selections that are well adopted by the grape grower and still under cultivation. Recently some extra elongated clones (6.0-6.5 cm long) of Thompson Seedless were reported by some farmers from Sangali district of Maharashtra and catching the attention of the grape grower's community.

VIII. Registered varieties of Indian grape grower

India adopted the system of plant variety registration to protect the intellectual property rights of the newly developed plant varieties. The new cultivars are registered by the Protection of Plant Varieties and Farmer's Right Authority of India (PPV&FRA). Since 2015, PPV&FRA start receiving applications for grape variety registration and till date four farmer's grape varieties and one variety from ICAR-NRRCG, Pune i.e. 'Manjari Medika' are successfully registered. The details of the grape varieties developed by farmers and registered under PPV&FRA are as follows;

1. Nanasaheb Purple Seedless: It is a clone of Sharad Seedless with bolder berries than Sharad seedless. This variety is developed by Nanasaheb Kale, from Nannaj in Solapur district of Maharashtra state. It is a registered farmer's variety under PPV&FRA (Reg. No. 179 of 2019). It is table purpose variety with bold (25-26 mm) and uniform oval shape berries. Berries are oblate shape, purple-black, seedless with medium skin thickness. Berry cracking is not evident in this variety. It matures between 115-125 days after fruit pruning. It is a regular bearer variety with a fruit yield of 12-14 tonnes yield per acre.

2. Sarita Purple Seedless: This is the bud-sport identified by Mr. Nanasaheb Kale Nannaj, Solapur, Maharashtra from Sharad Seedless. Now it is a registered farmer's variety under PPV &FRA (Reg. No. 178 of 2019). It is a promising table grape variety with elongated deep purple colour berries which are 1.5 to 2 inches long. It has thick skin and does not shows berry cracking. Berries are cylindrical in shape, purple-black, seedless with thin skin and high sugar content. Bunch weight varies between 400-500 gm. It matures between 110-120 days after fruit pruning. The average yield of this variety is 12 to 14 tonne per acre.

3. Jay Seedless: Mr. Haribhau Maruti Waykar a grape grower from Gunjalwadi (Aarvi), Pune, Maharashtra developed this

variety. This is another clone of Sharad Seedless with bold fruit size. Jay Seedless is table purpose variety and among the few varieties which are register under PPV&FRA (Reg. No. 180 of 2019). Berries are long elliptical shape, purple-black, rudimentary seeds with medium skin thickness. Berry size of Jay Seedless is bolder than Sharad Seedless. Bunch weight varies between 350-500 gm. It matures between 125-135 days after fruit pruning producing 12-14 tonne fruit per acre.

4. Sudhakar Seedless: It is a natural clone of the Thompson Seedless developed by Mr. Sudhakar Kshirsagar, Shivadi (Ugaon), Nashik, Maharashtra. It is a registered cultivar under PPV&FRA (Reg. No. 181 of 2019). It is a white table purpose variety with firm flesh. Berries are globose in shape, white, seedless with thick skin. Berry size is bolder than Thompson Seedless. Bunches are cylindrical in shape and bunch weight varies between 350-450 gm. It matures between 135-140 days after fruit pruning. The yield potential of this variety is 15-16 tonnes per acre.

4. Danaka: An innovative farmer Mr. Dattatray Nanasaheb Kale from Solapur in Maharashtra has developed a new grape variety through clonal selection from 'Sonaka' and named it 'Danaka'. This is the fifth variety in a row developed by this grape grower and his father. 'Danaka' has elongated berries (up to 4 cm long) with bold berry size (width 17-18 mm). The berries are crispy due to dense and tight flesh. The firm berry attachment of this variety imparts it stability and better shelf life during distant transport. This variety matures within 120 after fruit pruning and produces 12-13 tonnes of fruit per acre (Anonymous, 2017) [3].

Future perspectives

Indian viticulture requires indigenous grape cultivars with better fruit quality, wider adaptability, and tolerance against biotic and abiotic stresses. Demand for the table grape varieties possessing some important quality traits like self-thinning ability, loose bunches, bold berries (>18mm), elongated berries, etc. is up roaring. Grape varieties with uniform colour development attributes under rising day temperature environments are also required to expand the area under coloured grape varieties under a subtropical climate of India. India needs the varieties with better shelf life i.e. more than 50 days under cold storage for allowing their transport to distant markets within the country as well as outside the country. Early maturing varieties for the regions where fruit maturity coincides with rain and to expand grape cultivation to newer areas is a need of the time. Grape varieties with heritable resistance against diseases like mildews, anthracnose, and rust as well as against insects viz., sucking pests, borers, leaf-eating caterpillars, etc. to minimize the expenditure on agrochemicals are highly required. Grape varieties with diverse maturity periods are essentially required to avoid the glut in the domestic market. It will also help in broadening the production window so that grapes can be supplied in the global market around the year and the country will sustain as a competent supplier in the global market. Grape varieties with good processing traits like raisin making are also in demand since it is an important aspect of Indian viticulture next to table grape production.

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