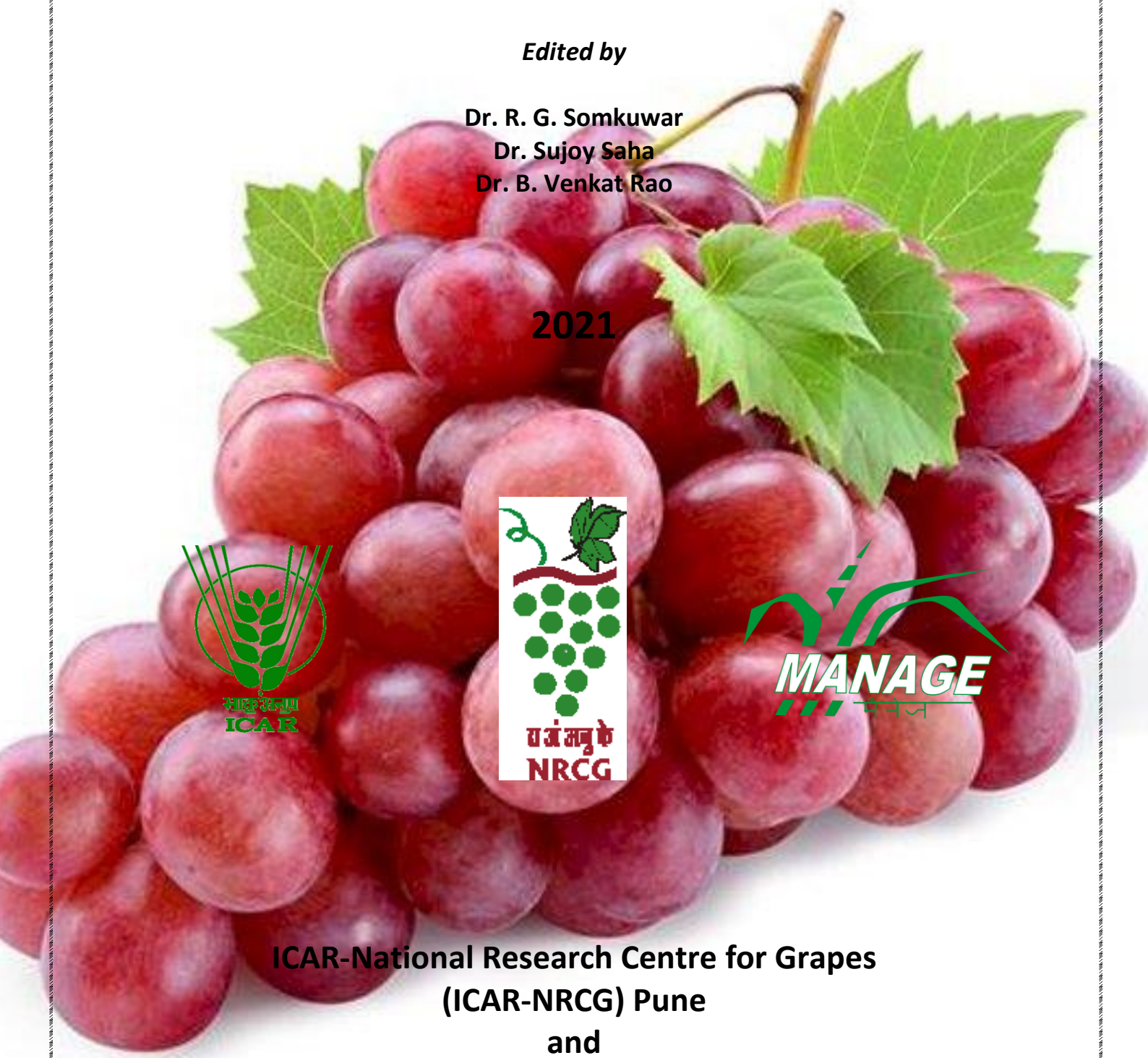
Innovation in Grape Trade: Joint Endeavour of the Private and Public Sectors

Edited by

Dr. R. G. Somkuwar
Dr. Sujoy Saha
Dr. B. Venkat Rao

2021



ICAR-National Research Centre for Grapes (ICAR-NRCG) Pune
and
National Institute of Agricultural Extension Management (MANAGE), Hyderabad
(An Autonomous Organization under the Ministry of Agriculture and Farmers Welfare, Govt. of India)

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Preface

Grape is a high value export-oriented fruit crop which has gained significance in tropical climate due to location specific suitable modifications. Indian viticulture is unique as it is being practiced in diverse climatic conditions. The area under grape cultivation have increased in multitudes and an acreage of 140 thousand ha area with a production of 3.12 million tons during 2020 was recorded and out of which 246107 MT was exported to different countries. To remain internationally competitive and to supply quality grapes to domestic consumers round the year, a number of strategic interventions are required. Sudden changes in climatic conditions, poor quality irrigation water, increasing pressure of diseases and pest due to change in climate, higher cost of cultivation, higher post-harvest losses, poor supply chain, problems in grape processing industry etc. are the major bottlenecks in Indian viticulture. To mitigate such challenges, it was imperative to render a training to the stakeholders with the major objective of guiding the grape researchers, academicians, policy makers, growers, state department officials and students regarding the status of present of cultivation of grapes with proper nutrient and irrigation management practices to produce export quality grapes, pest and disease management based on weather forecasting, use of artificial intelligence in weather forecasting and pest management, production of residue compliant grapes, post-harvest management to minimize the losses and value addition by processing are some of the important highlights of this training programme. Along with table grape production, cultivation of wine grape varieties needs to be boosted. This training is the platform to discuss and exchange the ideas which will be the future directions for safe and quality grape production in Indian conditions along with its marketing. Demand of the processing industry needs to be considered and specific requirement of processors and development of new and specific grape based product will be deliberated upon.

ICAR-NRCG, Pune is a premier institute established with the mandates of applied and basic research on grapes as per the needs of the grape growers and other stakeholders, efficient transfer of technologies in close interaction with grape growers and successful implementation of residue monitoring plan to promote export. Keeping this in backdrop, training will provide good insight into the advances in grape cultivation and to discuss the issues related to grape production and trade.

Date: 05.02.2022
Place: Pune

(R.G. Somkuwar)

Status of Grape Industry and Future Needs

Dr. R G Somkuwar, Director,
ICAR- National Research Centre for Grapes

Indian viticulture is unique as it is being practiced in almost all climatic conditions from tropical to temperate. Grape is a high value export-oriented fruit crop which has gained significance in tropical climate due to location specific suitable modifications. In India, around 72-745% of grape is produced for fresh consumption and about 25% for raisin making and around 2% collectively for juice and wine production. If we look 25 years back into the grape production scenario of the country, the area under the grape cultivation was about 45000 ha with the production of 1100 thousand tones. But due to the scientific inputs from ICAR-NRCG and with the innovativeness of the grape growers, almost three times expansion in the grape area and its production is achieved than it was in 1995-96.

Presently grapes are grown in India over an area of 1.40 lakh ha with production of 31.25 lakh MT and productivity of 21.00 MT/ha (NHB, 2020). India ranks first in world for grape productivity and secured 7th position in the world for table grape export with the quantum of exported fresh grapes 2.22 lakh MT. India is a major producer of the fresh grapes (after China, Italy, USA, Spain, France and Turkey) producing around 6% of total world grapes. Over 50% of Indian grapes are exported to the European Union (EU). The EU continues to be the most preferred destination by Indian table grape exporters. Top importing countries for Indian grapes remain the Netherlands (51%), Russia (36.53%), United Kingdom (13%), Bangladesh (9%) and Germany (8%) as per agriexchange.apeda.gov.in

ICAR-NRCG, Pune is a premier institute established with the mandate of need based research on grape considering the needs of the grape growers and other stakeholders, efficient transfer of technologies in close interaction with grape growers and successful implementation of residue monitoring plan to promote export. The institute is engaged in developing technologies concerning efficient use of water (subsurface irrigation), to minimize the economic losses due to unseasonal rains and hailstorm (plastic cover), weather and crop growth stage based advisory system (DSS; SMS advisory, Delta T calculator), bio-intensive

strategy for disease and pest management (Trichoderma) to produce residue free grapes, integrated disease and pest management by employing bio-control agents etc. Successful implementation of residue monitoring plan (RMP) by the institute for export grapes leads to minimal sample failures due to pesticide residues than rival exporting countries (Chile and South Africa) and it increased the export earnings. Institute is continuously working on establishment of Pre-harvest intervals for new generation pesticides and changing MRLs. The institute is trying hard for the expansion of grape cultivation in the non-traditional areas like north east regions and other parts of the country through it outreach program.

Being the National Active Germplasm Site, NRCG has maintained the collection of 480 different germplasm in its field gene bank which characterized and well documented. Molecular database of theses collection is also developed. Institute is engaged in various grape improvement activities since its inception and striving hard to develop the grape genotypes which will find place in the domestic as well as international market. To curtail the expenditure on agrochemicals used for diseases management, the institute has started the resistance breeding program for mildews wherein 62 downy mildew resistant (1-3 UPOV rating scale) hybrids were identified. Indian viticulture largely depends on Dogridge rootstock but its mono-culture may be risky under changing climate scenario hence keeping this in mind institute has initiated rootstock breeding program that will produce the genepool of salinity and drought tolerant rootstocks and a viable alternative to Dogridge. Efforts are also underway to find the suitable scion and rootstock combination for table grapes (Fantasy Seedless, Red Globe, Nanasaheb Purple Seedless) and wine varieties like Cabernet Sauvignon (Red wine) and Sauvignon Blanc.

To meet the demand of grape industry, ICAR-NRCG has released four varieties with different quality traits viz., Manjari Naveen (table purpose), Manjari Medika (juice), Manjari Kishmish (raisin) and Manjari Shyama (table purpose). Manjari Medika is well known juice variety of the institute which has deep purple coloured juice with 68-70% juice recovery. It is exceptionally high in anthocyanin (4.0g/kg) and has anti-cancerous properties. This variety is a model variety proposed for "zero waste" processing. Manjari Naveen is a clonal selection from Centennial Seedless recommended for table purpose. It produces scented fruit with unique Vanessa flavor. It is a white seedless variety with naturally bold, uniform berries and

firm pulp. Owing to its self-thinning property it is less labour intensive cultivar. It is an early genotype as compared to Thompson Seedless and suitable for table purpose and raisin making. Manjari Kishmish was released for raisin making with record high raisin recovery up to 26.50%. It produces crisp berries with tender skin and has light muscat flavor. Manjari Shyama is another table grape variety released by the Centre. It is a regular and heavy yielder cultivar; producing 12-15 tons fruits per acre.

Although India is an important exporter of table grape in world arena, the country has its own limitations like narrow genetic base of the Indian grape cultivars. Developing new variety through hybridization is very tedious and time consuming in grape. Long generation time (juvenile period), very little seed germination, incompatibility of some available sources of resistance with *Vitis vinifera* and inferior fruit quality of wild types are the major obstacles in grape breeding. Various Indian research institutes has released the grape varieties but those did not take up by growers due to lack of commercial potential. In India growers are still cultivating Thompson Seedless, its clones and also clones of Kishmish Cherneyi developed by growers.

The marketing window available in global is very crucial that decides the direction of the grape production in the country. Indian grapes starts coming in the market from January and it last up to April end and same is true for the country like Chile which pour their produce in the global market from January till May end. Whereas, South Africa and Peru are bit early to bring their grapes in global market (in the beginning of January). Thus Chile, South Africa and Peru are the main competitors for Indian grape in international market. Egypt brings its produce in market in late summer (May and it ends in July). The grapes from Italy, Brazil and Spain get ready for market during July to November. So, from the beginning of May till beginning of July is the lean period in international market when hardly any grapes are available and this period is needs to be tapped. Limited marketing window (February - April) is major restriction for our grape export followed by close competition with the countries such as Chile, South Africa, Peru and Australia in European market. These countries possesses diverse range of grape varieties which are highly productive with better fruit quality and longer shelf life. Hence, to cope up with the situation, India needs varieties with diverse maturity period which will fulfill the market demand during lean period.

India needs grape varieties with quality produce, higher productivity, better shelf life in cold storage for their longer availability in the market, uniform colour development under warm and dry climate, cost effectiveness, varieties with diverse maturity period and resistance to abiotic/biotic stresses to improve country's export. There are some varieties available with the firms working on grape and companies like Midnight Beauty, Coachella Seedless, Adora Seedless, Sable Seedless, Moon Drop, Sweet Jubilee, Cotton Candy, Sweet Surrender, Sweet Globe, Sweet Celebration, Timco, Allison, Scarlota Seedless, Prime Seedless, Sweet Scarlet, Passion Fire, Sweet Sapphire etc. which are endowed with these commercial traits and those needs to be imported to India to secure and improve our market share on world arena. But the threat of capturing international grape market by India is a major concern for owners of patented varieties if India gets access to those varieties. As a result these countries are hesitant to sell their patented cultivars to India. This is an important bottleneck in the import of exotic varieties.

India needs table grapes varieties with specific attributes like seedlessness, bold berries, self-thinning properties to curtail the labour cost involved. In this recurrent operation, loose bunches, variety with elongated berries for domestic market, varieties with vivid aromas and flavours. The country also needs early maturing varieties for the regions where fruit maturity coincides with rain and to expand grape cultivation to newer areas. Cultivation of export oriented variety and supply of quality planting material to end user is prerequisite for export oriented grapes production. Quality plating material is a key for quality grape production and the longevity of productive grape orchards. Unavailability of quality planting material leads to graft failure and death of young vines. Certified nurseries supplying authentic planting material of grape is urgently required for production of quality grapes. However, new competitive varieties are capturing global market due to their attractive appearance, large berry size, seedlessness, flavour, crunchiness and shelf life, etc. Further to compete in an international market, there is need to intensify the efforts to develop or introduce promising varieties (scion as well as rootstocks) and production of quality planting material to meet future planting material requirement. Development of technologies to enhance climate resilience of grapes like protected cultivation, improved input use efficiency, off-season availability are some key areas that needs to be addressed.

Looking in to the urgent need of new grape varieties and quality planting material in escalating Indian grape export, NRCG has organized this National Symposium on 'Indian Grape Export: Need of grape varieties and quality planting material' to deliberate this burning issue with eminent experts from Plant Quarantine, PPV&FRA, NRCG, National Horticultural Board, Maharashtra State Department of Agriculture and Maharashtra State Department of Horticulture for the benefit of different stakeholders like grape growers, grape exporters, commercial nursery owners and researchers.

Nutrition and Irrigation – The Need in Grapes

Dr. A.K. Upadhyay, Principal Scientist (Soil Science)
ICAR- National Research Centre For Grapes

Grapevine being a perennial crop stays at the site for at least 12-15 years. More than 85% of its roots are concentrated in the soil at 2' laterally from the vine and at 2' soil depth. Nutrient and water management needs to be focused in that area. Grapes can be cultivated in varied soil types. Deep and well drained soils with pH ranging from 6.5 to 8 are suitable for cultivation. A grower needs to understand that each plot is unique and should accordingly devise management strategy. Planning nutrient and irrigation water needs for the vineyard requires proper understanding of the growth stages, soil and irrigation water quality.

Before planning for pruning, the grower should test the soil and irrigation water. Irrigation water particularly from groundwater sources can supply large quantities to meet crop needs of nutrients like nitrogen (nitrate-N), magnesium, calcium etc. Further, it may also be noted that factors such as soil type, texture and depth, rootstock, irrigation water quality and the crop load affect its uptake and utilization. Thus, petiole analysis becomes important. Grape petioles are sampled twice under double pruning and single cropping season for regular monitoring for nutrient status of vines during the bud differentiation stage and full bloom stage and once during full bloom stage in single pruning and single cropping system. Results from petiole analysis are most useful when combined with other information from the site such as previous and current season's growth, weather conditions, recent inputs to the vines (fertilizer, irrigation), and past experience with the particular vineyard. Apply fertilizer based on soil, petiole and irrigation water analysis. The amount of fertilizer dose required will differ for different soil types and varieties even if the petiole test value is same. There is no well-defined formula to translate the soil/petiole test values directly in to fertilizer recommendations.

Calcareous soils have calcium carbonate content exceeding 3% and soil pH also ranges from 7.4 to 8.2. This affects the availability of nitrogen, phosphorus, potassium, magnesium, zinc, boron and iron. Lime induced iron deficiency is quite

common under such situations. The Free calcium carbonate can increase with soil depth, and if it is present in the top 18 inches of soil, it could be difficult to impossible to lower the soil pH, and can take several years. To manage such soils calcium carbonate content needs to be neutralized along with reduction in soil pH. Use of amendments viz. sulphur, sulphuric acid, Ammonium thiosulphate and Potassium thiosulphate are beneficial. Application of 50-150 kg elemental Sulphur depending upon calcium carbonate content in each pruning season on a per acre basis will be desirable. If soil has high calcium content, regular application for at least 2-3 year will be required. To improve the efficacy of sulphur applied, apply sulphur along with organic matter. Split application and soluble sources of fertilizers apart from Sulphur are key to improved management.

With irrigation water in many grape growing areas becoming saline in nature and the presence of specific ions like sodium, boron and chloride affects the vineyard productivity. The irrigation water with sodium level 100ppm will lead to sodicity issues. The sodium dominates the exchange complex in comparison to calcium and magnesium and thereby affects the soil structure. Soils are considered sodic if more than six percent of the CEC is occupied by sodium, and highly sodic if it occupies more than 15 percent of the CEC. The most common method to improve sodic soil is by applying amendments like gypsum or sulphur. Gypsum is calcium sulphate ($CaSO_4 \cdot 2H_2O$). It acts by replacing the sodium on the soil exchange complex and the sodium thus, displaced from exchange complex is leached by applying more water. In case of calcareous soils with sodicity issues, sulphur should be used as amendment. Restoration of sodic soils is slow because soil structure, once destroyed, is slow to improve. Soil practices to break the crusts and green manuring/ FYM/ compost/ sulphuric acid/ molasses application will improve the soil structure and lead to better leaching of sodium along with irrigation water. Flooding the land with large quantities of water must be avoided unless desired. Evaporation should be reduced so that salts from lower layers do not come to surface. For this mulching will be very helpful.

Heavy soils with high clay content have high water holding and nutrient supplying capacity but, suffer from low release rates for the nutrients. This can result in the development of topsoil structural problems such surface crusting/ sealing that could restrict the root growth. Application of organic manures to the tune of 8-10 t/acre before each pruning season, improves the soil physic-chemical and biological properties in both light as well as heavy soils. Improving the soil organic matter by 1% would approx. increase water holding capacity by 60,000 L/ acre and water has direct relationship with nutrient uptake.

FYM/ composts is complete food i.e. it supplies almost all the nutrients required for vine growth. It is source of food for microorganisms. Remember microbes play very-very important role in nutrient transformation and availability in soil. Minimum 10 ton well decomposed FYM should be added per acre. So more efforts should be made to increase the organic matter content of soil by adding FYM, green manure, organic mulching (jawar, maize, soyabean, Sugarcane leaves etc.). Only well decomposed press mud (composted one) should be added after testing for salt content in it.

Vineyards are mainly drip irrigated. Thus it is easier to apply water soluble fertilizers through drip. This allows flexible fertilizer programmes, with main advantages of control of timing, concentration, location and proportion of the nutrients. The recommended fertigation schedule is given below in table 1:

Table 1: Fertigation schedule for Thompson Seedless vines raised on Dogridge rootstock under saline irrigation

Growth Stage	Expected duration (days after pruning)	Month of operation	Nutrient application (kg/ha)		
			N	P2O5	K2O
Foundation Pruning					
Shoot growth	1-30	April-May	60	-	-
Shoot growth	31-40	April-May	20	35.5	-
Fruit bud differentiation	41-60	May-June	-	71	-
Cane maturity and Fruit bud development*	61-120	June-August	-	-	80
121 days - fruit pruning*	121 -	August- Fruit pruning	-	-	-
Fruit Pruning					
Shoot growth	1-40	October-November	80	-	-
Bloom to Shatter	41-55	November-December	-	26.5	-
Berry growth and development	56-70	December - January	-	26.5	-
Berry growth and development	71-105	December - January	80	-	80
Ripening to Harvest	106- harvest	January - March	-	-	80
Rest period (Harvest to Foundation pruning)	Upto 20 days	March-April	26	18	26

Note: The above fertigation schedule is a guideline and should be modified based upon soil, petiole and irrigation water analysis

Sulphur deficiency is rarely observed in vineyards since considerable quantities are indirectly added by use of S containing fertilisers like SOP and S as fungicide. Calcium deficiency in calcareous soils is not common and do not require specific fertiliser application unless vineyard soil has high pH or sodium. Certain climatic conditions (cold or rainy) or nutrient imbalance in soils may cause Ca deficiency in fruits (berries) which can be corrected by two to three foliar applications or bunch dipping between fruit set and 6-8 mm berry size @ 2g/L (calcium chloride or calcium nitrate). Apply magnesium sulphate @ 100 kg per hectare per pruning season in four splits for maintenance dose. However, the application must be done only if need is established based on petiole test value since in many vineyards ground water irrigation source may add substantial quantities of Mg in soil.

Amongst the micronutrients, zinc and iron are the most commonly deficient nutrients. Due to large variation in the type and content of calcium carbonate in soil, no specific recommendations are available. However, under established deficient conditions, on an average 50 kg per hectare each of zinc sulphate, ferrous sulphate and manganese sulphate should be applied per season. Micronutrients are preferably applied as foliar application and based on petiole analysis. On an average, 3-4 sprays of 0.2–0.4 % of sulphate forms of Zn, Mn and Fe in a pruning season meet the crop needs. Boron is strictly applied on the basis of petiole analysis report.

Applying micronutrients via foliar sprays is most common to correct micronutrient deficiencies and there are several valid reasons for this: i) Quick response compared to soil application ii) Micronutrients such as zinc, boron, manganese, and iron are required in relatively small quantities by grapevines and the small quantities applied by foliar applications can meet the vine requirements iii) Nutrients like zinc, manganese, and iron are also readily fixed by most vineyards soils. Soils having pH more than 6.5 often have low bioavailability of these nutrients and iv) Nutrients like zinc (Zn), Manganese (Mn) and copper (Cu) are known for their fungicidal properties. Thus, foliar sprays of micronutrients are more effective and can meet grapevines micronutrient's needs and prevent or correct a deficiency with relatively small amounts absorbed by the foliage.

There are also some disadvantages of foliar application such as i) The response from foliar sprays is temporary and ii) Only low doses can be sprayed and repeated sprays are needed in case of deficiency. iii) Micronutrients like Iron (Fe) and Boron (B) are highly immobile and only those leaves are benefitted which receive the sprays. Thus it should be used as complementary alternative to soil application.

Irrigation water management

Planning irrigation water needs for the vineyard requires proper understanding of the growth stages and water requirement for that stage. ICAR-NRC Grapes has developed irrigation schedule for Thompson Seedless vines raised on Dogridge rootstock using saline irrigation (EC – 1.7-1.8 dS/m) and is given in Table 2. These recommendations are for guidance purpose only and may change based on site conditions. In case, the irrigation water quality is good (EC < 1 dS/m), about 20% less irrigation water will be required. During rest period i.e. after harvest the vines can survive on stored soil water in heavy soils. If the rest period is more than a month then the vineyard should be irrigated twice or thrice during this period.

Table 2: Irrigation schedule for Thompson Seedless vines raised on Dogridge rootstock

Growth Stage	Expected duration (days after pruning)	Water requirement (litres/day/ha per mm of evaporation)	Month of operation	Expected Pan evaporation (mm)	Approximate water (litres /hectare/day)
Foundation Pruning					
Shoot growth	1-30	4200	April-May	8-12	33,600-50,400
Shoot growth	31-40	4200	April-May	8-12	33,600-50,400
Fruit bud differentiation	41-60	1400	May-June	8-10	11,200-14,000

Cane maturity and Fruit bud development*	61-120	1400	June-August	0-6	0-8,400
121days - fruit pruning *	121 -	1400	August-Fruit pruning	0-6	0-8,400
Fruit Pruning					
Shoot growth	1-40	4200	October-November	6-8	25,200-33,600
Bloom to Shatter	41-55	1400	November-December	4-6	5,600-8,400
Berry growth and development	56-70	4200	December - January	3-6	12,600-25,200
Berry growth and development	71-105	4200	December - January	3-6	12,600-25,200
Ripening to Harvest	106- harvest	4200	January - March	8-10	33,600-42,000
Rest period (Harvest to Foundation pruning)	upto 20 days	-	March-April	8-10	-

* The above growth stages generally coincide with rainy season and no irrigation may be required in heavy soils.
* The schedule has been worked based on experiment carried out in heavy and calcareous soils using saline irrigation water (EC ranging from 1.7-1.8 dS/m) and therefore this may be taken as guideline for stage wise irrigation for other soil types other than the one specified here.

Strategies to manage irrigation water in vineyards

1. **Use of mulch + Anti transpirant**: Use of anti transpirant (Antistress) on Thompson seedless vines during foundation pruning i.e. 4-6 ml antistress / litre after 30, 60 and 90 days after foundation pruning and two sprays @4 ml antistress / litre at 25 and 55 days after fruit pruning in combination with bagasse mulching could save 25% of irrigation water. The usage of Antistress or any antitranspirant, should be checked for any restrictions on its application based on Good Agricultural Practices etc.
2. **Subsurface irrigation:** Application of irrigation water from drippers with the help of microtube at nine inches below the soil saves 25% irrigation water. The irrigation water from microtube can be applied through plastic pipes/ waste mineral water bottle (2.5" diameter approx. for heavy soils). We can also directly bury the laterals with antisiphon drippers below the soil at 15-25 cm depth. Here the possibility of root intrusion in the drippers is possible. This can be avoided by frequent bursts of irrigation water at weekly intervals for short period of 5-10 min. when irrigation is not desired or use of certain chemicals which will not allow the roots to enter the drippers. In the case of light textured soil, irrigation should be provided at depth of 6-7 inches.
3. **Irrigation frequency:** In heavy and deep soils, irrigate less frequently i.e. 3-5 days and the water required for each day should be totalled and applied once. This pushes the water deeper into the soil where it is still available to the vine's roots, but is more protected from evaporation from the soil surface. In case of heavy soils with less depth, irrigate frequently as water holding capacity is less and possibility of more leeching losses. In case of light soils, more frequent irrigation may be required to maintain soil moisture status above the permanent wilting point as excess water will lead to leeching loss. Pulse irrigation leading to widening of the wetted zone, especially in light soils, where rapid entry to the soil favours movement of water beyond the effective root zone will be beneficial.
4. **Managing salinity:** If the irrigation water is saline, the only way to reduce salinity is to apply more water to leach the salts. When irrigation water availability is low, it is suggested to saturate or flood the root zone just before the pruning to leach

the salts below the root zone, so that the sprouting and initial growth is not affected. With age of the leaves, the impact of the salinity developed at a later stage will be less. Further, immediately after saturating the bund, apply mulch to keep the soil moist.

5. **Surface sealing:** Continuous falling of water through drip at one location could lead to surface sealing thus leading to runoff across the bunds and evaporation. Providing a shallow furrow on top of the bund under the drip line will reduce run-off by ponding the water until it has soaked into the soil. Alternatively, provide a thin layer of mulch just below the dripper in the furrow to allow the percolation of water in the root zone. Maintaining good soil condition on the bund will minimise evaporative loss of water by favouring water infiltration. Adequate mixing of the organics like FYM/ compost in the bunds will improve the water infiltration through the root zone.
6. Excessively dry top soils can lead to water run-off and thus significant evaporative loss of water. It is thus, necessary to maintain adequate moisture at the soil surface to facilitate water entry at the next irrigation. Several short irrigations followed by a medium to long irrigation often helps to maintain surface moisture, enabling easier infiltration of water.

Pest management in grapes for higher returns and new markets

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Profitability is the main objective of any agricultural enterprise. Higher profits or returns can be achieved by either reducing the cost of cultivation or increasing the production or increasing the quality of the produce to fetch better prices. Pest attacks in grapes cause significant economic losses in grapes every year. There are various pest management methods which are employed by farmers to manage these pests. However, the main focus of the pest management strategy relies on use of pesticides. the grape is mostly cultivated as a monoculture. therefore, the natural balance between the best and their natural enemy is disturbed. with the use of pesticides, the remaining natural enemies get also destroyed thus further aggravating the situation. this leads to ticket use of pesticides to manage increasing test problems. with repeated use of pesticides there are problems such as development of resistance pesticide residues damage to the environment. this in turn affects the sustainability of the production. post office logos the cost of the cultivation goes up and the quality of the produce deteriorates leading to the declining returns over the years.

The insect and mite pests increase in numbers due to imbalances in the vineyard ecosystem. In a balanced agro-ecosystem, pests are usually kept under check by their antagonists and natural enemies. Monoculture, two pruning in a year and use of broad-spectrum pesticides reduce populations of biocontrol agents and upset the natural balance. Over-dependence on use of pesticides to manage pests further erodes the natural balance and put the farmer into vicious cycle of repeated use of pesticides. This leads to increase in cost of cultivation, development of resistance in pests, problems of pesticide residues in final produce and environmental contamination. Therefore, bio-intensification of vineyards with bio-control agents is necessary to re-establish the natural balance in the vineyard ecosystem. Further, not only the augmentative application of bio-agents but also their conservation is also important for sustainable management. By avoiding use of broad-spectrum pesticides and use of relatively safer

chemicals during the periods when activity of natural biological control agents like entomopathogens, predators and parasitoid is high, pest populations can be kept under check naturally due to enhanced natural biocontrol activity. This can ultimately lead to lesser number of pesticide applications and enhancing sustainability. It also results in reduced levels of pesticide residues and ensuring food safety.

Higher returns from the vineyards can be achieved by increasing production, reducing cost of cultivation, increase the quality of produce or finding newer markets to get higher prices for the final produce. High production can be achieved through minimizing the production limiting factors such as pest incidences. Thrips, leafhopper, mealybug, flea beetle, caterpillar and red spider mites are major limiting factors in grape production. The main management strategy to manage these pests relies on use of insecticides. The cost of cultivation can be reduced by following alternative pest management strategies such as instead of spraying for caterpillar during bud sprouting stage, banding of main trunk at two feet height with 2 inches thick cello tape with slippery side outwards. With the use of this methodology, the caterpillars will not be able to climb up the grape plants at night and sprouting buds can be saved without spraying any insecticide thus saving in cost of cultivation. Use of light traps is another strategy which can help in reducing application of insecticides by attracting and killing leafhoppers and moths. Just changing the time of spray can also help in increasing the efficiency of the insecticides. For example, leafhoppers and flea beetle are managed more efficiently if the insecticides are sprayed after dusk. Installing a white light behind tractor at the time of spraying in night for leafhoppers will help in achieving better results. All these tips can help in reducing cost of cultivation and saving the environment.

The quality of produce can be increased by better pest management and using the insecticides in such a way that minimal insecticide residues below maximum residue limit remains in the final produce. These kinds of grapes can fetch higher prices in the market and thus give higher returns. New markets can be created by making pest free areas and developing protocols for export of produce to countries limited by pests of quarantine importance for example Australia and New Zealand. Opening new markets can lead to more avenues for the final produce, thus fetching higher prices.

Bio intensive disease management in grapes: an indispensable tool for residue compliance

Sujoy Saha, Principal Scientist (Plant Pathology)
ICAR- National Research Centre for Grapes

Commercial grape varieties belonging to *Vitis vinifera* are highly susceptible to three important disease viz. downy mildew, powdery mildew and anthracnose. However, during recent times rust infection is becoming serious in certain areas, especially in the nurseries. Similarly in hotter areas, where warm and humid conditions prevail bacterial infection is also seen. Both rust and bacterial spot diseases cause premature leaf drop. Grapevine leaf roll associate virus-3 too has been observed in some vines. The incidence and severity of most of the grape diseases depend on young growing tissues and weather conditions. Generally from April to first week of June the climate is hot, and hence there is less chance of disease development, but during south-west monsoon season chances of infection of powdery mildew, downy mildew and anthracnose are increased. Thus, the strategy of disease management after foundation pruning, aims at providing protection during wet weather to reduce the disease.

1. Downy mildew

Downy Mildew (c.o. *Plasmopara viticola*) is the most destructive disease of grape and causes colossal losses under favourable conditions. White downy growth is seen on the leaves, cluster, flowers, rachis, pedicle, young berries or young shoots. On the upper leaf surface yellow circular spots with an oily appearance in white grape varieties and red spots in coloured grape varieties are observed while the white downy growth later can be seen on the lower leaf surface on the underside of these spots (Fig 1A and B). Young clusters turn necrotic and young infected berries appear greyish (Fig. 1C).

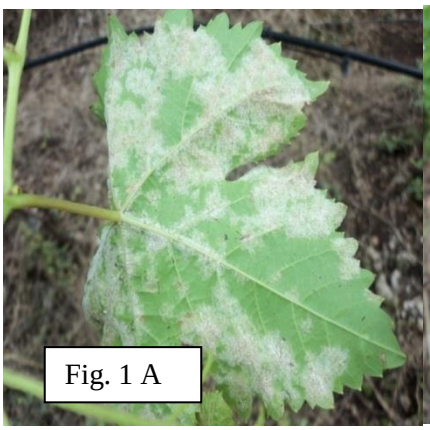


Fig. 1 A

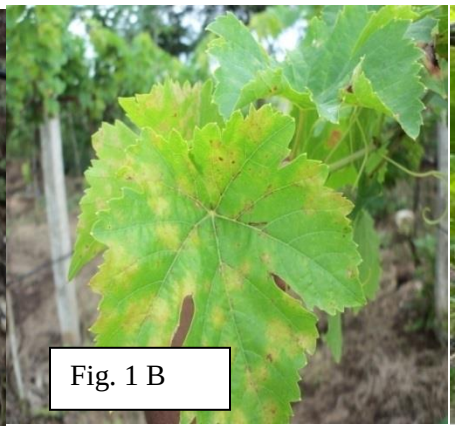


Fig. 1 B

Fig. 1 C

A temperature of 17 to 28ºC with a rainfall/irrigation of 10 mm and relative humidity more than 40% favors infection. Wetness of leaf or soil further predisposes the plants to the disease. If running water flows in the vines for 2-3 days, then there is a high probability of disease incidence. A moist, dark condition following a period of light favours maximum sporulation.

Downy mildew infections are first observed after the start of the monsoon rain and when the maximum temperature is below 30ºC. Several cultural practices like removal and burning of infected leaves as well as removal of excess new shoot growth during monsoon may help in reducing primary infection. Proper tying of shoots to the trellis and avoidance of excess doses of nitrogen also reduces the primary inoculum.

Systemic fungicides for the control of downy mildew are not encouraged after foundation pruning. Low risk systemic fungicides are used during 25 days after fruit pruning and after high risk fungicides are used. In one fruiting season maximum 5 sprays of low risk systemic fungicides and 2 to 3 sprays of high risk fungicides are recommended. Prophylactic use of Mancozeb 75WP is recommended as it inhibits the formation of secondary haustoria and growth of mycelium. A tank mix of potassium salt of phosphorus acid @4g/L and Mancozeb75WP @ 2g/L gives a good control of the disease. The current list of fungicides, their nature, recommended doses, pre harvest interval (PHI) and the European Union Maximum Residues Limit (MRL) are given in Table 5. The regularly updated list can be accessed at https://nrcgrapes.icar.gov.in/Warning

system through weather based advisory enable effective control of downy mildew with reduced numbers of sprays.

2. Powdery Mildew

Powdery Mildew (c.o. *Erysiphe necator*) is a serious problem during the vegetative growth phase especially when cloudy and humid conditions prevail. Thick canopy creates favorable conditions for disease development. Optimum temperature for growth is 20-27˚C but no fungal growth occurs below 6˚C or above 32˚C. Relative humidity more than 60% favour and less than 30% does not favor the disease respectively.

The first powdery mildew lesions are frequently found on the undersides of leaves. As the disease progresses, lesions become apparent on the upper sides of leaves as well (Fig 2 A). Grey to whitish powder is usually seen on rachis and severe infections of the rachis can result in clusters being dropped. Berries turn into an ash grey colour and quickly become covered in spores giving them a floury appearance (Fig. 2B). Affected berries dry out and may drop off.

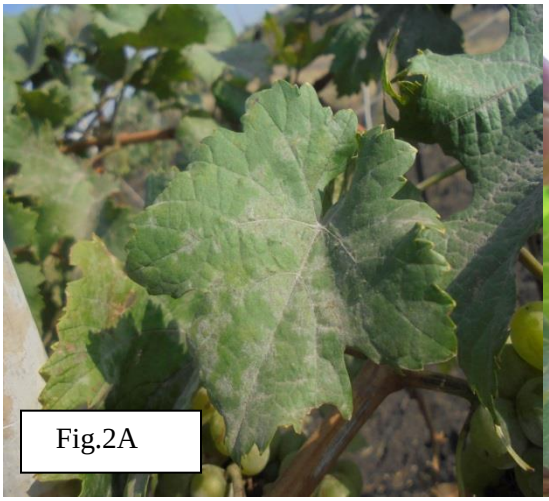


Fig.2A

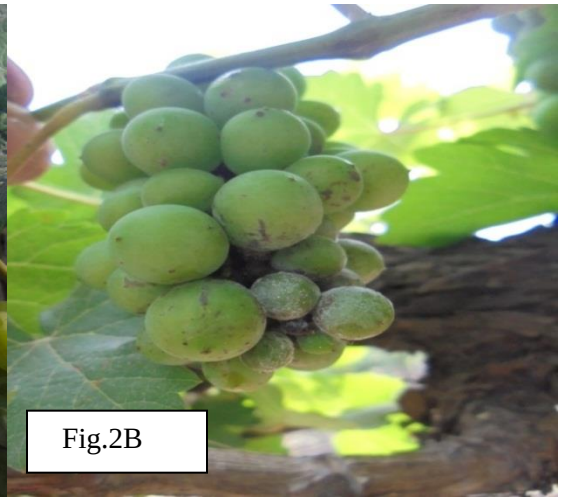


Fig.2B

Cleistothecia of the fungi is not found in India due to the absence of mating types. Excessive use of nitrogen fertilizer should be avoided and by removing non- photo synthetically active and non-bearing shoots will help to open up the canopy and improve the efficacy of spray application. *Bacillus subtilis* @2g/L and *Ampelomyces quisqualis*@

4-5g/L gives a good control of the disease and should be applied during the rainy season when humidity is high for their profuse multiplication. Though a number of fungicides have been evaluated against powdery mildew, at present only the following are registered for use in grapes in India. The regularly updated list can be accessed at https://nrcgrapes.icar.gov.in/.

3. Anthracnose

Anthracnose (c.o**.** *Colletotrichum gloeosporioides*) occurs during warm, wet and cloudy weather and can cause complete kill of new growth, reduce the vigor, fruit falling, yield and quality. The disease occurs mainly during monsoon corresponding to vegetative growth season.

Small, yellowish spots on the leaves are seen, which turn into circular, grey lesions (Fig. 3A). Numerous lesions are formed on the leaf and the dead tissue drop out the spots causing hole in the center, which is a typical symptoms of anthracnose called as **"Shot Hole**" (Fig. 3 B). The lesions may show cracking at the late infection stage and if the infection is at the base of the stem, the stem may crack and break.

Fig.3A

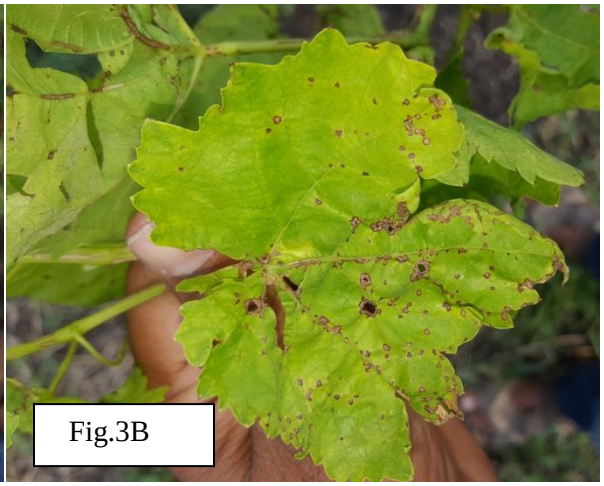


Fig.3B

To control the disease all shoots canes with anthracnose lesions should be removed at the time of pruning. Through a number of fungicides have been evaluated against anthracnose, at present only the following are registered for use in grapes in India. The regularly updated list can be accessed at https://nrcgrapes.icar.gov.in/.

4. Rust

Rust (c.o**.** *Phakospora euvitis*) can cause severe defoliation during July-August and January-February, which usually coincides with veraison and thus hampers the berry ripening and development. After the introduction and adoption of Dogridge as a rootstock for table grapes, rust was observed on Dogridge rootstock plants and from the infected Dogridge plants it was seen getting transmitted to the scion plants. Thus, in recent years rust is also being observed during September-October *i.e.* at the end of monsoon period on Thompson Seedless and its clones in Maharashtra.

Characteristic sign of the disease are numerous yellow-orange colored pustules present on the lower surface of the mature leaves. Sometimes these pustules are also present on the petioles, young shoots and rachis as well. Occasionally the upper surface of the leaf corresponding to the uredial pustules shows brown necrotic spots. In severe infections the entire leaf area may be covered by these fruiting bodies and the leaves fall off. Copper based fungicides e.g. Bordeaux mixture, copper hydroxide or copper oxy-chloride or chlorothalonil provide effective control of the disease. Curative applications with triazole fungicides also showed good control of the disease.

5. Bacterial Blight

Bacterial Blight (c.o. *Xanthomonas citri* pv*. viticola*) occurs on all the aerial parts of the vine during wet and warm weather. Minute water soaked lesions are seen on the lower surface, which enlarge and become angular and cankerous. Stunting, cracking and irregular growth of shoots is seen in advanced stage of infection. Recent studies depict that spray of mancozeb 75WP @2-2.5g/L gives a good control of the disease. Kasugamycin 5% + Copper Oxychloride 45%WP @750g/ha is also registered against the pathogen.

Conclusion:

Disease management in grapes is predominantly dependent upon weather conditions and hence weather-based advisories generated by ICAR-NRCG should be followed for effective control.

Sharing Euro Fruits Grape Journey

Nitin Agrawal, Managing Director, Euro Fruits, India

Mr. Nitin Agrawal, Managing Director of Euro Fruits narrated the three-decade journey of the company and the precious lessons learnt by him and his team during this period. Euro Fruits is pioneering Grapes Exporter from India to the United Kingdom / European Union Markets since 1992. The company's operations are focused on Premium Quality for Premium High Street Retailers in the UK and EU. We have many exclusive supply contracts for retailer branded packouts. Our relationship with farmer supplier families now extend to the second generation.

The company is India's most accredited Grape Exporter with certifications across food safety, Traceability, Due Diligence, Social Compliance, Environmental Stewardship and Sustainability spectrum. While all these lessons and learnings are in the course of Grapes Export operations, most of them are really applicable and relevant to all businesses.

- Always Think Long Term – We are required to take present decisions that impact our future. We typically face dilemma in taking a particular course of action. It is easy to be attracted by short term results. But while taking decision, its impact in the long run also must be evaluated. Actually, decision making process becomes easy when one considers long term impact. **Euro Fruits always banks on people (rather than circumstances) with long term intent.**
- Trust based Relationship- Business is about People, not about products or money. Being Consistent and Credible in all our relationships builds the Trust amongst all stakeholders. Rich dividends can be harvested based on mutual Trust. Euro Fruits works with the same importer in Europe on mutual exclusive basis for nearly 25 years - **a unique example in a volatile perishables trade globally**

- Learn, Earn and Return - The golden rule in the personal life of a businessman is - the first 15 years of any business is only learning time, while the next 15 years is to make money to make the business sustainable for all stakeholders and the rest of the time, one must give back to the society. **Euro Fruits proudest achievement is the relationship and support structures developed with an old age home, a cancer patients care NGO, a school for the blind, a differently abled children day school.**
- Educate People not to Train them- Human beings need to be educated. They are not animals to be trained! **We do not have training sessions in Euro Fruits – only Enabling Education camps.**
- Never Burn the Bridges- Even in the case of any disagreement with anyone, we should not break the relationship. No one knows when you will need to associate with the same person you disagreed earlier. **Even our local competitors and their overseas clients speak good about Euro Fruits.**
- You are always Only as Good as Your last Pallet – Never rest on your laurels. You are always judged by the world by your last mistake…**We never argue with a Client and own up all that he says, even if we believe we are not at fault.**
- Integrity and reputation – The company is known by the company it keeps. In this competitive world, Integrity and Reputation are the only traits that give your long lasting competitive edge. Always protect them at all costs. Spoiling name and reputation in business, even for seemingly long term monetary benefit is suicidal. **While developing any new business relationship, Euro Fruits conducts thorough due diligence on the reputation of the party.**
- Try to be street smart. It is no use getting sad or dejected by the failures. Failures are learning opportunities. Stay always connected with all stakeholders with ears to the ground. **We always tell our Clients that Euro Fruits loves Challenges, please offer!**

- Managing your Grey Areas – None of us are masters in all aspects of business. We are vulnerable. Rather than dreaming to conquer all your weaknesses, better manage them well.
- Networking – Out of Sight is Out of Mind – Always stay connected with all stakeholders, particularly Clients – both at professional and personal level – even in an otherwise seasonal business. **We stay connected with global Clients personnel on personal and festive occasions across the year.**
- Listen not hear – In all interactions, it is crucial to understand the underlying feelings and messages and body language – rather than hearing only the spoken words. Such conversations become mutually satisfying and rewarding.
- Passion - You are never required work for a living if you have passion for that work. Such Passion is infectious, spreading across your team. **All visitors to Euro Fruits facilities feel surprised with the passion and commitment of our people.**
- Under Promise and Over Deliver – Normally most people tend to do exactly the opposite by over promising in business deals and eventually not being able to keep the commitments. Instead better Under Promise in business transactions and Over Deliver to Wow the Client.
- Zeal to Learn – We need to always be excited to learn with an enthusiasm of a startup even after decades in business. You will be surprised about the scope of learning in the areas one otherwise thinks he is an expert with experience.
- Empowerment of Euro Stars – In Euro Fruits all are designated as "Euro stars". In dealing with Clients, all Euro Stars have complete authority and sense of ownership. **Average per Euro Star employment association at Euro Fruits is over 15 years, speaking volumes of our human resources practices.**
- Sustainability Initiatives – With global Climate Warming challenges affecting all walks of life, impact of our operations on Environment must be assessed before taking every business decision. All external stakeholders like Bankers, Government evaluate businesses on sustainability initiatives parameters. **Euro**

Fruits implements demanding global standards on water stewardship, environmental compliance etc. as industry leader.

- CSR Initiatives – Corporate Social Responsibility is not just charity – it makes good business sense, promoting the central purpose of business of increasing shareholders and stakeholders value along with societal good. **Euro Fruits has set up an English medium primary school for the children of our pack-house workers and smallholder farmers.**
- Gender Equity – In the current socio-economic setting in India, Gender Equity practices with equal pay for equal work for ladies, placing women in authority of power and responsibility, gender specific concessions and privileges make good commercial sense. **Euro Fruits implements UN Gender Equity Seal Standard at the packhouse.**
- Riveted Focus – Business situations present many opportunities to get into various segments – it is important to stick to the segment of your core competence – rather than getting lured to commit resources in areas where one does not expertise or competitive edge. **Euro Fruits keeps complete focus on a single product - Grapes - across value chain for nearly three decades till date.**
- Key Product Characteristics – Just as in Grapes business, Taste Profile/ Mouthfeel/ Crunchiness are key product specifications which are difficult to define objectively and mathematically. Sometimes, these crucial subjective aspects get over shadowed by other objective requirements stated by the trade players. **Euro Fruits has identified cultural practices to positively influence such subjective but all-important product traits, during cultivation stage.**
- Tech Savvy Key Stakeholders – Technology is all pervading reaching out at the bottom of the food pyramid. New demands of such technologically adroit business partners (small holder farmers in our context) must be understood and supported. **Ag-Tech revolution is sweeping Indian agriculture and we introduce the new technologies to our farmer suppliers.**

- Importance of Food Safety and Traceability – In every business there are few pre-competitive issues, which are mandatory for the strictest possible compliance by all suppliers. It is important to strive for best in class practices in such issues and transparently share the same even with competitors for long term overall progress of the sector - like Food Safety and Traceability aspects in fresh produce sector. **Euro Fruits is India's first ever GlobalGAP and BRC certified Grape exporters since 2003.**
- All Stakeholders are Equal Partners – With this mindset, even the smallest supplier gets as much attention and respect as a major customer. This helps us working with the very same set of suppliers and customers for decades. With complete mutual understanding of all players, the operations become very smooth. **Our supplier of staple pins in the office is the same for decades!**
- Being Responsible – With Clients, we must take 100% responsibility for all aspects of the product/ service/ process/ compliance/ communication across the value chain – we must stand behind the product at all times – **Euro Fruits therefore calls our product as Responsible Grapes**

Pesticide Application Strategies for an Effective Management of Diseases in Grapes

Sujoy Saha, Principal Scientist (Plant Pathology)
ICAR- National Research Centre for Grapes

Introduction:

The application of pesticides has been a concern for many years, particularly methods of reducing drift, improving deposition and coverage along with the maintenance of spray equipment. Most growers know that there are three factors which affect application rate i.e. forward speed, nozzle size and system pressure but often overlook the factors which help get the spray onto the target i.e Timing, Coverage, Dosage and canopy structure. Progress lies in a better understanding of the factors involved in getting the spray from the tank to the vines. Some of the salient points regarding effective application of pesticides are briefly discussed as follows:

Timing: It is important to know the most vulnerable stage of development of the disease in grape vines. The weather parameters and epidemiological factors needs to be consulted for this understanding. The decision also needs to be taken whether a particular chemical is to be applied during the early incidence of disease or as a prophylactic measure. In many instances a slight delay in the application might lead to a heavy loss of the crop. In majority of the cases growers wait for the disease symptoms to appear and then resort to curative spray but this should be monitored carefully so that the application is done in the optimum time frame.

Coverage: The coverage depends on the number of droplets per given area and more the number of droplets impinging per unit area, better is the efficacy. Normal volume sprayer have droplet size about 300u while that in low volume sprayer is 50u. If one droplet of 300 u drops on leaf surface it is likely to be rolled off. Moreover, if it remains on leaf surface it will occupy at least 6 times less area than that occupied by droplets of 50 u. Hence smaller droplets give better coverage of the plant surface.

Dosage: In India doses are mentioned as g of pesticide / litre of water. Normally 1000 L of water per hectare is required when spraying is done with normal volume sprayer. For low volume sprayer water required may be proportionately low as in case of 2x, or 4x low volume sprayer water required will be 500 or 250 L of water respectively. The dose of pesticide per hectare remains same even though spray volume is reduced in low volume sprayers.

Canopy structure: The total spray volume required depends upon the canopy structure and size. If 1000L of spray volume is required per hectare when the canopy is 100% (Dense canopy where light penetration in inside canopy is much less. At noon no light is seen on soil beneath the canopy), 700L will be required in 70 % canopy (Canopy immediately after pruning)

Sprayer calibration:

Calibration is a compulsory exercise, to guarantee the legal amount of product and water that will be required to treat the target area. Calibration should be done when spraying is done for the first time with a new equipment or at the beginning of each season or after changing nozzle, speed or spraying pressure. It is advised to do calibration at least two times in a spray season. The advantages of proper calibration are manifold. This allows us to spray the correct amount and the wastage of chemical is avoided. Effective control of pests and diseases is possible and the environment is protected from pollution. The application of pesticides has been a concern for many years, particularly methods of reducing drift, improving deposition and coverage along with the maintenance of spray equipment.There are many inter-related factors which affect spray application, depending upon the target, the efficacy of the spray, the attitude of the operator, the standard of management, the weather etc.

Calibration in Low volume and high volume sprayers

1. Efficiency of the sprayers depends up on droplet size. Smaller the droplet size better will be the coverage of plant surface. The size of the droplet emitted by the sprayer depends on type of nozzle. There are two common types of nozzles:
2. Pressure nozzles: The liquid under high pressure is released through small diameter jet to automize it in to small droplets. Increase in pressure on liquid leads to reduction in droplet. However, in case of such nozzles normally about 85 % droplets are in the range of 250 – 300 µ and by increasing pressure the droplet size is not reduced further
3. Air-shear nozzles: In case of air shear nozzles, air with high velocity is passed through ventury tube and liquid to be automised is introduced without pressure at the throat of the ventury tube. The liquid is sheared by air into fine and uniform droplets. Studies have shown that about 90 % of the droplets in such nozzle are 50 – 100 u in size. As the droplet size becomes small instead of water being the carrier of the chemical to be sprayed, air becomes the carrier and volume of liquid required for spraying is reduced.
4. The sprayer with the pressure nozzle, which is commonly used, is called as normal volume sprayer while sprayer with air shear nozzle called as low volume sprayer as it requires relatively low volume of water for spraying. Depending up on the extent of reduction in volume the sprayer are called 2x, 3x or 4x sprayer. These sprayers require 2, 3, 4, times less water for spraying as compared to normal volume sprayer respectively.
5. Once it is known how much spray volume is to be used, to ensure correct application rate one should know how much volume the sprayer is releasing per minute. The sprayer manufacturer should make this information available. However, it is not provided by the most Indian manufacturers. Rough estimation can be done at field level. For such estimation following values should be known:

6. Total output of water from nozzles: It can be estimated by fixing hose pipe on one or two nozzles when sprayer is in action. Water released by the nozzles at known speed of the tractor is collected in any container with the help of hose fixed on it and its volume is measured. Based on total number of nozzles fixed on each sprayer total output from the nozzles can be estimated
7. Tractor speed in km / h: It can be read from the speedometer
8. Width of the row where spray droplets are covered
9. Once the water output of the sprayer and factors determining it are known, one can easily optimize the sprayer output by changing number of nozzles and tractor speed.

Selection of nozzles:

Usually in Indian vineyards, two types of nozzles are used i.e. Pressure nozzles, and Air-shear nozzles. In pressure nozzle the liquid under high pressure is released through small diameter jet to automize it in to small droplets. In case of air shear nozzles, air with high velocity is passed through ventury tube and liquid to be automised is introduced without pressure at the throat of the ventury tube. The liquid is broken by air into fine and uniform droplets. Based on their use there are different types of nozzles which are in use vizCone nozzles (Hollow cone, Full cone and Variable cone), Fan nozzles (Standard fan, Spray fan and Low Pressure fan) and deflector nozzles. Nozzles made of plastic and stainless steel should be used as they are less damaged with constant use.

Drift management:

It is the part of the spray not reaching the target mainly due to improper wind velocity. There are two types of drift i.e. vapour drift (associated with volatilization, gases, fumes) and particle drift(movement of spray particles) Drift results in loss of chemical, damage of neighbour crops or environment and contamination of farm workers which in turn leads to higher costs and inefficient application. Spraying should be avoided at any wind speed if itis blowing towards sensitive areas as all nozzles can drift. Spraying operations should be carried out when breeze is gentle, steady, and

blowing away from sensitive areas. To reduce drift anti-drift nozzles should be used. Moreover buffer zones needs to be maintained as it helps in protection of the drinking water and protection of neighbour's property and neighbouring crops.

Use of electrostatic sprayer for better coverage and drift reduction:

In these sprayers air and spray fluid enters the rear of the nozzle separately. As the spray mix is atomized, the droplets pass an electrode that induces a negative charge on each one of them.

Force of air propels the charged droplets into the plant canopy and the positive electrical charges on plant surface causes natural attraction of droplets. Some droplets wrap around (wrap around effect) the plant leaves and stems to coat their undersides as well. Once the droplets contact the leaves, they lose their electric charge. The major advantages are the following:

1. They produce spray droplets which are 900 times smaller than those of conventional sprayers
2. The spray fluid is carried deep inside canopy in a high-speed air-stream.
3. Twice the deposition of spray material occurs than both hydraulic and non-electrostatic air-assisted sprayers.
4. It requires 10-25 times less water carrier

Agitation of spray mixture:

Wettable powder (WP) and emulsifiable concentrates (EC) formulations most commonly in use and they are not water soluble. Hence, formulations are made to ensure uniform suspension of the active ingredient in spray liquids. Stability of these suspension is usually very low and while spraying if the spray liquid is not agitated, the active ingredient settled at lower surface is pumped out early by the sprayer pump and concentration of the active ingredient in left over solution is proportionately reduced. It may go below lethal concentration and in area where this liquid is sprayed may develop

resistance in pest against pesticide due to presence of sub-lethal doses. To avoid such serious consequences it is essential to have good agitator in the sprayer tank.

Conclusion:

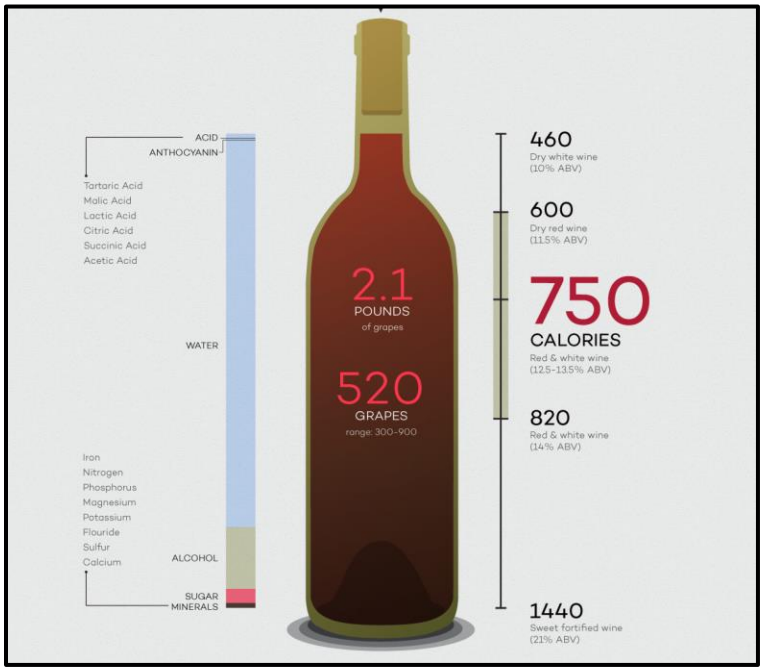
Attention should be given by the farmers regarding the minutest detail regarding application of pesticides and maintenance of sprayers so as to get a satisfactory control of diseases and pests. Novel techniques such as use of adjustable louvres allow air adjustment of the sprayers on the move and matches air flow to the changing crop canopy. Sensors can also be used to adjust liquid flow particularly in early season when minimum foliage exists to intercept the spray. Spraying requires thorough preparation, attention to detail, and constant vigilance if mistakes are to be avoided and an efficient application is to be made so as to obtain a durable protection to the crops.

Wine Grape Cultivation

Pushkaraj Mali, Senior Manager, Vineyard Operations,
Sula Vineyard Private Limited, Nashik

Wine is oldest alcoholic beverage known to mankind. What is Wine exactly made of? Wine is an alcoholic beverage made with the fermented juice of grapes. Any fruit is capable of being used for wine i.e., apples, cranberries, plums, etc., but if it just says "wine" on the label, then it's made with grapes.

Vitis (grapevines) is a genus of 79 accepted species of vining plants in the flowering plant family *Vitaceae*. The genus is made up of species predominantly from the Northern hemisphere. It is economically important as the source of grapes, both for direct consumption of the fruit and for fermentation to produce wine. The study and cultivation of grapevines is called viticulture. Wine grapes are different than table grapes: they are smaller, sweeter, and have lots of seeds. Most wines originate from a single species of vine that originated in the Caucasus called *Vitis vinifera*.

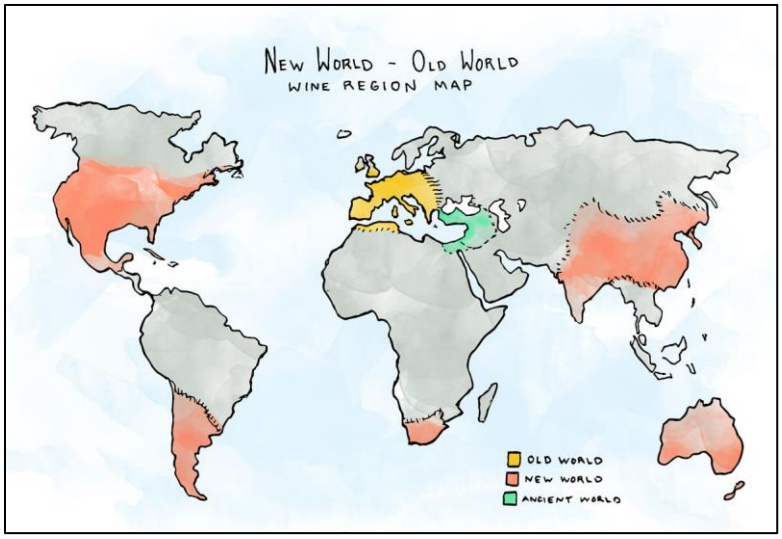


What's in a bottle of Wine. (Source: Wine folly)

History of Wine: India & Globe

Wine has been produced for thousands of years, with evidence of ancient wine production in Georgia from c. 6000 BC (the earliest known traces of wine), Iran from c. 5000 BC, Armenia from c. 4100 BC (large-scale production), and Sicily from c. 4000 BC. The earliest evidence of a grape and rice mixed based fermented drink sometimes compared to wine was found in ancient China (c. 7000 BC).

Indian Wine History has first mentioned in 300-400 BC in writings of Chanakya, Chief Minister of Emperor Chandragupta Maurya has first known mention of grape-based wines. During 1000-2000 AD Aryan tribes of the region were known for their indulgence in intoxicating drink. The religious text of the Vedas also has mentions at least one alcoholic drink that may have been wine related Sura which seems to have been a type of rice wine that was fermented with honey. In the 16th century, Portuguese colonists at Goa introduced port-style wine and the production of fortified wines soon spread to other regions. Under British rule, viticulture and wine making was strongly encouraged as a domestic source for the British colonists. Vineyards were planted extensively through the Baramati, Kashmir and Surat regions. In 1883 at the Calcutta International Exhibition, Indian wines were showcased to a favorable reception. The Indian wine industry was reaching a peak by the time the phylloxera epidemic made its way to country and devastated its vineyards.



Wine region map (Source: Wine folly)

Modern Era of Indian Wine

Chateau Indage, founded in 1979, was one of the first wineries in India. The first Indage vineyard was established in 1979 at Narayangaon in the Sahyadri valley with French varietals. In 1982 Champagne Indage was formed to produce sparkling wine for export, utilizing technical assistance from Piper-Heidsieck. Their first wine was launched in 1986 and won several international awards. By 1988 Indage has begun sell in the Indian domestic market.

Sula Vineyards was founded by Mr. Rajeev Samant in 1999. Sula has grown to be India's largest and most awarded wine brand. Sula introduced grape varietals such as Chenin blanc, Sauvignon blanc, Riesling and Zinfandel in India and is the leading player in the Indian wine industry. Also Sula is successful model of Contract wine grape farming model for last two decades. Starting from few acres in year 2000 to reaching upwards of 2100 acres in year 2021. Sula has provided farmers alternate option to Table grape with assurity of grape purchase & financial stability.

Indian Wine Industry potential -

- The wine market is expected to grow at a compound annual growth rate (CAGR) of 20 to 25 percent & Currently India's wine market is estimated to be valued at US$150 million.
- From a mere one million litres per annum in 2001 to over 30 million litres per annum in 2019 Wine consumption has pick up momentum.
- Rapid urbanization, changing lifestyles, rising disposable incomes, exposure to new and western cultures, and overseas education have contributed to the popularity of wine in India, particularly among urban consumers.
- India's population above drinking age is over 485 million and appears to be experiencing a shift that is normalizing a drinking culture, especially in the metropolises. Wine is becoming a status symbol among the among the upper and middle-class population.

- Wine has also become one of the most viable gifting options for birthdays, anniversaries, and other events.
- As a result of the pandemic, the importance of sustainability has been reinforced in the minds of consumers. In tandem with increasing the focus on environmental concerns, the pandemic has amplified the trend towards health and wellness. Together, these issues have acted as major drivers of the wine movement.

Planting wine grapes

It has been advised to be contact local winery prior to planting any wine grapes. Winery viticulturist will suggest wine grape verities as per market need & suitable for farmers land considering soil type, climatic conditions & other relevant aspects of grape growing. Following factors to be considered prior to planting wine grapes,

i. <u>Vineyard Site selection</u>

A. Soil type -

Wine grapes can adapt to a wide variety of soil types ranging from coarse gravelly sands to heavy clay, shallow to very deep soils & soils of low to high fertility. Best performance is however obtained in deep medium textured soils (i.e. Loam & sandy loam) which are low in salts & are well drained. Wine Grapes are successfully grown under irrigation on soils that provide 45-60 cm of root zone. However most *Vitis vinifera*. L varieties are deep rooted & fully explore the soil to a depth of 6-10 feet or more if the aeration is satisfactory & there is no obstruction to root zone. Soil physical features such as soil colour affect the absorbance of radiant heat. Soil texture influences water holding capacity, the nutrient status, & infiltration rate, permeability & aeration.

B. Terroir -

Terroir refers to the combination of natural factors associated with any particular vineyard. These factors include such things as soil, underlying rock, altitude, slope of hill or terrain, orientation toward the sun, and microclimate (typical rain, winds,

humidity, temperature variations, etc.) No two vineyards have exactly the same Terroir.

In general, a grapevine produces the best fruit when the moderate climate provides much sunshine, cool nights & well drained soil. Daily variation with cool nights (15^0-18^0C) & warm days (28^0-32^0C) is vital for successful wine grape production. Degree days that are available during September to March normally influences which wine variety to grow & the type of wine to produce in particular area. The organic constituents of wine such as alcohol, acids, esters, colour, tannins & aldehydes do have direct bearing on the bouquet, taste & other qualities of individual wines. The level & balance of these constituents in the musts & wines in turn are largely determined by climate.

ii. Wine grape varieties

Grapevine is grown mostly for wine making in world over. The main grapevine cultivated for wine production is the European wine grapes, *Vitis vinifera* L., native areas along the Black, Caspian & Mediterranean seas. Today there are more than 5000 verities of *Vitis vinifera* L. grown in the world. *Vitis vinifera* L. grape verities grown under wide range of climatic condition. Grapevine grows best in sandy, chalky or rocky soils. These conditions are exactly similar to Indian grape growing regions; because of that *Vitis vinifera* L. is perfectly suitable for Indian conditions.

ICAR-National Research Centre for Grape (NRCG) being nodal agency for research & development of table & wine grapes in India. NRCG has established a "Field Gene Bank" of grapes with about 450 verities & nearly 100 of them are wine grapes at Manjari Farm, Pune since 1998. Wine cultivars from different sources have been collected & evaluated for yield performance & must, juice quality. Following wine grapes are commercially successful & best grown in different grape growing regions across India.

A. Red Wine grape verities -

Cabernet Sauvignon, Shiraz, Zinfandel, Tempranillo, Granache, Merlot are some of the most planted varities in India.

Red wine grape varities (from Left) Shiraz, Zinfandel, Tempranillo & Cabernet Sauvignon.

B. White Wine grape varities -

Sauvignon Blanc, Chenin Blanc, Viognier, Riesling, Chardonnay, Muscat, Ugni Blanc are most planted varities across Indian grape growing regions.

White wine grape verities (from Left) Chenin Blanc, Viognier, Chardonnay & Riesling.

Apart from these famous wine grape varities more grape varities are under evaluation for Indian climatic conditions.

iii. Viticulture Practices

A. Training, trellising & Canopy Management -

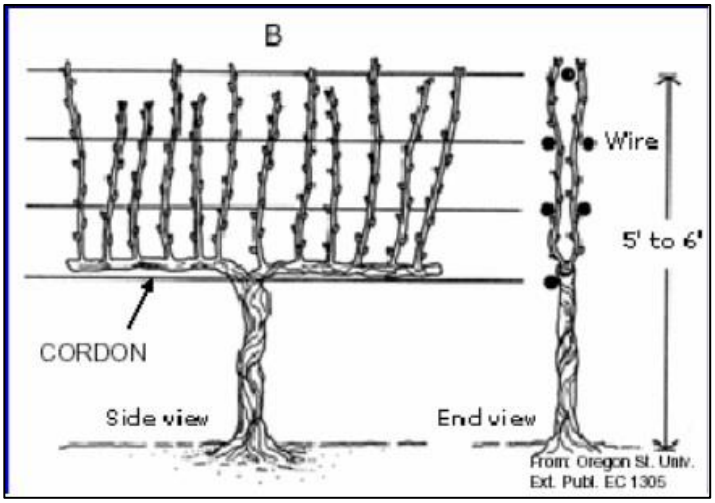
Training is structure development of vine & trellis support vine structure. To efficiently conduct cultural activities of spraying, pruning, microclimate management, supporting vine structure & to optimize yield, training & trellising is important.

Trellising is key tool for management of canopy affecting fruit quality & ultimately wine quality. The no. of shoots per vine, their arrangement in the canopy, no. of leaves per shoots & how they exposed to sunlight & no. of bunches per shoot & their exposure or shading to sunlight influence the wine & fruit quality. Training & Trellising complement each other & inseparable.

The canopy management is an important aspect in wine making. Traditionally in India for table grape production "Bower system" is used extensively, but for production of wine grapes it is not suitable. In table grapes fruit quality & appearance is important, but in wine grape the wine quality is most important aspect. For quality grape production for wine making, the micro climate around the vine, vine growth & fruit maturity is important. Vine training systems widely used in India,

A. Vertical shoot Position (VSP) :

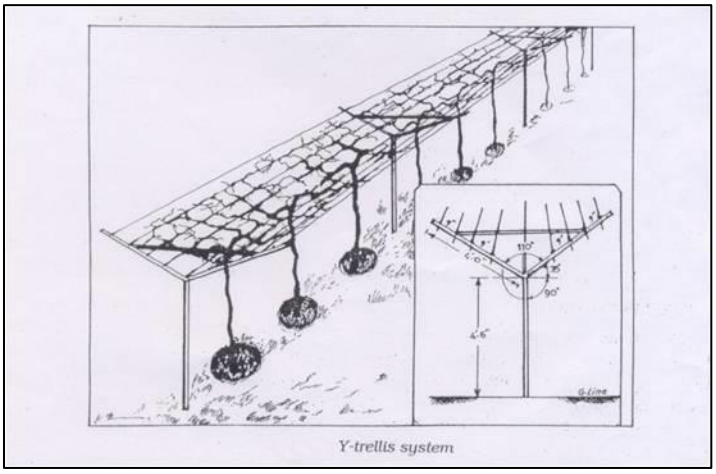
It is very common in wine regions throughout the world. Two cordons run parallel in either direction on both sides. All of the shoots are trained upwards with wires. Ape bunches grow from 36 to 48 inches above the ground. The VSP system is very easy to mechanically harvest. Low-yielding vineyards thrive using the VSP trellis system and produce very good, but rarely the best wines. The trunk is usually kept short, and the vines and rows are spaced close together.



VSP Training

B. 'Y' Trellis system :

It is very common in Indian grape growing region for table grape production. With minor changes it can be adapted for wine grapes. In this training system two shoots from graft train at right angle to form Y. These two shoots will form arms of Y. From the tips of Y a second head will be established. From each of this heads two cordons parallel to row will be developed. A four armed cordon/ Quadrilateral will be developed.



B. Pruning

In India the vines are forced to undergo rest for about a month immediately after harvest. This helps in storing the food material in the mature parts of the vine. The canes are cut back in April by keeping 1-2 buds which develops into canes in 4-5 months. The dried canes are also removed. Here it is called 'back pruning' or 'growth' pruning.

In the month of September-October these canes are pruned for fruiting. This pruning is called 'forward pruning' or winter pruning. Vines, which have attained the age of one year, can be subjected to this pruning. The level of forward pruning depends upon the region, variety and vine vigour.

Following are the practices to be followed for fruit pruning:

- The canes of 6 mm and fewer diameters are to be removed during fruit pruning.
- Based on the bud break and the bunch emergence, shoot thinning is to be followed at 4-5 leaf stage.
- Retain bunches based on vine spacing & leaf no on the shoot.
- Retained only two bearing shoots on each cane. If the cane diameter is less than 8 mm, retained only one shoot.
- Shoot growth is controlled by manipulating Nitrogen and water application.
- No artificial hormone application for elongation of bunch or berries should be done. This will affect the quality, aroma of the produce. Girdling also not required in wine grape production.
- Shoot topping should be only after veraison stage if required. In red wine grape verity if the canopy is dense, remove 3-4 leaves near bunch at the onset of version.

iv. Irrigation Management

Irrigation is required to provide water to meet the crop growth and evapotranspiration (ET) requirements of the vine when there is insufficient water from rainfall or existing soil moisture. Water is also an important input during the wine-making process. A range of practices are used in the vineyard to conserve and manage water resources efficiently and sustainable way.

Irrigation can be an important management tool for managing vine water relations, particularly in areas with sandy or light soils, young vineyards with limited root systems, and soils with limited water-holding capacity. The availability of water to the vine (both in amount and timing) plays a crucial role in fruit quality. Drought stress limits yield and reduces the vine's ability to fully ripe fruit, while surplus water can lead to excessive vine growth, loss of fruit quality and delayed or reduced winter acclimation. Irrigation also presents the opportunity to deliver fertilizers efficiently to vines through fertigation. The benefits include better timing and placement of fertilizer in the root zone, minimization of losses to volatilization and leaching, and reduced costs associated with field application of fertilizers. Efficient use of irrigation involves proper maintenance and design of irrigation systems and an understanding of how to apply the right amount of water at the right time to benefit vines.

In Wine grapes Regular deficit irrigation (RDI) & Partial root zone drying (PRD) are followed to influence grape quality.

v. Nutrient Management

Fertility refers to a soils ability to supply mineral nutrients. A limited mineral nutrient supply causes grapevine deficiencies that include damaged tissues, restricted vine growth, limited fruit production, delayed fruit maturation, diminished fruit quality & increased susceptibility to various pest & diseases.

An excessive nutrient supply in the soil quality is also detrimental to balanced vine growth & fruit quality & sometimes causes toxicity in plant tissues. Therefore,

the basic goal of vineyard soil fertility management is to provide a supply of mineral nutrient that avoids both of these extreme conditions.

To decide exact amount of fertilizer application soil analysis & petiole analysis is very important. We also have to calculate the amount of nutrient grapevine will get from FYM & water.

`Effects of Macro & Micro nutrient deficiency & excess are as follows,

Nutrient	Effect of deficiency in vine	Effect of excess in vine
Nitrogen (N)	Reduced vigour, small shoots & leaves, pale foliage, reduced yield.	Excess vigour, enlarged leaves, reduced bud fruitfulness, reduced fruit size, reduced root growth
Phosphorus (P)	Retarded growth, reduced bud fruitfulness, reduced yield, restricted foliage growth, reddened or yellowed tissues between leaf veins.	Zink Deficiency
Potassium (K)	Leaf chlorosis & death, early leaf fall, retarded shoot growth, reduced cluster size & number, uneven ripening, increased susceptibility to cold damage.	High fruit pH, decreased magnesium uptake.
Calcium (Ca)	Restricted shoot & root growth.	Reduced potassium & magnesium uptake.
Magnesium (Mg)	Yellowing at leaf edges, sometime extending inwards between main veins.	Reduced potassium uptake.
Sulphur (S)	Uniform chlorosis, retarded plant growth, nitrogen accumulation.	Soil acidification.

Boron (B)	Very short internode, mottled & patched chlorosis, poor or no fruit set, shot berries, shoot tip death.	Dark brown speckles or necrosis on edges of older leaves, cupped & wrinkled young leaves.
Zink (Zn)	Distorted, mottled apical leaves, stunted shoots, poor fruit set & shoot berries.	Inhibited root growth, young leaf chlorosis
Manganese (Mn)	Chlorosis bands on basal leaves & death decreased cold hardiness.	Tissue injury, deficiency symptoms of other nutrients.
Iron (Fe)	Interveinal creamy chlorosis on apical leaves, stunted shoots, reduced yield.	Reduced yield.
Copper (Cu)	Short internodes, pale colour, distorted young leaves.	Reduced vigour, inhibited root growth or root damage.

vi. <u>Harvesting</u>

Harvest is the picking of the grapes and in many ways the first step in wine production. In India Grapes are harvested by hand. The decision to harvest grapes is typically made by the winemaker and informed by the level of sugar (°Brix), acid (Titratable Acidity as expressed by tartaric acid equivalents) and pH of the grapes. Other considerations include phonological ripeness, berry flavour, tannin development (seed colour and taste). Overall disposition of the grapevine and weather forecasts are taken into account.

Advantages of Wine grape cultivation

- It has been observed that Wine grapes are more Pest & Disease resilient as compare to table grapes. Giving more time window to respond to adverse weather conditions & fewer losses.
- No Plant Growth Regulators (PGR) need to be used in Wine grapes. Thus, reducing production expenses of vineyard.

- Wine grape intercultural activities are much simpler & common to table grapes. In wine grapes Berry thinning, Bunch dipping, Hi-tech sprayers for PGR sprays, Paper wrapping for bunches is not required. Most of these are labour dependent activities & costlier too.
- Wine grape plantation is advisable to be done with consultation with Winery & with purchase contract. It gives assurity to farmer about grape purchase with contracted rate. Protects farmer from Market vulnerabilities as in case of Table grapes & other crops.
- To maintain & enhance wine quality, wineries focus on grape quality. They provide Technical guidelines & vineyards visits by Viticulturist to contracted vineyards. Thus reducing workload of farmer & help him in vineyard related decision making.

Sula vineyards is actively increasing its foothold in all wine grape growing regions across India & interested in exploring new suitable regions. Thus, providing chance to farmers to associate with India's leading winery M/s Sula Vineyards Pvt Ltd through contract farming. Interested farmers for wine grape plantation can contact us at,

Grape processing: Status and Opportunities

Dr. Ajay Kumar Sharma, Principal Scientist (Post-Harvest Technology)
ICAR- National Research Centre for Grapes

Grapes are widely produced under temperate to tropical conditions of different countries. Italy, France, Spain, US, China, etc. are major grape producing countries. Worldwide grapes are mainly produced for winemaking, but consuming pattern of grapes is changing and shift from wine grapes to table grapes is observed. Grape growing in India is becoming very popular in tropical regions. As per an estimate 140 thousand ha area was under grapes and production was 3.12 million tons during 2020. As Maharashtra and Karnataka has monopoly in grape production and contributing 95% of total grape production of country. Grapes is the highest among all the fruit crops to earn foreign exchange and is also creating employment opportunities for farmers, farm labours, exporters, traders and others who are associated with it. Following the criteria of GAP can further help the stakeholders to attain international standard and thus to explore more opportunity for export and eventually to upgrade their economic status. GAP in terms of training, pruning, vineyard management, irrigation, fertilization, crop protection, appropriate stage of harvesting, method of harvesting, packaging, storing and transporting are important and these practices also ensure the safety of the produce.

Due to tropical conditions, the grape berries face higher temperature during maturity, ripening and harvesting. Supply chain in domestic market is very poor and has direct impact on bunch quality including shelf life. Many times due to high temperature, berry shattering, rachis browning and shriveling starts in the supply chain only and before reaching at destination, berries lose their shelf life. Not only high temperature, improper handling of bunches during harvesting and transportation, lacking of grading, improper packaging materials etc. lead to heavy post-harvest losses and deterioration in quality.

Worldwide about 48% of total grapes are fermented and wines are being prepared and about 36% grapes are dried for raisin making. But in India about 68% of total produce is consumed as fresh grapes and 30% are used for raisin making while only 1-2% are converted into wines. Very negligible quantity is used for juice purpose. Various processed products developed from grapes are described below:

Wine

In India wines production is mainly concentrated in Maharashtra state followed by Karnataka. Nashik is known as wine capital of country. Maximum wine production come from Nashik district only. A GI named as Nashik Valley Wines is also provided. Wine is produced through a biochemical process called fermentation, initiated by the yeast added. During this process the sugar contained in the must (the fresh grape juice) is transformed into alcohol along with the output of carbonic gases that escape into the environment. Yeast is only able to fulfill its task between -3 and 36 °C. Fermentation stops completely when the sugar is completely transformed, but may also be stopped artificially. The grape skins give the colour to the wine. White wine can be made with red grapes if the marc is removed before the colour passes into the liquid. Fermentation and maturation can be completed in steel or oak containers.

The fermentation period lasts from a few days, for lighter wines and up to 30 days for stronger wines. The longer the contact of the juice with the skins is maintained, the stronger the colour and tannin content of the wine. This can give the wine a fuller body and potentially a longer life span in the form of age reachable. Too much tannin can, however, ruin a wine. At this point the wine is separated from the skins and begins the aging process in barrels and later bottles. White wine differs from red not only in terms of colour. Traditionally they are fermented without maceration, have a lower tannin content, a lighter body, a higher acidity and a shorter aging time compared to red wines. A white wine usually has less alcohol but a greater fruit and floral characteristic. Several fermentation conditions such as fermentation temperature, skin contact time, and skins to must ratio (berry size) influence the extraction of anthocyanins and other phenolic compounds.

Broadly wines are categorized as, demi-sec, semi-sweet and sweet based on sugar content in finished wines. *Dry:* when the wine contains a maximum of either 4 g/l sugar or 9 g/l when the level of total acidity (expressed in grams of tartaric acid per litre) is no more than 2 g/l less than the sugar content. *Demi-sec:* when the sugar content of the wine is more than that specified dry, up to a maximum of either 12 g/l or 18 g/l when the content in total acidity is fixed according to the dry wine *Semi-sweet*, when the sugar content of the wine is more than that specified in the demi sec, up to a maximum of 45 g/l. *Sweet*, when the wine has a minimum sugar content of 45 g/l.

Opportunities in wine industry

Indian wine industry is facing several problems like higher productions cost, wine quality, low demand, taxation issues, etc. However, a growth of 10-12% has been registered in this sector. By the support of Govt. agencies and awareness of consumers, this industry can perform very well. With problems, India has good opportunities also.

- Higher demand of alcoholic drinks within domestic market
- Higher yield potential under tropical conditions
- Adoption of DSS for maintain vineyards at lower inputs
- Utilization of locally available microbes without compromise on wine quality
- Utilization of locally available machineries
- Wealth from waste
- Wine-tourism

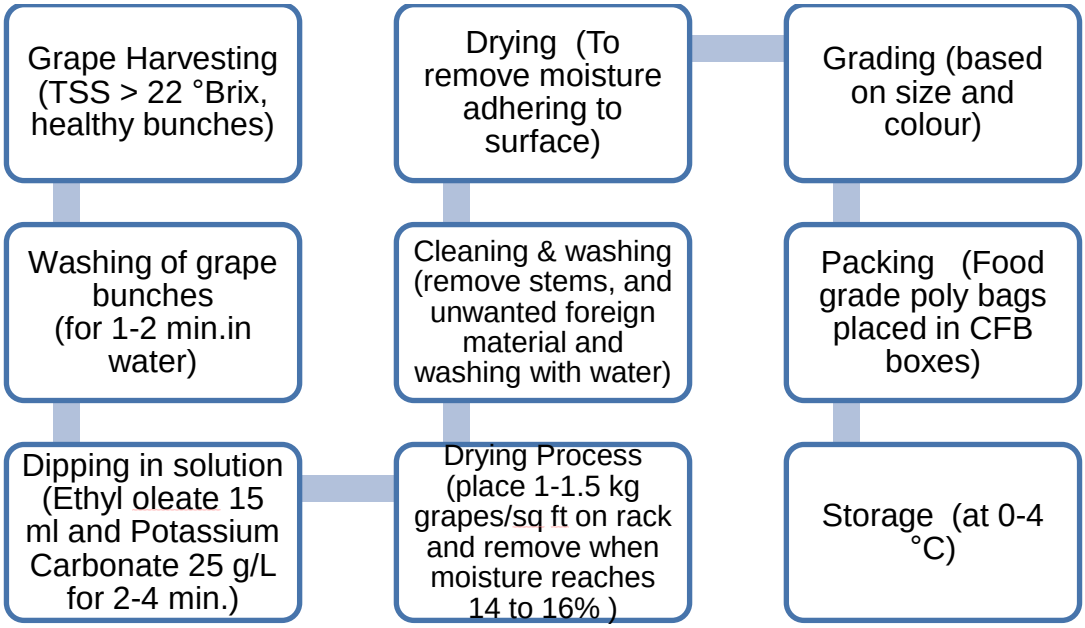
Raisins

Grape drying is a major available method of grape processing in almost all grape growing countries. It can process grapes into raisins for longer shelf-life and further utilization in various forms. Drying of grape is difficult because grapes contain wax in its outer peel layer which acts as a barrier for moisture movement across the membrane. Different drying technologies for grape drying are being used worldwide such as natural open sun drying, shade drying, solar drying, hot air drying, microwave drying, vacuum pulsed drying etc. Commercial grape production in India is mainly confined in tropical

belts of Maharashtra and Karnataka and about 95% grape is produced from this area. The consumption behaviour of Indian consumers is entirely different from those in other parts of the world and about 71per cent of total production is consumed as fresh fruit and nearly 30 per cent is dried for raisin production. As per an estimate about two lakh tons raisins are produced from areas of Maharashtra (Sangli, Solapur and Nashik) and Karnataka (Vijayapura and Bagalkot). Presently India is producing about 3.2 lakh tons raisins. In India, Australian method of raisin making is well adopted where grape bunches are treated with solution of ethyl oleate and potassium carbonate before drying in racks inside sheds. The pretreatment activates the diffusion process by reducing the skin resistance to water transfer at the beginning of the process. The major active components of the emulsion are ethyl esters contained in the oil, potassium carbonate is required to achieve proper emulsification and to maintain the alkalinity of the emulsion.

The efficiency and quality of the post-drying operations are significantly influenced by biomechanical and physical properties of the dried grapes. The post-drying operations may vary depending on the drying method. The operating conditions may affect the physical and hygienic characteristics of the dried product. The cleaning involves individualizing the dried fruit, removal of stems and foreign materials, and removal of off-grade raisins. Water is used to eliminate foreign materials such as dust and soil, through multiple washing, this may lead to further rehydration. The rehydration, leakage of some of the dissolved sugars of the dried fruit into the washing water, and extension of micro-cracks and skin-wounds are the main phenomena taking place during the post-drying practices. Because of an increases in the moisture content of the dried product during the washing, especially when the grapes have been partially dried or washed off before packaging, one additional step, finish-drying, is needed in order to control the amount of the moisture content.

Raisin making flowchart



Opportunities in Raisin industry

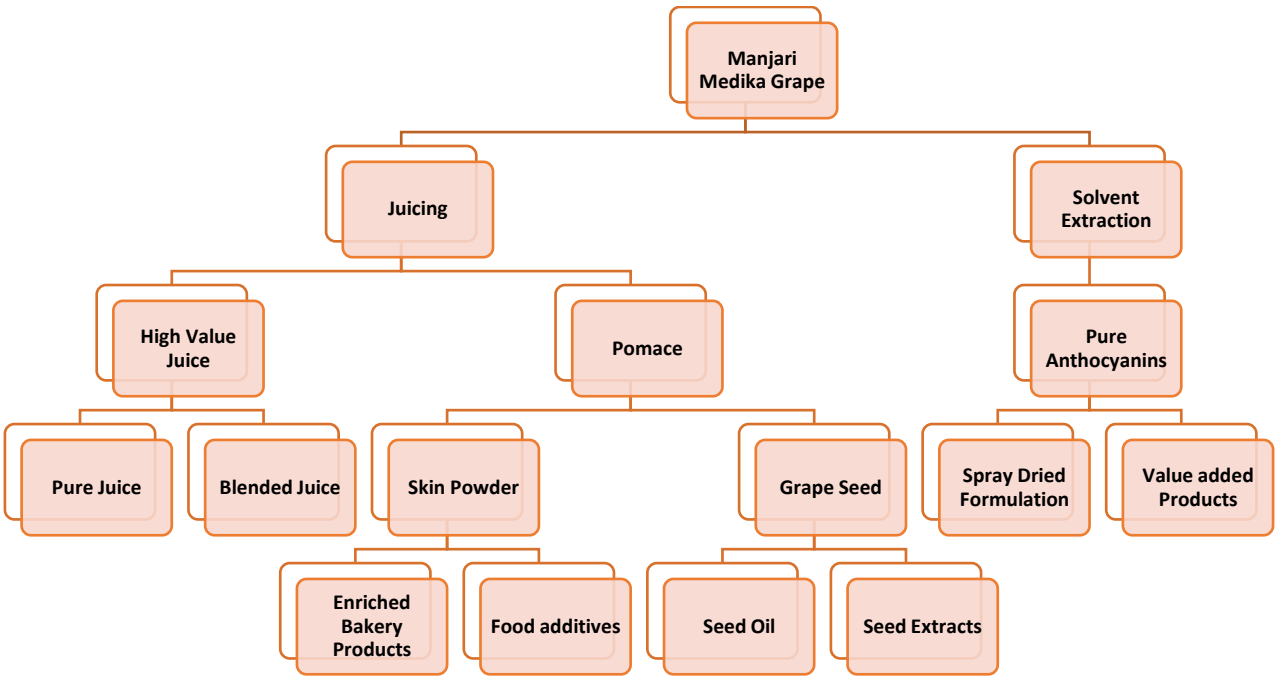
- Higher yield potential and suitable climatic conditions
- High domestic demand
- Production of naturally dried (without using chemicals during grape drying) raisins
- Utilization in dairy, bakery and confectionary industry will one lot of opportunities
- Utilization in preparation of other valuable products like Raisin juice, wine, paste and pekmez
- Ethanol
- Establish brand value
- Better return from export market: need to address quality

Juice

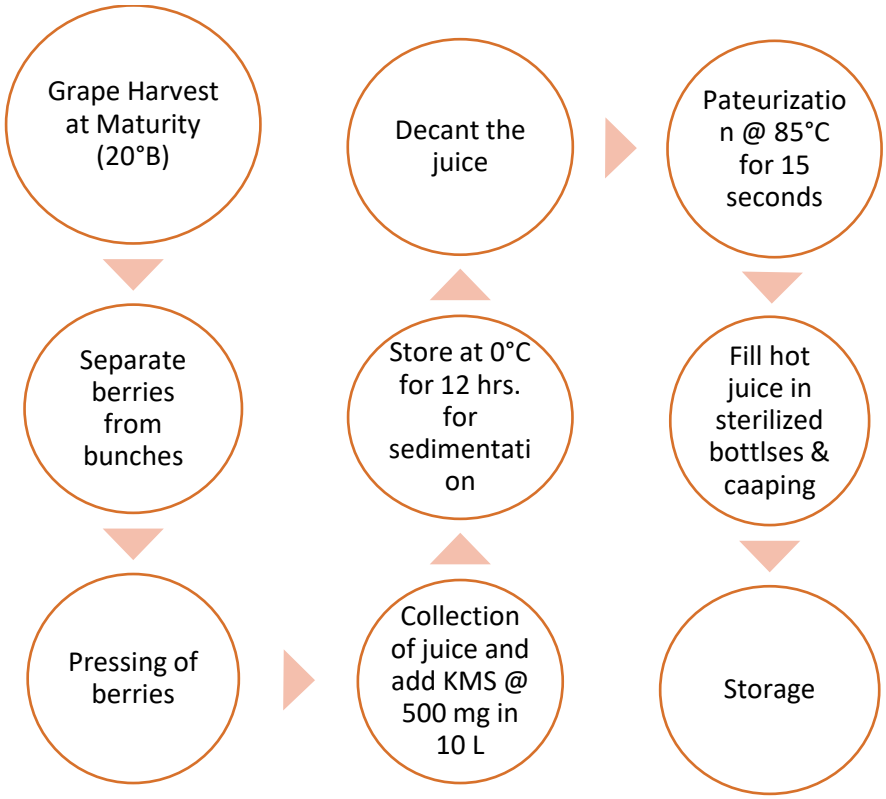
The quality of grape juice depends to a great extent on the sugar level, acid content and flavor constituents. The specific composition of the juice from any cultivar varies from year to year and changes continually during ripening. The composition of a specific cultivar will also vary from one area of growth to another and from one vine-

yard to another since composition is affected by soil, climatic conditions, and vineyard management practices. In general, color of grape juice is the result of anthocyanin pigments located in or near the skin. Different cultivars have different types and amounts of these pigments.

Zero waste processing of Manjari Medika grapes



Juice preparation flow chart



Opportunities

- Available brands in market are not have true juices
- Grape juice varieties have yield potential with higher juice recovery
- Highlight nutraceutical values of grape juices for establishing these juices as drink for health
- Manjari Medika juice: Grape variety juice has very high antioxidant properties
- Zero waste processing of Manjari Medika grapes can be promoted
- Make competitive with other drinks by adding package values, storability and value addition by carbonation.

Artificial Intelligence, a Realm of New Possibilities in Grape production

Dr. D. S. Yadav, Senior Scientist (Agricultural Entomology)
ICAR- National Research Centre for Grapes.

The problem solving revolved around three steps, perceive, analyze and act. Artificial intelligence (AI) can work on all three aspects of problem solving and thus opened up new possibilities in grape production. Artificial intelligence (AI) strives to make machines to become capable of performing tasks which typically require human intelligence. The advancements in AI have led to paradigm shifts in almost every sector. AI in Indian horticulture has immense potential. Few of the major challenges in Indian horticulture are drudgery in farm work, lack of skilled labour, time consuming and inefficient manual operations, timing of operations, appropriate technical and financial decision making, marketing, lack of knowledge of peak time of farm input demand, predictions on demand of farm produce, market discovery, acreage planted, price prediction, crop choices, inefficiency in irrigation, nutrition and pesticide applications, lack of accurate and long term farm specific weather forecasting, etc. AI can provide efficient solutions to many of these challenges.

Automated monitoring and advisory

AI powered wireless network of sensors and autonomous navigation robots mounted with image capturing devices can help in automated monitoring of farms, geo tagging of plants with specific problems and generating automated advisory for timely decisions.

Precision horticulture

Trained machine learning models for plant stress conditions can help in geo tagging of affected individual plants for precision horticulture. The diseases and pests can be identified at the beginning before their spread to whole farm which will help in timely action and reduction in cost of cultivation.

Spraying

Automation

Timely availability of skilled labour is becoming a major challenge in horticulture. AI enabled bots can help overcoming the labour challenge. These bots can be developed to automatically navigate inside the farm, identify and kill weeds, do pruning at precise site on the plant, apply growth regulators on specific plant part, scare birds away, tying and training plants, harvest, grade and pack final produce. It can reduce drudgery involved in the farming. These bots can also provide round the clock watch and labour to the farm making non-availability of labour on time a thing of past.

Extension education

AI can also help in disseminating information and knowledge complementing Krishi Vigyan Kendras (KVKs). AI enabled tools such as chatbots, decision support systems, automated call centres capable of processing natural language, etc. can be developed which will bridge the extension gap.

Market intelligence

Machine learning models can be trained for identification of areas under sowing and/or pruning for different crops at different time intervals. It can help in predicting the time of arrival of produce in the market and price predictions can also be made. It can help policy makers or food processing industries to plan ahead regarding there future course of action. More accuracy can be added by identifying stress conditions during crop growth period. It can also help in predicting input demands which can help in farm input industries to plan their production.

Therefore, it can be concluded that the realm AI has opened up new possibilities of applications for all pre-production, production and post-production sectors involved in grape production.

Value addition to grapes through pesticide residue testing

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ICAR- National Research Centre for Grapes

Pesticides are essential agro-inputs. Their applications at pre- and post-harvest levels are essential to ensure desired production and productivity of crops. Once a pesticide is applied in the field, a portion of the applied amount may remain in the crop at harvest, which is designated as "pesticide residue".

Sources of agrochemical residues

In grapes, the agrochemical residues may appear from the following sources:

Direct source: Agrochemicals are mostly organic compounds which degrade with time to non-toxic metabolites on exposure to physico-chemical agents (e.g. sunlight, heat, humidity, chemical agents in atmosphere, etc.), and interaction with biological factors viz. enzymes, microbial metabolism, etc. When agrochemicals are applied on plants, a fraction of it gets adsorbed on plant surface, which eventually gets absorbed and contaminates the commodity matrix. The time required for degradation of a pesticide to a non-detectable level or non-toxic metabolites might vary depending on the chemical nature of the compound and its susceptibility to the degrading factors. If a crop is harvested before such a safe waiting period, then analysis of the fruit or vegetable samples might result in detection of one or more of agrochemical residues. The residue of an agrochemical beyond a certain concentration could be toxic to human and animal health, and consumption of such contaminated foods might result in acute and chronic toxicities.

Indirect source: In addition to direct field applications, the residues of agrochemicals might also appear from various indirect sources. These include spray drift from adjoining crop fields, contaminated soil and irrigation water, and contaminated agro-inputs, e.g. manures, fertilizers, to name some.

Maximum Residue Limit (MRL) and its relationship with the Good Agricultural Practices

MRL is the permitted concentrations of the residues of a pesticide in or on food, derived by taking into account both the ranges of residues actually remaining on the food when offered for consumption following Good Agricultural Practices (GAP). MRLs are the trade standards that are set in a way that there are no concerns for public health, especially with regard to vulnerable sub-population groups (as children and the unborn). GAP takes into account the application of minimum quantities of pesticides necessary to achieve adequate pest control in such a manner that the amount of residues in the food is smallest possible. At the international level, the Codex Alimentarius Commission of the FAO/WHO decides MRLs. The Codex Committee on pesticide residues (CCPR) was formed by United Nations with primary mandate to establish MRL for pesticides in food. The MRL of pesticides is usually crop or food item specific.

Although the Codex MRLs (http://www.fao.org/fao-who-codexalimentarius/codex-texts/dbs/pestres/en/) are applicable to all nations, individual countries may also have their own MRL regulations. For agro-export, it is thus essential that the commodities should comply with the latest MRL regulations of the importing countries, which are usually available in their Government websites. For example, the MRLs set by the European Union (EU) have to be complied for export of the fruits and vegetables from India to any of the EU member countries. Earlier, individual EU countries used to have their own MRLs. Since September 2008, these MRLs were harmonized across the European Union territory (https://ec.europa.eu/food/plant/pesticides/eu-pesticides-database/public/?event=homepage&language=EN). In India, MRL is recommended by Food Safety and Standards Authority (FSSAI). The agrochemical companies generate residue data and submit to Central Insecticides Board & Registration Committee (CIB&RC) for crop specific label claim or expansion of label claim. CIB&RC forwards the residue reports to FSSAI, where a Scientific Panel evaluates those data and estimates MRL using the MRL-calculator (https://read.oecd-

ilibrary.org/environment/mrl-calculator-users-guide-and-white-paper_9789264221567-en#page14) recommended by Organisation for Economic Co-operation and Development (OECD). These risk assessment based MRLs (https://fssai.gov.in/upload/uploadfiles/files/Contaminants_Regulations.pdf) are utilized for evaluation of food safety in the country. In case where risk assessment based MRL is not available, detection of such agrochemicals is regulated at the default value of 0.01 mg/kg, or the analytical limit of quantification (LOQ).

The terminal residue load of an agrochemical in grapes and any other commodities mainly depends upon its environment-stability and dissipation pattern. The rate of dissipation again largely depends upon the amount and concentration applied, initial deposit and the prevailing environmental conditions during fruit development stage. The data available on persistence and dissipation pattern of agrochemicals in temperate climate may not hold good for tropical environment as the factors like period of sunshine and atmospheric temperature are more prominent under the tropical environment. Similarly, the dissipation pattern of a pesticide in one crop may not be similar to another crop. Keeping in view this fact, supervised multi-location trials are usually conducted to establish a crop specific MRL. Efforts are taken to derive the maximum residues of a pesticide likely to occur on a crop through the application of its minimum effective dose. In this regard, the dose is usually decided considering the most critical use situations, i.e. maximum probable pest and disease pressure and related recommended package of practices. The results of the detail toxicological studies of the pesticides with its metabolic pathway are also considered in this regard. Such a safety evaluation is done by comparing the dietary exposure from the sample to the maximum permissible intake (MPI), which is determined by multiplying the acceptable daily intake (ADI) with the body weight of an average population. The dietary exposure of a consumer to the residues is calculated by multiplying the amount of residue deposits with average per capita daily consumption of the particular food or the group of commodities where the same chemical is applied. In India, food consumption data is available through National Institute of Nutrition. If the dietary exposure is found to be

above the MPI, the food commodity is decided to be unfit for human consumption. Furthermore, all possible metabolites are toxicologically assessed to determine their effect on beneficial and non-target organisms. This is so because; in many cases the metabolites could be more toxic than the parent compound.

The knowledge on MRL acts as a valuable guide to the growers and phyto-sanitary certificate issuing authorities of the Government. It alarms a grower regarding the fact that if he does not follow the recommended package of practices, the terminal residue levels of pesticides may exceed the permissible MRLs and he might face marketing set back along with legal hazards. The regulatory bodies at the National and International levels may use this information to decide whether a commodity is fit for sale in domestic and international markets.

Maintaining pre-harvest interval – the practical approach to minimize pesticide residues

On the basis of the MRL, the pre-harvest intervals (PHI) of pesticides are calculated. PHI is the safe waiting period, which is the minimum time in days that must be provided between last application of a pesticide and harvesting of the produce so that its residue level at harvest reaches below the MRL. The data generated on PHI for different agrochemicals are usually recommended in the guidelines of good agricultural practices, which are usually crop specific, and could be widely different across crops. Estimating PHI of a pesticide ideally involves multi-location field trails wherein the pesticides are applied following the guidelines of GAP. Representative samples are collected from the treated plants and analyzed for residues. The sampling is initiated on the day of the final application and continued at regular time interval till harvest. After precise estimation of the residues in each sample, the residue data are statistically processed to correlate the dissipation with progress of time. Although first order rate kinetics is largely used for estimating PHI, on many occasions, non-linear kinetics are better applicable (e.g., first + first order model), where the residues dissipate with time following a non-linear relationship. In such occasions, the dissipation rate is usually faster at the beginning, which gets slowed down with passage of time. This indicates a

non-linear pattern of degradation and often implies that simple first order kinetics might not be adequate to explain the dissipation behaviour of most of the pesticides and predict the PHI. At ICAR-NRC Grapes, the residue dissipation pattern of several agrochemicals has been studied in grapes and other horticultural commodities, which have been recommended in relation to their recommended application rate and PHI.

Residue analysis in grapes – the system established in the country:

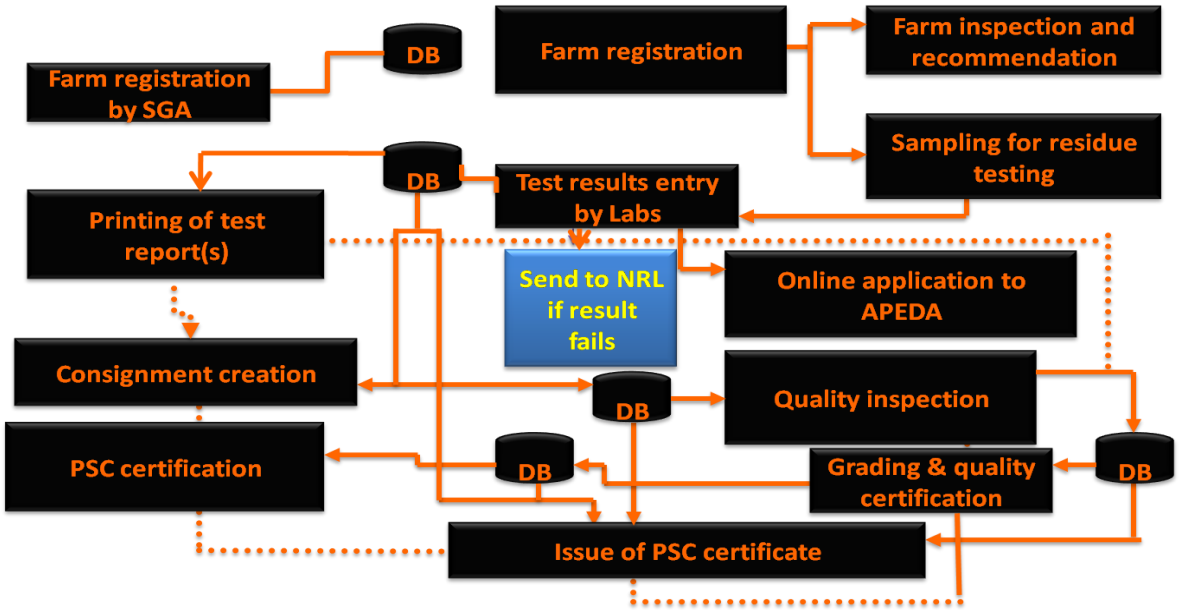
For export purpose, the samples randomly drawn from 100% of the registered farms are analyzed by the accredited laboratories (as per the guidelines of ISO/IEC 17025) by using a harmonized and validated testing procedure developed by ICAR-NRC Grapes. The performance of the laboratories is ensured by regular monitoring by NRL through physical inspection, desktop audits and performance in proficiency testing rounds conducted at regular interval.

The residue analysis involves extraction, clean up and final estimation by multiresidue technique based on GC-MS/MS and LC-MS/MS. A list of around 240 chemicals were monitored in 100% of the farm samples last year that are registered for export. The list is being expanded to cover all the chemicals that are currently registered with CIB&RC. In case, the test results exceed the MRL of the EU, the testing laboratory immediately (within 24 hours) brings the matter to the notice of the NRL and on the basis of this information, the NRL issues internal alert within 24 hours to stop the export of grapes from specified plots. Since the residues are monitored at pre-harvest level, hence there is a possibility of re-sampling after the PHI and on re-sampling, if the samples comply with the MRL, the laboratory immediately intimates the NRL through the *Grapenet* and the NRL revokes the alert. While issuing the alerts or revoking the same, the NRL officials examine the test results with respect to the chromatograms and mass spectra and in case everything is satisfactory, then only the action is initiated. With the success of residue monitoring in grapes, a similar system is also implemented in other horticultural crops including pomegranate, okra, etc.

GrapeNet- A complete traceability software

GrapeNet is the first internet based residue traceability software system established in the country, for monitoring of fresh grapes for export to the European Union countries. This software was developed by APEDA with inputs from all the stakeholders in grape industry. This is the first of its kind initiative in India that has put in place an end-to-end system for monitoring pesticide residue, achieve product standardization and facilitate tracing back from retail shelves to the farm of the Indian grower, through the various stages of sampling, testing, certification and packing.

This software system integrates all stakeholders in the supply chain of grapes export, namely Farmers, State Government Horticulture Departments, Residue testing laboratories, Agmark Certification Department, Phyto-sanitary department, Pack houses, Exporters, and APEDA. Each stakeholder has certain duties to perform for residue free export of table grapes to European Union. GrapeNet has been very well received and actively been used by all stakeholders in the supply chain. Every consignment of fresh grapes during the season 2007 from India to European Union is monitored through this system. This system permits its stakeholders to carry out the following activities involved in the grapes export process as indicated in the diagram below.



DB: Database PSC: Phyto-sanitary certificate SGA: State Govt. Authority

The application of this system starts at the very root of the process; registration of farmers up to plot level, at district headquarters, by the State Horticulture departments and subsequently issuing a registration certificate to the farmers. Each farmer, who intends to export directly or supply fresh grapes to an exporter, should get the registration of its farm and plot(s). A registration number is given to each farm upto the plot level. The farm/plot is allotted a unique 12 digit registration number only in the following code format:

State Code	**District Code**	**Taluka Code**	**Product Code**	**Farm Code**	**Plot Code**
AA	01	01	001	0001	01

One plot should constitute a maximum area of 1 Ha or part thereof and extendable up to 1.2 ha. The registration system facilitates the State Horticulture departments to tabulate their inspection details on completing their visits to the farms, after which they can recommend to the Laboratories to draw samples for testing of agrochemical residues. Farmers can approach any of the APEDA recognized laboratories in the country for testing their produce.

The laboratories record the details of the samples drawn from each plot for testing and conduct stringent testing for agrochemicals. This system automatically finds out from the test measurements entered whether the sample qualifies for export to specified countries and generates their test reports. These laboratories are among the best in the world, which are equipped with high precision and calibrated equipment, and are ISO 17025 compliant.

Conclusion

Although residue analysis costs money, it adds a significant value to the agricultural produces, especially a commodity like grape, the cultivation of which frequently receives pesticide applications. A commercial product when sold with a residue test report indicating "no" or nominal (toxicologically insignificant) residue levels, it provides confidence to consumers and facilitate achieving a better price. This in turn helps in enhancing farmers' income and improving their standard of living. With the advent of information explosion, the consumer awareness is growing with respect to the right to have safe food. No one in the society is ready to tolerate the menace from the food intended for his/her nurture. On the other hand, being in tropical belt we do not have the luxury of avoiding the use of the agrochemicals in pest management. Agrochemicals are used purposefully in the environment to ensure a good harvest. It is the dose and time of application, which differentiates the safe and unsafe use. If the recommendations of the GAP and PHI are sincerely followed, it is definitely possible to minimize the residue load of agrochemicals in grapes, which in turn, will ensure safety to the health of the consumers and environment as a whole. The implementation of the residue monitoring system through Grapenet has emerged as a model system in the whole country and is being expanded to cover all the horticultural commodities on a time scale through the traceability system of Hortinet.

Collaborative role of policy- makers and stakeholders in promoting Grape exports

Mr. Sanjay Dave, Ex-Chairman of Codex Alimentarius Commission

Monitoring of pesticides residues in table grapes

Monitoring includes different domains like policy makers and the stake holders including private sector, farmers and laboratory. Representation of the ministry of commerce, i.e., APEDA is responsible for export promotion of agriculture products, by providing recognition pack houses and laboratories for the purpose of food testing. Inspection of the product in ICAR-National Grapes Research Centre provides great scientific support which is engaged in monitoring the work of laboratories and also supporting the farmers with training at the field level. The plant protection department also has a role to play whose job is to issue phytosanitary certificate and to check consignments before they are exported. Finally, the state departments of Horticulture of three states which play a key role are Maharashtra, Telangana, Karnataka.

Major stake holders are the farmers who are the producers. Grape growing areas are mostly confined to Maharashtra, Telangana and Karnataka but production in Telangana has declined. The concept of supply chain that is how farmers supply produce to the export, exporters in turn to the traders and finally traders to super market needs to be understood. Nowadays, supply chain is changed in India (Dec-May) with the scientific progress that has taken place in the country.

The year of 2003, where in Indian grape were termed as "poisonous" *(it was more of a trade issue than food safety)* changed the whole export scenario of grape. Indian grapes were found to contain pesticides higher than the maximum residue limits given by the European Union and rapid alerts were given by Europe which affected grape trade adversely.

Mitigation mechanisms like registration, record keeping, and two times monitoring of farms were put in place under the Residue Monitoring Programme (RMP).

Later, sampling procedures were introduced with clear documentation. Setting laboratory was the primary objective at ICAR-NRCG. Updated AGMARK standard for grapes and Codex methods were used for entire analysis. Good agricultural practices and traceability were practiced. Labs were required to be compulsorily ISO-17025/NABL compliant. Work at APEDA, strict monitoring, good agricultural practices, and implementation of GAP at farms, were undertaken. National Referral Laboratory was responsible for monitoring the laboratories.

Implementation and regulation of export of fresh grapes from India were possible through monitoring of pesticide residues. In 2004-2005, digitization of the RMP started. Marketing through traceability was on display through labels and barcode on every pallet. It helped the importers to manage inventory and advantage that the traceability software can be operate from anywhere, anytime through internet. Most important was it was based on zero paper work and complete transparency. It helped Indian farmers to gain confidence, increased good implementation of agricultural practices, earned more value, good food quality and safety. It benefited 40,000 farmers and 150 exporters and a worldwide acknowledgement of Indian labs. The unit-value realization increased and the export of table grapes which was of the order of 3000 MT in 2003 has now grown to 250,000 MT without any rejections on account of pesticide residues.

This sustainable work could take place due to team work through collaboration, cooperation and coordination and this is the Message that is conveyed. It was work implemented as a Public-Private Partnership. This information can also be seen on website of Standards and Trade Development Facility (STDF) of the WTO at the following link:

https://www.standardsfacility.org/sites/default/files/STDF_PPP_TableGrapes_India_Sep2021.pdf

Wealth from Waste: Opportunities in grape industry

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Dr Ajay Kumar Sharma, Principal Scientist (Horticulture)
ICAR- National Research Centre for Grapes

India is becoming a strong member of new world of wines. Increased commercial wine grape cultivation and its processing into wine by many number of wineries has resulted in generation of number of winery wastes and by-products. These materials include vine prunings, grape stalks, grape pomace and grape seeds, yeast lees, tartrate, carbon dioxide and wastewater. Only a very small portion of these materials is used world- wide. The winery waste contains 61% moisture and 25% crude fiber with a pH of about 3.6. Grape marc can account for 22% of the fruit processed at small wineries. Stalks are a significant waste for both red and white wines accounting for up to 5.5% of the crush. After wine and juice are recovered from yeast lees in both red and white ferments, there are still 0.5-0.7 tonnes dry lees per 100 tonnes fruit. The majority of wineries at global scenario do not process their wastes, and the most common practise is to dispose them on-site, by dumping or settling in ponds or burning in open. The destinations for winery waste off site include processing for tartaric acid, low quality wine and ethanol, animal feed and composting. The value-added conversion of the bio-products from winemaking can help in reducing the negative costs and demonstrating sustainability in winemaking. In our country policies are not available for utilization of winery waste. But, strategic utilization of winery waste not only solves the environmental issues, it will provide opportunities for generation of food, fuel and employment.

Composting

Modest amounts of pomace (less than 25%) can be fed to cattle without any adverse effects. Pomace cannot be added directly back to the vineyards because of potential pathogens associated with it and also because it cannot be ploughed into the soil without damaging the shallow roots of grape vines. On the other hand, it is possible that pomace could be easily composted to eliminate potential pathogen problems and then can be used as a soil amendment, perhaps in a potting mixture in nursery

operations. The composting of winery waste is an alternative to the traditional disposal of residues, and also involves a commitment to reducing the production of waste products. The resulting compost will have a high agronomic value and is particularly suitable for the soils of the vineyards which have very low organic matter content. The compost can be reintroduced into the production system, thereby closing the residual material cycle.

Fodder

Pomace can, and has, been used as animal feed, especially in the dry season. Its use is limited due to its very low nutritional value and its antinutritional factors. Low grade winery waste having a low economic value can be upgraded to have a higher economic value by converting the wine waste into high grade animal fodder which can be used as animal fodder in times of drought to maintain cattle healthy.

Fuel and biofuel

Fuel ethanol production from grapes is already a reality in Europe. This situation arises as a result of surplus wine production and is a continuing problem. Bioethanol is an octane enhancer. It was estimated that a net energy output of 69 GJ/ha is possible (with an energy output: input ratio of 1.8), and production costs (after deduction of revenue for co-products) could be reduced to $0.80 per liter. Biodiesel production is also possible. After mechanical separation, the seeds are pressed to yield (at approx. 12% by weight) poly-unsaturated oils. While this oil can be burned directly in internal combustion engines (possibly resulting in some fouling or glazing over time), splitting the tri-glyceride molecule can result into cleaner-burning single-stranded methyl or ethyl esters. Because of the high production cost seed derived oils are more attractive as friction-reducing fuel additives that improve delivered horsepower and extend engine life by reducing internal heating and wear.

The "press cake," from the seed press, also has energy potential. It can be pelletized and burned, yielding – per initial calorimetric studies – approximately 50% of the heating value of wood pellets. Many of the organic components of the press-cake

pellets can also be volatilized to form a biogas for subsequent heat and power production. Grape seed with the oil removed also has uses as fuel-pellets which have 133 percent the heating value of wood pellets. This strategy of producing biofuels can be initiated/planned in India in years when there will be excess wine production to recover the cost from unsold wines.

Wine lees in Ice cream

Wine lees is the residue that forms at the bottom of recipients containing wine, after fermentation, during storage or after authorized treatments, as well as the residue obtained following the filtration or centrifugation of this product. Unexpectedly it also shows significant antibacterial properties as well as antioxidant properties from wine lees could include spreads, non-caloric thickeners, flavor enhancers, and functional food additive, such as β-glucans. The fine wine lees obtained from red grapes is source of natural color also. The lees of red wines which consist of tannins and plant pigments precipitated around crystals of potassium tartrate can advantageously be used directly as a tonic or demulcent. Due to nutritive value, rheological properties, attractive flavour and colour, fine wine lees may be used as a suitable source of natural additive in ice cream making to enhance nutritional values, sensory properties and improve physicochemical properties.

Grape seed flour

Grape seed flour has 3,000 to 5,000 fold more antioxidant value than regular flour. Grape skins and seeds contain flavonoids (catechin, epicatechin, procyanidins and anthocyanins), phenolic acids (gallic acid and ellagic acid) and stilbenes (resveratrol and piceid). Grape seed procyanidin extract has in vivo antioxidant activity and could be as important as vitamin E in preventing oxidative damage in tissues by reducing the lipid oxidation and/or inhibit the production of free radicals.

Grape seed oil

Grape seed oil is a vegetable oil pressed from the grape seeds. It has a relatively high smoke point, approximately 216 °C, so it can be safely used for heating. In addition, it has a clean, light taste that has been described as 'nutty' and is safe for cooking food. Less grape seed oil is needed for cooking purposes, compared with other oils. Grape seed oil is reputed to contain plentiful antioxidants, as well as substances which lower serum cholesterol levels. It also contains vitamin E (0.8 to 1.2 g/kg), vitamin C and Beta-Carotene. The availability of grape seed oil in domestic market will also help in managing prices of cooking oils.

Grape seed extract (GSE)

GSE is 50 times more potent than vitamin C and 20 times more potent than vitamin E. Apart from it, GSE retains for longer time in blood than either of the antioxidants (up to 72 hours), giving benefit of sustained antioxidant power against free radicals. Many topical face creams have GSE in them but an oral dose in supplement form can raise the level of GSE (and vitamin C) in human body in hours, working from the inside out. GSE may also slow down skin damage from sun and pollution exposure. When treated with mega doses of GSE via a feeding tube, the tumors shrank 44% compared to controls but more importantly, an increase in the protein that helps cancer cells self-destruct increased as well.

Nanoparticles

Use of nanoparticles for various purposes is new era. Metal nanoparticles of Au, Ag, Pd, and Pt have been synthesized in aqueous media using red grape pomace as a reducing agent and a capping agent. The opportunities for synthesizing nanoparticles from winery waste can be exploited.

Conclusion

As many number of wastes generated in wineries and no attempts have been made to utilize those wastes in productive way, it is essential to understand the potential

benefits of these wastes so that they can be properly processed. Effective utilization of such wastes will reduce the negative cost and thus increase the revenue to the persons engaged in wine grape cultivation and wine making. The Indian wine industry is facing financial problems. The adoption of strategies for better utilization of winery waste will help them and provide employment opportunities.

Manjari Medika: A complete technology for processing

Manjari Medika Juice: A juice recovery of 70 per cent has been recorded in this variety. Juice is very dark in colour and found with high anthocyanins and poly phenolic content. Due to higher anthocyanins and phenolics content, higher antioxidant activities were recorded in the juice of Manjari Medika. In a sensory evaluation by an expert panel, juice of Manjari Medika obtained good ranking with higher acceptability.

Availability of the variety:

Duration of variety is 115-125 days after fruit pruning and the variety will be available throughout the grape season from December to April. Currently the area coverage under this variety is increasing due to its juice quality. The genuine plant material in required quantity will be supplied by ICAR-NRCG as per the demand.

Manjari Medika based technologies:

This centre has identified the variety as one of the most suited variety for processing industry. The centre has developed diversified technologies based on this variety so that none of the bi-products is underutilized. A "zero waste" processing model has been proposed by this centre for this variety. The following technologies were identified.

Enriched cookies:

The Cookies can be enriched by replacement of fine wheat flour by addition of grape pomace powder. Grape pomace powder is added to dry ingredients. The addition grape pomace powder increase antioxidant properties comprising ferric reducing antioxidant power, total phenol content, flavonoid and anthocyanin. Grape pomace powder imparts brown colour to cookies as compared to control.

Pure anthocyanins from Manjari Medika: A technology has been optimized for extraction of pure anthocyanin from Manjari Medika. Grapes of Manjari Medika contain pure anthocyanin in the range of 4-6 g/Kg of mature grape. Anthocyanin extraction is based on affinity chromatography. Complete procedure is shown in Figure given below. Whole grape was extracted with solvent, then concentrated by using vacuum evaporator, absorption on anthococyanins specific ion exchange raisins and then pure anthocyanin was eluted from the column with solvent. In the entire process, 80-90%

Blending with Manjari Medika juice:

The colour of juice attracts consumers and gives more acceptability. As Manjari Medika juice is very rich in colour it can use for enriching and giving the colour to juice of other grape varieties. The blending with Manjari Medika will enrich the grape juices with functional properties

Anthocyanin in human body:

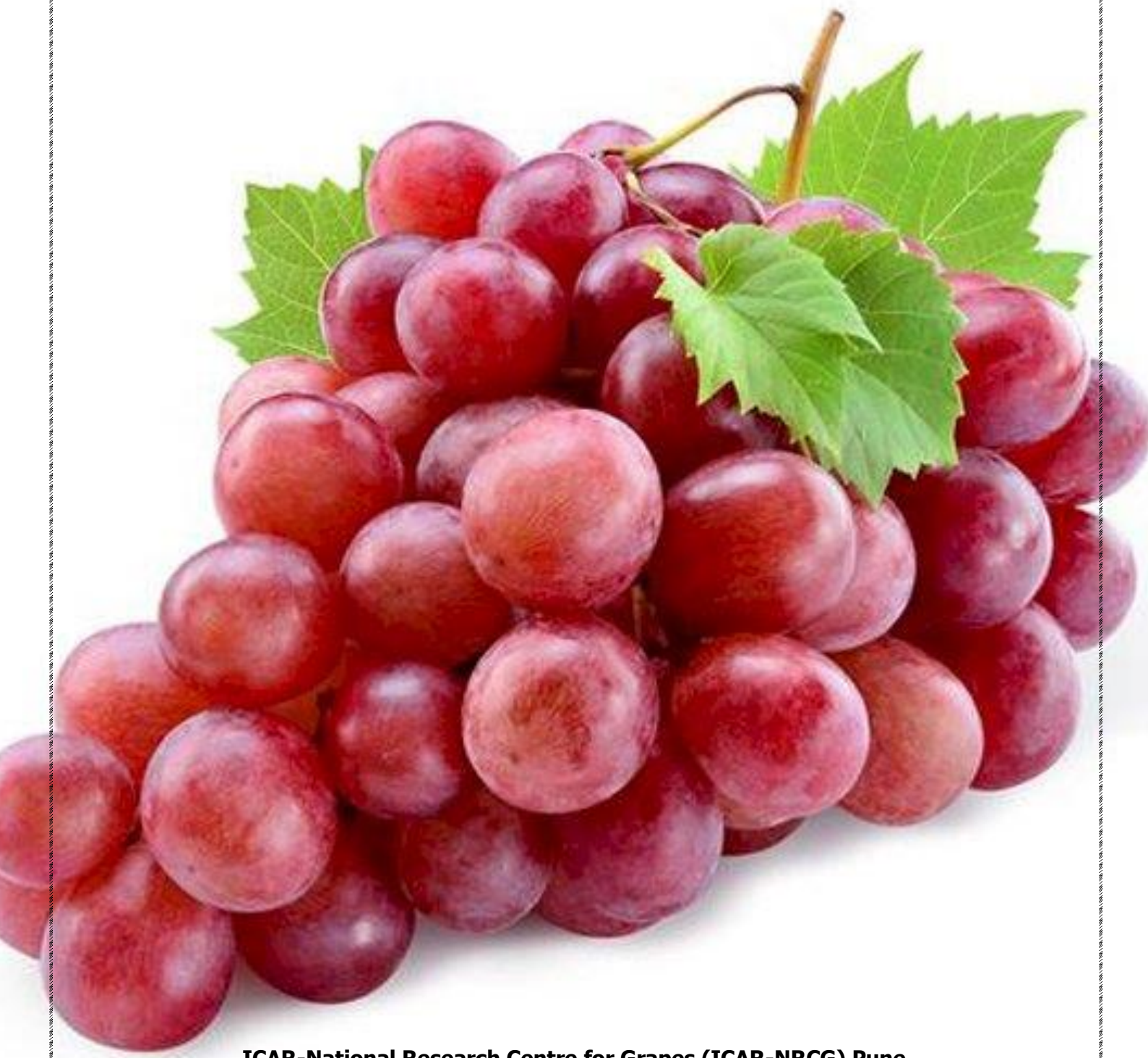
1. Anti-inflammatory action
2. Hormone regulation
3. Lipid peroxidation
4. Use to treat vision disorders
5. Antimicrobial
6. Remedy for liver dysfunction
7. Use to treat hypertension
8. Anticancer
9. Antioxidant
10. Cardiovascular health

solvent can be reused and the ion exchange raisins can be reused again and again. Purified anthocyanin extract was further freeze dried and lyophilized to get the powder.

The anthocyanin can be used for dietary supplement as general antioxidant after suitable formulations, as a natural dye/ food colorant or an active ingredient of cosmetic products.

Micro-encapsulated anthocyanins:

Anthocyanins are not essential nutrients, and no deficiency disorder has been associated with the lack of anthocyanin consumption. The value of anthocyanins and other dietary bioactive compounds could be their potential to promote health maintenance throughout the life span. Regular intake of colorful fruits and vegetables is an important component of a healthy lifestyle that can confer protection against chronic diseases. It is being proposed a daily requirement of 50-100 mg/day anthocyanin. That's why we have produced anthocyanin capsules. Pure anthocyanin was encapsulated in maltodextrin and gum Arabic mixture and citric acid to for a final formulation containing 10 or 20% of pure anthocyanin. Each capsule contains 50 or 100 mg anthocyanins.



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(An Autonomous Organization under the Ministry of Agriculture and Farmers Welfare, Govt. of India)